Electronic Supplementary Material (ESI) for Chemical Communications.

Chiral phosphoric acid-catalyzed enantioselective [5+1] cycloaddition reaction of *C,N*-cyclic azomethine imines with isocyanides

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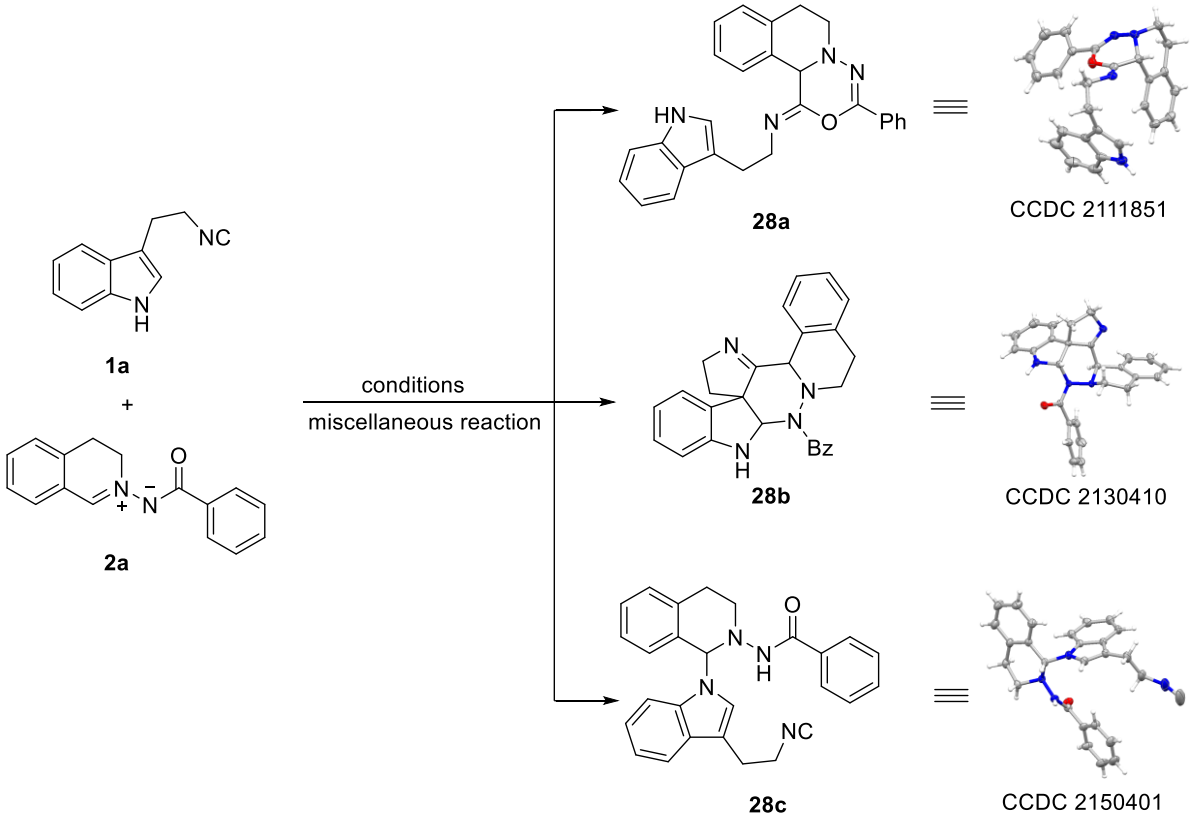
Contents

1. General Information

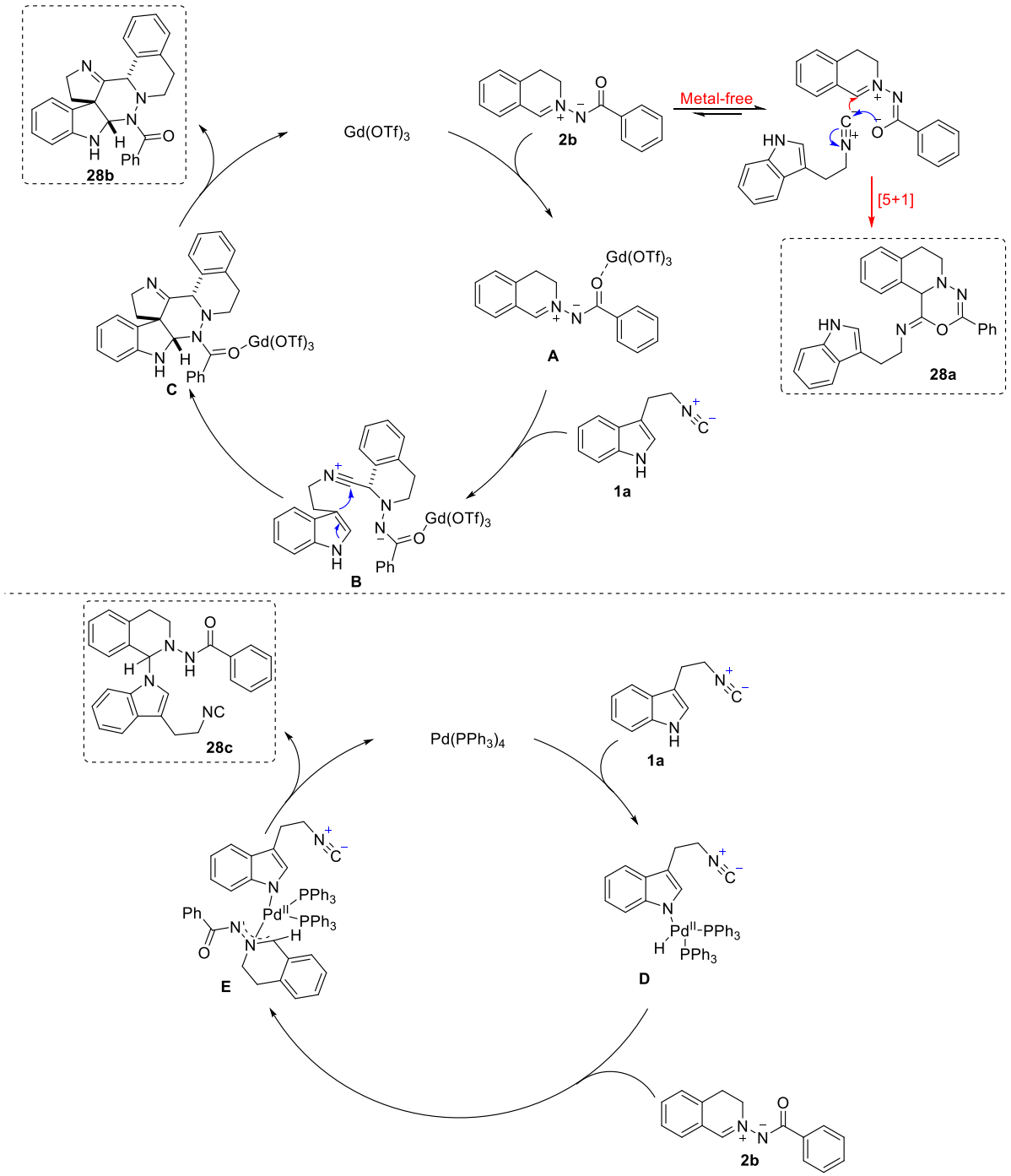
Reactions were carried out using commercial reagents in over-dried apparatus. Anhydrous solvents 1,4-dioxane and tetrahydrofuran as well as chiral phosphoric acids (CPA) were purchased from Adamas. ^{1}H NMR spectra were recorded on commercial instruments (400 MHz and 600 MHz). Chemical shifts are recorded in ppm relative to tetramethylsilane and with the solvent resonance as the internal standard ($CDCl_3$, δ = 7.26 ppm; DMSO-d_6, δ = 2.50 ppm). Spectra are reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, t = triplet, m = multiplet), coupling constants (Hz), integration and assignment. ^{13}C NMR data were collected on commercial instruments (101 MHz and 151 MHz) with complete proton decoupling. Chemical shifts are reported in ppm from the tetramethylsilane with the solvent resonance as internal standard ($CDCl_3$, δ= 77.0; DMSO-d_6, δ = 39.5 ppm). ^{19}F NMR data were collected on commercial instruments (376 MHz) with complete proton decoupling. Enantiomeric excesses (ee) were determined by chiral HPLC analysis using the corresponding commercial chiral column as stated in the experimental procedures at 27 °C with UV detector at 254 nm. Melting points (m. p.) were measured on the electrothermal digital melting point apparatus. HRMS was recorded on a commercial apparatus (ESI-TOF Source). All isocyanides **1**[1] and *C,N*-cyclic azomethine imines **2**[2] were prepared according to the literature.

2. Primary screening of the miscellaneous reactions of 3-(2-isocyanoethyl)indole and *C,N*-cyclic azomethine imine



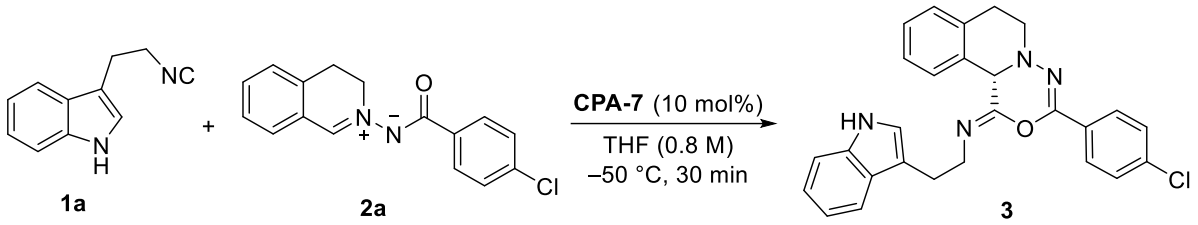
Entry	Conditions	Product (**28a**/**28b**/**28c**)
1	$Gd(OTf)_3$	**28a** and **28b**
2	Metal free	**28a**
3	$Pd(PPh_3)_4$	**28c**

In a continue of our recent work on the divergent synthesis of polycyclic spiroindolines via Lewis acid catalytic cascade reaction of 3-(2-isocyanoethyl)indole with *N,N*-cyclic azomethine imine (*Org. Lett.*, **2023**, *25*, 3829-3834), we then tried to apply 1,3-dipole *C,N*-cyclic azomethine imine to this cascade reaction. The primary results showed that miscellaneous active sites existed in the reaction system and several compounds containing both indoles and tetrahydroisoquinolines framework could be smoothly isolated. For example, the corresponding cascade reaction product **28b** and [5+1] cycloaddition product **28a** could be generated simultaneously with Lewis acid catalyst. When the reaction was performed without Lewis acid catalyst, only product **28a** could be obtained. Meanwhile, N1-alkylation reaction product **28c** could also be obtained in the presence of $Pd(PPh_3)_4$. The possible reaction mechanism was proposed.



The possible mechanism of generating products **28a**, **28b** and **28c**

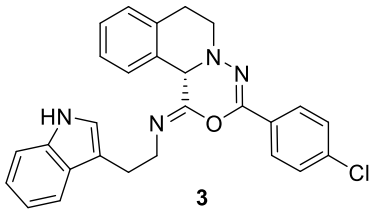
3. General Procedure and Spectral Data of Chiral Products



For chiral product: A dry reaction tube was charged with *C,N*-cyclic azomethine imine **2a** (0.3 mmol, 1.5 equiv.) and chiral phosphoric acid **CPA-7** (0.02 mmol, 10 mol%). Under N_2 atmosphere, dry THF (0.25 mL, 0.8 M) was added. The reaction mixture was cooled to −50 °C, isocyanide **1a** (0.2 mmol, 1.0 equiv.) was added under stirring and the reaction mixture continued stirring at -50 °C for 30 min. The residue was directly purified by flash chromatography on silica gel using petroleum ether/ethyl acetate = 3/1 as eluent. The chiral [5+1] cycloaddition product **3** was obtained in 71% yield (64.5 mg). The enantiomeric excess (89% ee) was determined by high performance liquid chromatography (HPLC) with Chiralcel IA.

For racemic product: A dry reaction tube was charged with isocyanide **1a** (0.2 mmol, 1.0 equiv.) and *C,N*-cyclic azomethine imine **2a** (0.3 mmol, 1.5 equiv.). Then dry 1,4-dioxane (1.0 mL, 0.2 M) was added. The reaction mixture was stirred at 35 °C for 2 h. The residue was directly purified by flash chromatography on silica gel using petroleum ether/ethyl acetate = 3/1 as eluent. The [5+1] cycloaddition product **3** was obtained in 97% yield (88.0 mg).

(*S*)-N-(2-(1H-indol-3-yl)ethyl)-3-(4-chlorophenyl)-7,11b-dihydro-[1,3,4]oxadiazino[5,4-a] isoquinolin-1(6H)-imine 3



The reaction was performed at −50 °C for 30 min, affording chiral product **3** in 71% yield (64.5 mg) as a white solid. R_f = 0.2 (PE:EA = 3:1), m.p. 74–75 °C.

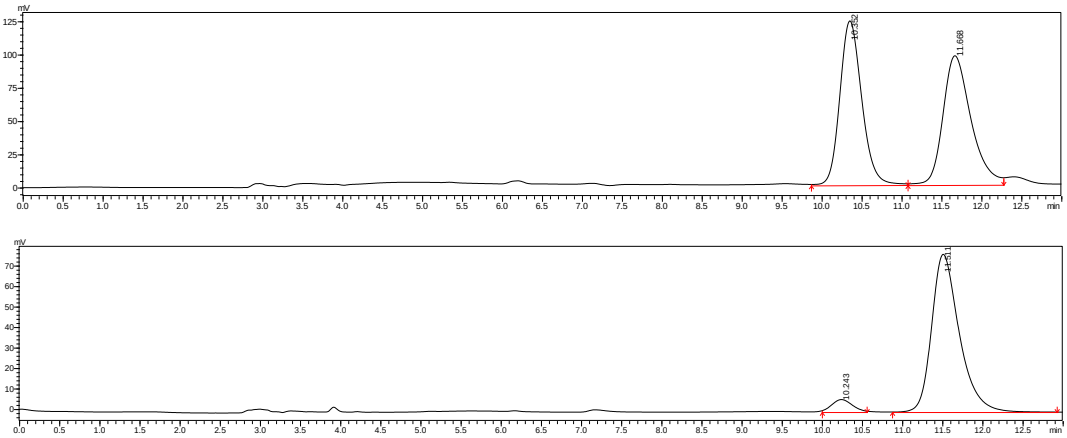
HPLC (Chiralcel IA, hexane/*i*PrOH = 85/15, flow rate 1.0 mL/min, λ = 254 nm), t_r (major) = 11.51 min, t_r (minor) = 10.24 min, *ee* = 89%. $[a]_D^{20}$ = 14.7 (c = 0.42 in EtOAc).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.09 (s, 1H), 7.73 (dd, *J* = 7.6, 1.2 Hz, 1H), 7.59 – 7.56 (m, 2H), 7.37 – 7.32 (m, 2H), 7.25 – 7.23 (m, 2H), 7.22 – 7.13 (m, 3H), 7.12 – 7.07 (m, 3H), 4.99

(s, 1H), 4.10 – 3.96 (m, 2H), 3.94 – 3.85 (m, 1H), 3.45 – 3.31 (m, 2H), 3.30 – 3.18 (m, 2H), 2.74 – 2.64 (m, 1H).

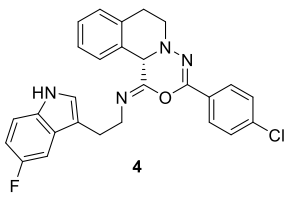
^{13}C NMR (101 MHz, $CDCl_3$) δ 147.1, 142.3, 136.3, 135.6, 134.4, 129.9, 129.2, 128.6, 128.4, 127.7, 127.6, 127.3, 126.5, 126.3, 122.0, 121.9, 119.3, 118.9, 114.4, 111.1, 58.2, 51.0, 46.8, 26.4, 25.9.

HRMS (ESI-TOF) calcd for $C_{27}H_{24}ClN_4O^+$ ([M+H$^+$]) = 455.1633, Found 455.1630.



	Retention Time	% Area
1	10.24	5.61
2	11.51	94.39

(*S*)-3-(4-chlorophenyl)-N-(2-(5-fluoro-1H-indol-3-yl)ethyl)-7,11b-dihydro-[1,3,4]oxadiazino[5,4-a]isoquinolin-1(6H)-imine 4



4

The reaction was performed at –50 °C for 30 min, affording chiral product **4** in 79% yield (74.9 mg) as a white solid. R_f = 0.3 (PE:EA = 3:1), m.p. 70–72 °C.

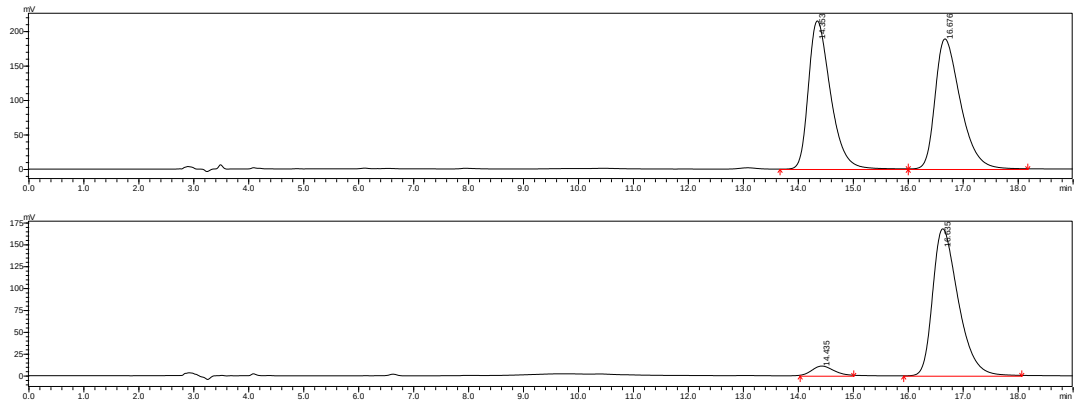
HPLC (Chiralcel IA, hexane/*i*PrOH = 90/10, flow rate 1.0 mL/min, λ = 254 nm), t_r (major) = 16.64 min, t_r (minor) = 14.44 min, *ee* = 89%, $[a]_D^{20}$ = 9.2 (c = 1.45 in DCM).

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.10 (s, 1H), 7.60 – 7.55 (m, 2H), 7.36 (dd, *J* = 9.6, 2.4 Hz, 1H), 7.29 – 7.27 (m, 1H), 7.26 – 7.20 (m, 3H), 7.19 – 7.16 (m, 1H), 7.14 (d, *J* = 2.4 Hz, 1H), 7.10 – 7.04 (m, 2H), 6.93 (td, *J* = 9.0, 2.4 Hz, 1H), 4.96 (s, 1H), 4.03 (dt, *J* = 13.2, 7.2 Hz, 1H), 3.96 (dt, *J* = 13.2, 7.2 Hz, 1H), 3.91 – 3.86 (m, 1H), 3.43 – 3.30 (m, 2H), 3.21 – 3.12 (m, 2H), 2.68 (dd, *J* = 16.2, 3.6 Hz, 1H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 157.8 (d, J = 235.6 Hz), 147.3, 142.2, 135.6, 134.5, 132.8, 129.9, 129.3, 128.6, 128.5, 128.0 (d, J = 10.6 Hz) 127.7, 127.3, 126.5, 126.3, 123.8, 114.6 (d, J = 4.5 Hz), 111.7 (d, J = 6.0 Hz), 110.4 (d, J = 27.2 Hz), 103.9 (d, J = 24.2 Hz), 58.2, 51.1, 46.6, 26.4, 25.9.

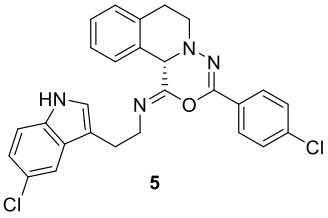
^{19}F NMR (376 MHz, $CDCl_3$) δ −124.75.

HRMS (ESI-TOF) calcd for $C_{27}H_{23}ClFN_4O^+$ ([M+H$^+$]) = 473.1539, Found 473.1539.



	Retention Time	% Area
1	14.44	5.44
2	16.64	94.56

(*S*)-N-(2-(5-chloro-1H-indol-3-yl)ethyl)-3-(4-chlorophenyl)-7,11b-dihydro-[1,3,4]oxadiazino[5,4-a]isoquinolin-1(6H)-imine 5



5

The reaction was performed at −50 °C for 30 min, affording chiral product **5** in 73% yield (71.2 mg) as a white solid. R_f = 0.3 (PE:EA= 3:1), m.p. 149–150 °C.

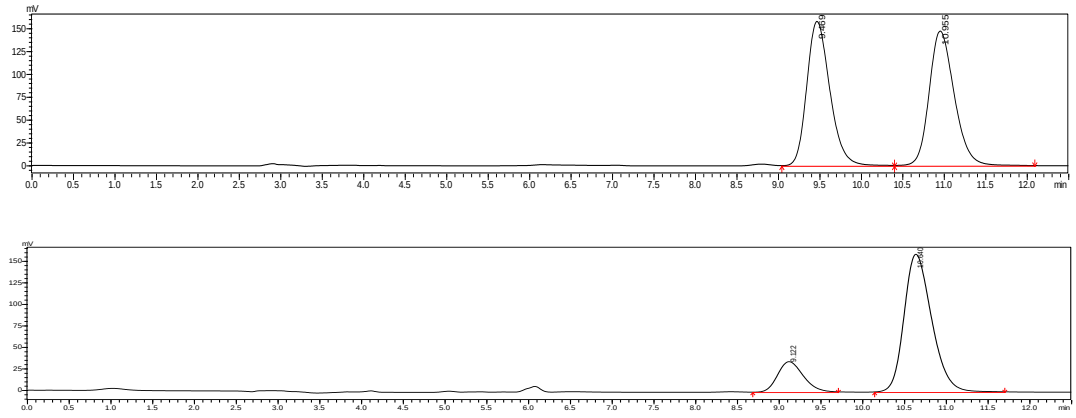
HPLC (Chiralcel IA, hexane/*i*PrOH = 85/15, flow rate 1.0 mL/min, λ = 254 nm), t_r (major) = 10.64 min, t_r (minor) = 9.12 min, *ee* = 66%, $[a]_D^{20}$ = 13.9 (c = 0.32 in EtOAc).

^{1}H NMR (400 MHz, DMSO-d_6) δ 11.07 (d, J = 2.5 Hz, 1H), 7.69 (d, J = 2.1 Hz, 1H), 7.56 (td, J = 5.8, 4.9, 2.3 Hz, 2H), 7.42 – 7.32 (m, 4H), 7.15 (dd, J = 8.1, 3.9 Hz, 1H), 7.06 (ddd, J = 16.6, 5.6, 4.0 Hz, 4H), 5.06 (s, 1H), 4.05 (ddd, J = 13.0, 8.3, 6.3 Hz, 1H), 3.83 (ddd, J = 11.1, 7.8, 5.6 Hz, 1H), 3.77 – 3.68 (m, 1H), 3.48 (td, J = 12.5, 4.6 Hz, 1H), 3.20 – 3.04 (m, 3H), 2.70 – 2.64 (m, 1H).

^{13}C NMR (101 MHz, DMSO-d_6) δ 146.51, 141.75, 135.22, 134.96, 134.80, 130.45, 129.58, 129.12, 128.90, 128.84, 127.91, 127.25, 126.87, 126.57, 125.48, 123.49, 121.27, 118.19,

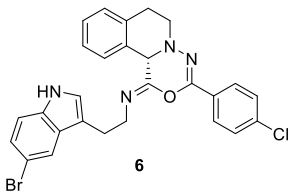
113.34, 112.98, 57.69, 50.49, 46.58, 26.28, 25.76.

HRMS (ESI-TOF) calcd for $C_{27}H_{23}Cl_2N_4O^+$ ([M+H$^+$]) = 489.1243, Found 489.1244.



	Retention Time	% Area
1	9.12	17.19
2	10.64	82.81

(*S*)-N-(2-(5-bromo-1H-indol-3-yl)ethyl)-3-(4-chlorophenyl)-7,11b-dihydro-[1,3,4]oxadiazino[5,4-a]isoquinolin-1(6H)-imine 6



6

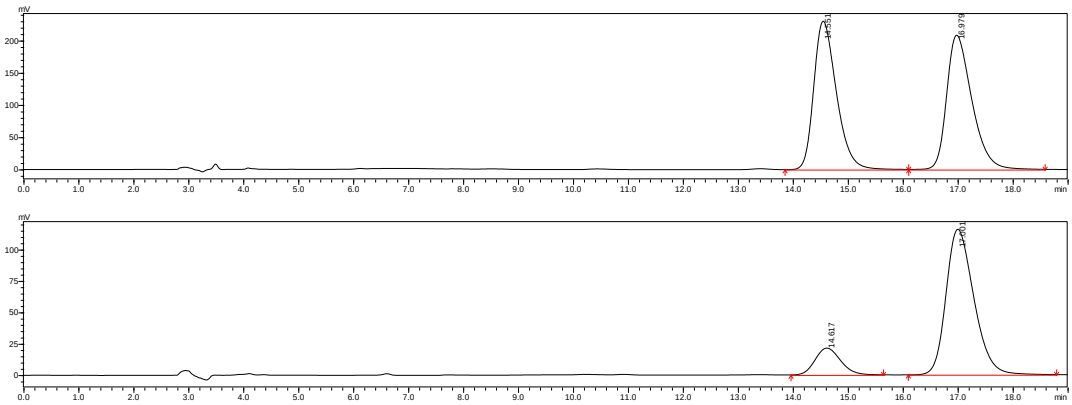
The reaction was performed at −50 °C for 30 min, affording chiral product **6** in 75% yield (79.7 mg) as a white solid. R_f = 0.3 (PE:EA = 3:1), m.p. 151−152 °C.

HPLC (Chiralcel IA, hexane/*i*PrOH = 90/10, flow rate 1.0 mL/min, λ = 254 nm), t_r (major) = 17.00 min, t_r (minor) = 14.62 min, *ee* = 71%, $[a]_D^{20}$ = 2.6 (c = 1.22 in DCM).

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.10 (s, 1H), 7.84 (d, *J* = 1.8 Hz, 1H), 7.56 – 7.53 (m, 2H), 7.27 – 7.26 (m, 2H), 7.25 – 7.23 (m, 2H), 7.20 – 7.15 (m, 2H), 7.11 – 7.04 (m, 3H), 4.95 (s, 1H), 4.03 – 3.93 (m, 2H), 3.88 (dd, *J* = 12.6, 6.0 Hz, 1H), 3.40 (td, *J* = 12.6, 4.2 Hz, 1H), 3.35 – 3.30 (m, 1H), 3.20 – 3.10 (m, 2H), 2.67 (dd, *J* = 16.2, 4.2 Hz, 1H).

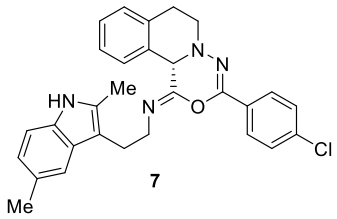
^{13}C NMR (151 MHz, $CDCl_3$) δ 147.3, 142.1, 135.5, 134.9, 134.4, 129.8, 129.3, 129.2, 128.5, 128.5, 127.7, 127.2, 126.4, 126.3, 124.8, 123.3, 121.5, 114.1, 112.6, 112.5, 58.1, 51.0, 46.6, 26.2, 25.9.

HRMS (ESI-TOF) calcd for $C_{27}H_{23}BrClN_4O^+$ ([M+H$^+$]) = 533.0739, Found 533.0738.



	Retention Time	% Area
1	14.62	14.50
2	17.00	85.50

(*S*)-3-(4-chlorophenyl)-N-(2-(2,5-dimethyl-1H-indol-3-yl)ethyl)-7,11b-dihydro-[1,3,4]oxadiazino[5,4-a]isoquinolin-1(6H)-imine 7



7

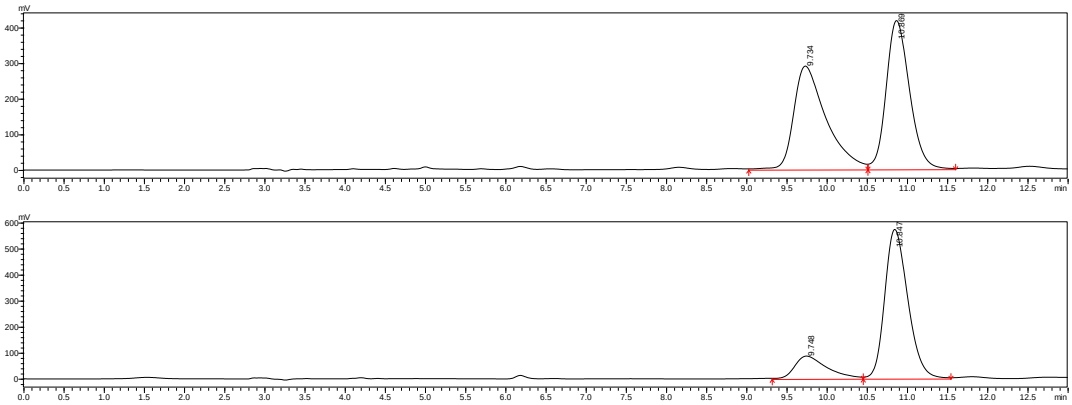
The reaction was performed at –50 °C for 30 min, affording chiral product **7** in 49% yield (47.0 mg) as a white solid. R_f = 0.3 (PE:EA = 3:1), m.p. 50–52 °C.

HPLC (Chiralcel IA, hexane/*i*PrOH = 90/10, flow rate 1.0 mL/min, λ = 254 nm), t_r (major) = 10.85 min, t_r (minor) = 9.75 min, *ee* = 64%, $[a]_D^{20}$ = 3.9 (c = 0.66 in DCM).

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.67 (s, 1H), 7.58 – 7.53 (m, 2H), 7.40 – 7.36 (m, 1H), 7.35 (dt, *J* = 7.8, 1.2 Hz, 1H), 7.25 – 7.20 (m, 2H), 7.18 (dt, *J* = 7.2, 1.2 Hz, 1H), 7.14 – 7.11 (m, 2H), 7.08 (dd, *J* = 7.8, 1.2 Hz, 1H), 6.92 (dd, *J* = 8.2, 1.6 Hz, 1H), 4.95 (s, 1H), 3.95 – 3.87 (m, 3H), 3.45 – 3.30 (m, 2H), 3.17 – 3.04 (m, 2H), 2.69 (dd, *J* = 16.8, 4.2 Hz, 1H), 2.43 (s, 3H), 2.42 (s, 3H).

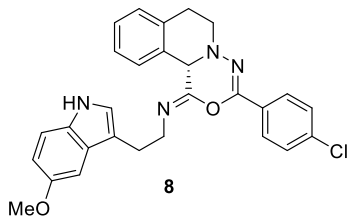
^{13}C NMR (151 MHz, $CDCl_3$) δ 147.0, 142.4, 135.5, 134.5, 133.6, 131.8, 130.0, 129.2, 129.0, 128.7, 128.4, 128.4, 127.7, 127.4, 126.6, 126.4, 122.5, 117.8, 109.9, 109.3, 58.3, 51.1, 46.9, 26.0, 25.5, 21.6, 11.8.

HRMS (ESI-TOF) calcd for $C_{29}H_{28}ClN_4O^+$ ([M+H$^+$]) = 483.1947, Found 483.1946.



	Retention Time	% Area
1	9.75	17.66
2	10.85	82.34

(*S*)-N-(2-(5-methoxy-1H-indol-3-yl)ethyl)-3-(4-chlorophenyl)-7,11b-dihydro-[1,3,4]oxadiazino[5,4-a]isoquinolin-1(6H)-imine 8



8

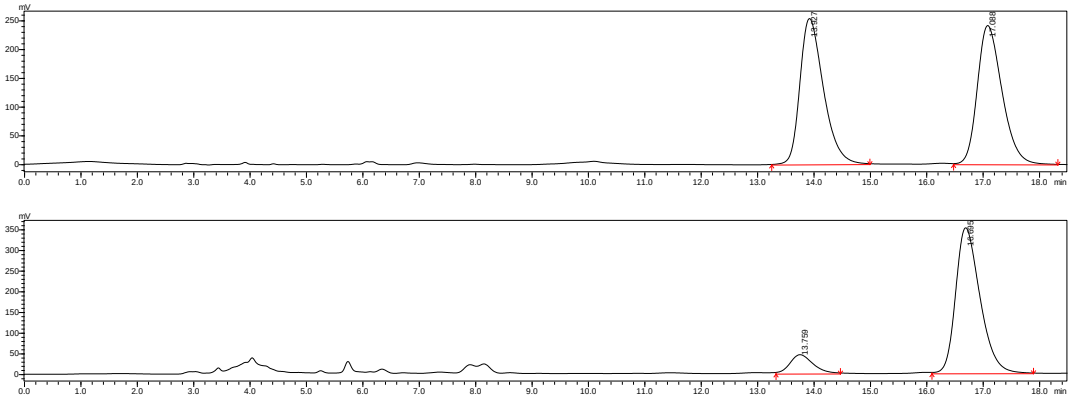
The reaction was performed at -50 °C for 30 min, affording chiral product **8** in 62% yield (59.9 mg) as a white solid. R_f = 0.2 (PE:EA= 3:1), m.p. 71–73 °C.

HPLC (Chiralcel IA, hexane/*i*PrOH = 85/15, flow rate 1.0 mL/min, λ = 254 nm), t_r (major) = 16.70 min, t_r (minor) = 13.76 min, *ee* = 78%, $[a]_D^{20}$ = –41.1 (c = 0.15 in EtOAc).

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.84 (s, 1H), 7.47 (d, *J* = 8.3 Hz, 2H), 7.21 (d, *J* = 7.7 Hz, 1H), 7.17 – 7.10 (m, 3H), 7.10 – 7.02 (m, 2H), 7.01 – 6.93 (m, 3H), 6.76 (dd, *J* = 8.9, 2.4 Hz, 1H), 4.87 (s, 1H), 3.93 (dt, *J* = 12.5, 7.5 Hz, 1H), 3.87 (dt, *J* = 13.3, 7.3 Hz, 1H), 3.78 (dd, *J* = 12.7, 5.7 Hz, 1H), 3.75 (s, 3H), 3.27 (dtt, *J* = 28.9, 12.4, 5.2 Hz, 2H), 3.09 (dq, *J* = 19.4, 7.2 Hz, 2H), 2.58 (dd, *J* = 16.3, 3.9 Hz, 1H).

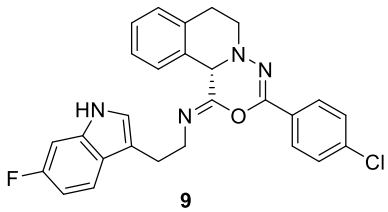
^{13}C NMR (151 MHz, $CDCl_3$) δ 154.1, 147.2, 142.3, 135.6, 134.5, 131.5, 130.0, 129.2, 128.9, 128.5, 128.0, 127.7, 127.4, 126.6, 126.4, 122.8, 114.1, 112.2, 111.9, 100.9, 58.2, 56.0, 51.1, 46.7, 26.5, 25.9.

HRMS (ESI-TOF) calcd for $C_{28}H_{26}ClN_4O_2^+$ ([M+H$^+$]) = 485.1739, Found 485.1739.



	Retention Time	% Area
1	13.76	11.21
2	16.70	88.79

(*S*)-3-(4-chlorophenyl)-N-(2-(6-fluoro-1H-indol-3-yl)ethyl)-7,11b-dihydro-[1,3,4]oxadiazino[5,4-a]isoquinolin-1(6H)-imine 9



9

The reaction was performed at –50 °C for 30 min, affording chiral product **9** in 73% yield (68.4 mg) as a white solid. R_f = 0.2 (PE:EA = 4:1), m.p. 80–81 °C.

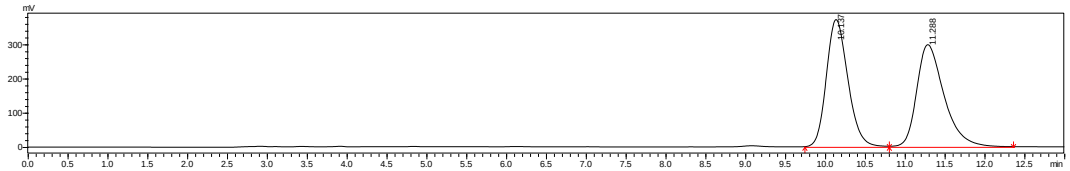
HPLC (Chiralcel IA, hexane/*i*PrOH = 85/15, flow rate 1.0 mL/min, λ = 254 nm), t_r (major) = 11.34 min, t_r (minor) = 10.23 min, *ee* = 91%, $[a]_D^{20}$ = –20.9 (c = 0.62 in EtOAc).

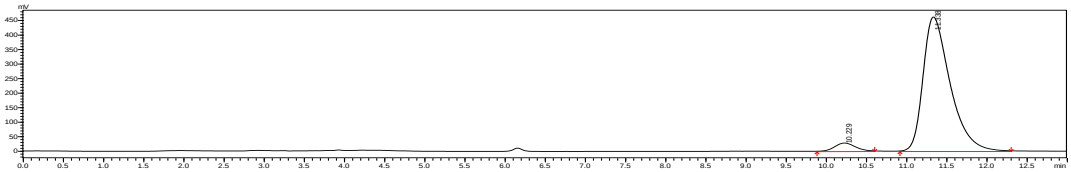
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.06 (s, 1H), 7.64 – 7.52 (m, 3H), 7.29 – 7.23 (m, 3H), 7.18 (tt, *J* = 7.6, 1.1 Hz, 1H), 7.10 – 7.04 (m, 3H), 7.01 (dd, *J* = 9.7, 2.3 Hz, 1H), 6.92-6.87 (m, 1H), 4.97 (s, 1H), 3.99 (qt, *J* = 12.9, 7.2 Hz, 2H), 3.92 – 3.84 (m, 1H), 3.47 – 3.29 (m, 2H), 3.19 (q, *J* = 7.6 Hz, 2H), 2.68 (dd, *J* = 15.9, 3.4 Hz, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 160.0 (d, *J* = 238.4 Hz), 147.3, 142.2, 136.2 (d, *J* = 12.1 Hz), 135.6, 134.4, 129.8, 129.2, 128.6, 128.4, 127.7, 127.2, 126.5, 126.3, 124.2, 122.1 (d, *J* = 3.0 Hz), 119.6 (d, *J* = 10.1 Hz), 114.5, 108.0 (d, *J* = 25.3 Hz), 97.4 (d, *J* = 26.3 Hz), 58.1, 51.0, 46.6, 26.3, 25.8.

^{19}F NMR (376 MHz, $CDCl_3$) δ –121.36.

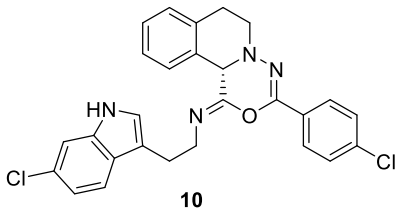
HRMS (ESI-TOF) calcd for $C_{27}H_{23}ClFN_4O^+$ ($[M+H^+]$) = 473.1539, Found 473.1537.





	Retention Time	% Area
1	10.23	4.55
2	11.34	95.45

(*S*)-N-(2-(6-chloro-1H-indol-3-yl)ethyl)-3-(4-chlorophenyl)-7,11b-dihydro-[1,3,4]oxadiazino[5,4-a]isoquinolin-1(6H)-imine 10



10

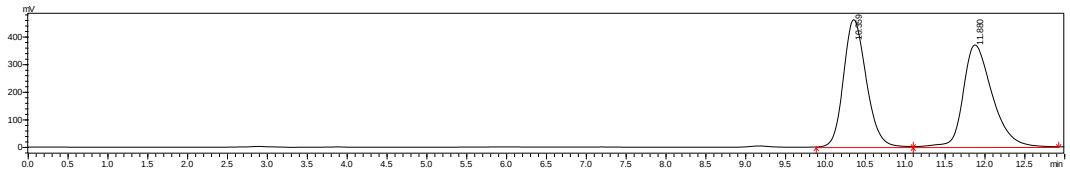
The reaction was performed at −50 °C for 30 min, affording chiral product **10** in 89% yield (86.5 mg) as a white solid. R_f = 0.2 (PE:EA= 4:1), m.p. 83–84 °C.

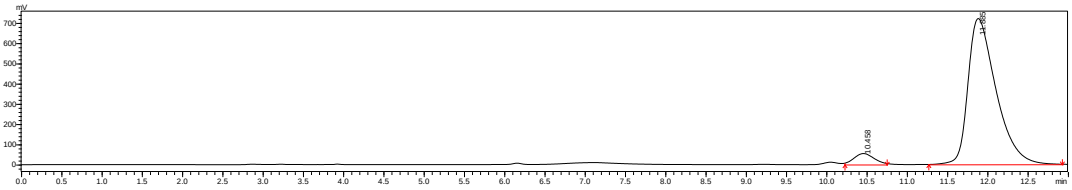
HPLC (Chiralcel IA, hexane/*i*PrOH = 85/15, flow rate 1.0 mL/min, λ = 254 nm), t_r (major) = 11.89 min, t_r (minor) = 10.46 min, *ee* =90%, $[a]_D^{20}$ = –10.1 (c = 0.32 in EtOAc).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.10 (s, 1H), 7.60 (d, *J* = 8.5 Hz, 1H), 7.55 – 7.50 (m, 2H), 7.30 – 7.22 (m, 4H), 7.19 – 7.15 (m, 1H), 7.11 – 7.05 (m, 4H), 4.96 (s, 1H), 4.05 – 3.93 (m, 2H), 3.92 – 3.85 (m, 1H), 3.44 – 3.29 (m, 2H), 3.24 – 3.13 (m, 2H), 2.67 (dd, *J* = 15.6, 3.3 Hz, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 147.3, 142.2, 136.6, 135.6, 134.4, 129.8, 129.2, 128.5, 128.4, 127.9, 127.7, 127.2, 126.4, 126.3, 126.2, 122.6, 120.0, 119.8, 114.6, 111.0, 58.1, 51.0, 46.6, 26.2, 25.9.

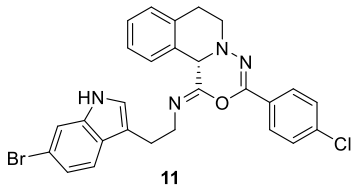
HRMS (ESI-TOF) calcd for $C_{27}H_{23}Cl_2N_4O^+$ ([M+H$^+$]) = 489.1243, Found 489.1241.





	Retention Time	% Area
1	10.46	5.17
2	11.89	94.83

(*S*)-N-(2-(6-bromo-1H-indol-3-yl)ethyl)-3-(4-chlorophenyl)-7,11b-dihydro-[1,3,4]oxadiazino[5,4-a]isoquinolin-1(6H)-imine 11



11

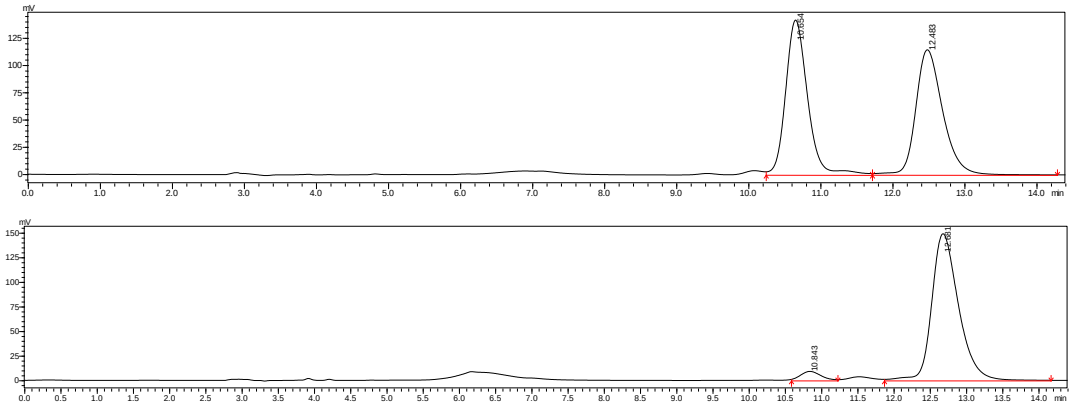
The reaction was performed at −50 °C for 30.min, affording chiral product **11** in 76% yield (81.1mg) as a white solid. R_f = 0.2 (PE:EA = 4:1), m.p. 145–146 °C.

HPLC (Chiralcel IA, hexane/*i*PrOH = 85/15, flow rate 1.0 mL/min, λ = 254 nm), t_r (major) = 12.68 min, t_r (minor) = 10.84 min, *ee* = 91%, $[a]_D^{20}$ = 8.9 (c = 1.0 in EtOAc).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.02 (s, 1H), 7.58 – 7.44 (m, 4H), 7.27 – 7.21 (m, 4H), 7.19 – 7.14 (m, 1H), 7.07 (dt, *J* = 8.0, 1.7 Hz, 3H), 4.96 (s, 1H), 3.97 (q, *J* = 7.1 Hz, 2H), 3.91 – 3.83 (m, 1H), 3.44 – 3.28 (m, 2H), 3.24 – 3.10 (m, 2H), 2.67 (dd, *J* = 16.2, 3.5 Hz, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 147.4, 142.1, 137.1, 135.7, 134.4, 129.8, 129.2, 128.5, 128.4, 127.7, 127.3, 126.5, 126.4, 126.3, 122.6, 122.5, 120.2, 115.6, 114.7, 114.0, 58.1, 51.0, 46.6, 26.2, 25.9.

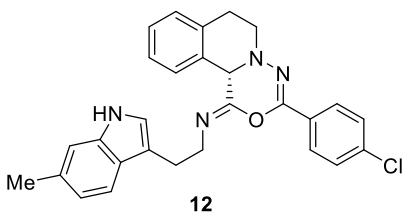
HRMS (ESI-TOF) calcd for $C_{27}H_{23}BrClN_4O^+$ ([M+H$^+$]) = 533.0738, Found 533.0732.



	Retention Time	% Area

1	10.84	4.52
2	12.68	95.48

(*S*)-3-(4-chlorophenyl)-N-(2-(6-methyl-1H-indol-3-yl)ethyl)-7,11b-dihydro-[1,3,4]oxadiazino[5,4-a]isoquinolin-1(6H)-imine 12



12

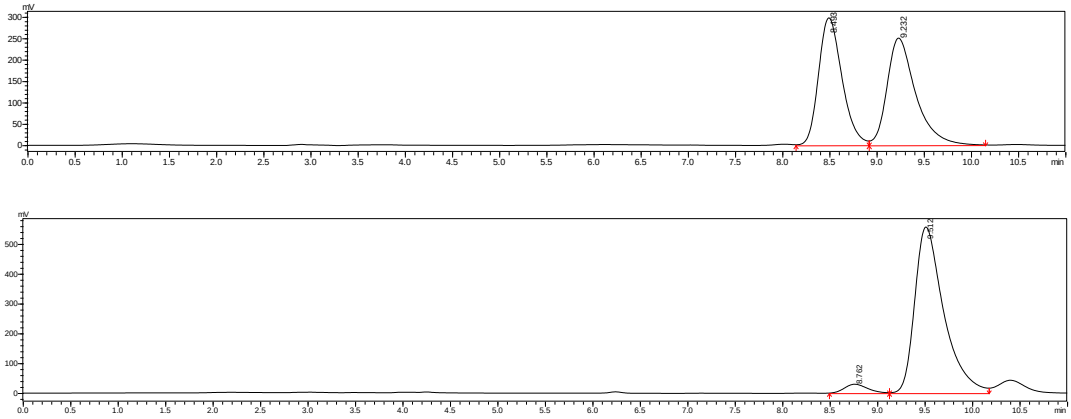
The reaction was performed at –50 °C for 30 min, affording product **12** in 78% yield (73.3 mg) as a white solid. R_f = 0.2 (PE:EA= 4:1), m.p. 65–67 °C.

HPLC (Chiralcel IA, hexane/*i*PrOH = 85/15, flow rate 1.0 mL/min, λ = 254 nm), t_r (major) = 9.51 min, t_r (minor) = 8.76 min, *ee* = 92%, $[a]_D^{20}$ = –51.8 (c = 0.38 in EtOAc).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.98 (s, 1H), 7.61 – 7.54 (m, 3H), 7.37 – 7.33 (m, 1H), 7.26 – 7.17 (m, 3H), 7.14 – 7.06 (m, 4H), 7.04 – 7.00 (m, 1H), 5.00 (s, 1H), 4.12 – 3.95 (m, 2H), 3.94 – 3.88 (m, 1H), 3.46 – 3.31 (m, 2H), 3.29 – 3.18 (m, 2H), 2.73 – 2.66 (m, 1H), 2.47 (s, 3H).

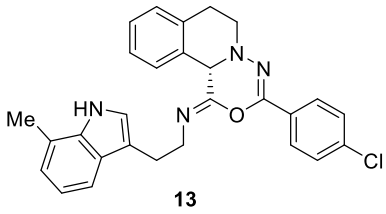
^{13}C NMR (101 MHz, $CDCl_3$) δ 147.1, 142.2, 135.9, 135.5, 134.4, 129.9, 129.2, 128.6, 128.4, 127.6, 127.3, 127.1, 126.5, 126.3, 122.5, 121.6, 120.3, 119.5, 116.6, 114.9, 58.2, 51.0, 46.9, 26.6, 25.9, 16.5.

HRMS (ESI-TOF) calcd for $C_{28}H_{26}ClN_4O^+$ ([M+H$^+$]) = 469.1790, Found 469.1791.



	Retention Time	% Area
1	8.76	4.23
2	9.51	95.77

(*S*)-3-(4-chlorophenyl)-N-(2-(7-methyl-1H-indol-3-yl)ethyl)-7,11b-dihydro-[1,3,4]oxadiazino[5,4-a]isoquinolin-1(6H)-imine 13



13

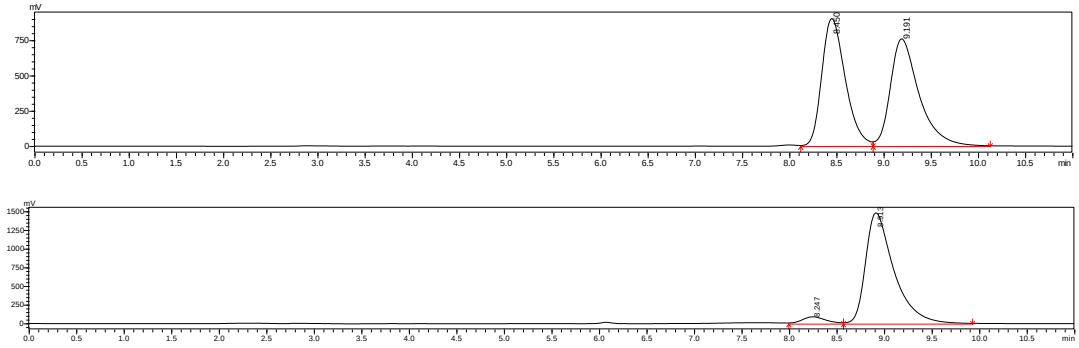
The reaction was performed at –50 °C for 30 min, affording product **13** in 72% yield (67.7mg) as a white solid. R_f = 0.1 (PE:EA= 4:1), m.p. 91–92 °C.

HPLC (Chiralcel IA, hexane/*i*PrOH = 85/15, flow rate 1.0 mL/min, λ = 254 nm), t_r (major) = 8.91 min, t_r (minor) = 8.25 min, *ee* = 90%, $[a]_D^{20}$ = –55.2 (c = 0.16 in EtOAc).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 (s, 1H), 7.62 – 7.50 (m, 3H), 7.33 (dt, *J* = 8.0, 1.1 Hz, 1H), 7.25 – 7.20 (m, 2H), 7.17 (dt, *J* = 7.7, 1.1 Hz, 1H), 7.14 – 7.04 (m, 4H), 7.01 (dt, *J* = 7.0, 1.1 Hz, 1H), 4.99 (s, 1H), 4.08 – 3.94 (m, 2H), 3.92 – 3.85 (m, 1H), 3.47 – 3.30 (m, 2H), 3.27 – 3.15 (m, 2H), 2.68 (dd, *J* = 16.0, 3.6 Hz, 1H), 2.47 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 147.2, 142.2, 135.9, 135.5, 134.4, 129.9, 129.2, 128.6, 128.4, 127.7, 127.3, 127.1, 126.5, 126.3, 122.6, 121.6, 120.3, 119.6, 116.6, 114.9, 58.1, 51.0, 46.9, 26.6, 25.9, 16.6.

HRMS (ESI-TOF) calcd for $C_{28}H_{26}ClN_4O^+$ ([M+H$^+$]) = 469.1790, Found 469.1792.

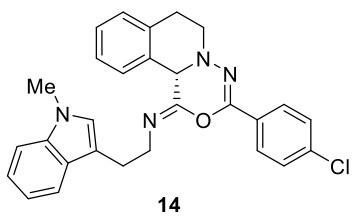


	Retention Time	% Area
1	8.25	5.03
2	8.91	94.97

(*S*)-3-(4-chlorophenyl)-N-(2-(1-methyl-1H-indol-3-yl)ethyl)-7,11b-dihydro-[1,3,4]oxadiazino[5,4-a]isoquinolin-1(6H)-imine 14

The reaction was performed at –50 °C for 30 min, affording chiral product **14** in 82% yield (76.9 mg) as a white solid. R_f = 0.3 (PE:EA= 4:1), m.p. 69–71 °C.

HPLC (Chiralcel IA, hexane/*i*PrOH = 85/15, flow rate 1.0 mL/min, λ = 254 nm), t_r (major) = 7.15 min, t_r (minor) = 10.52 min, *ee* = 71%, $[a]_D^{20}$ = –28.0 (c = 0.19 in EtOAc).

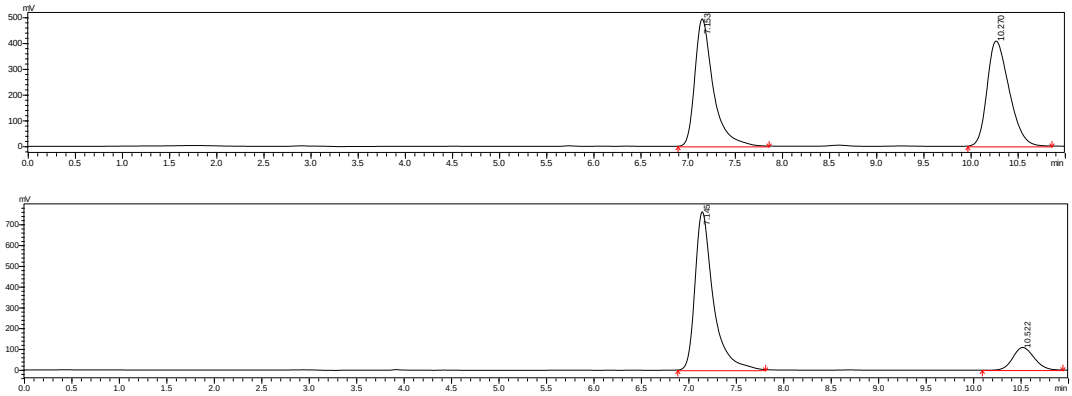


14

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.72 (dt, *J* = 7.8, 1.0 Hz, 1H), 7.60 – 7.56 (m, 2H), 7.34 (d, *J* = 7.8 Hz, 1H), 7.31 – 7.23 (m, 4H), 7.22 – 7.14 (m, 2H), 7.10 (t, *J* = 8.0 Hz, 2H), 6.99 (s, 1H), 5.00 (s, 1H), 4.08 – 3.88 (m, 3H), 3.76 (s, 3H), 3.48 – 3.33 (m, 2H), 3.23 (q, *J* = 7.4 Hz, 2H), 2.70 (dd, *J* = 16.3, 3.5 Hz, 1H).

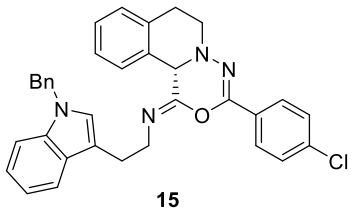
^{13}C NMR (101 MHz, $CDCl_3$) δ 147.1, 142.2, 137.0, 135.5, 134.4, 130.0, 129.2, 128.6, 128.4, 127.9, 127.7, 127.4, 126.8, 126.5, 126.3, 121.6, 119.0, 118.7, 112.8, 109.2, 58.2, 51.0, 47.0, 32.6, 26.4, 25.9.

HRMS (ESI-TOF) calcd for $C_{28}H_{26}ClN_4O^+$ ([M+H$^+$]) = 469.1790, Found 469.1792.



	Retention Time	% Area
1	7.15	85.60
2	10.52	14.40

(*S*)-3-(4-chlorophenyl)-N-(2-(1-methyl-1H-indol-3-yl)ethyl)-7,11b-dihydro-[1,3,4]oxadiazino[5,4-a]isoquinolin-1(6H)-imine 15



15

The reaction was performed at −50 °C for 30 min, affording product **15** in 67% yield (72.4 mg) as a white solid. R_f = 0.3 (PE:EA= 4:1), m.p. 48–50 °C.

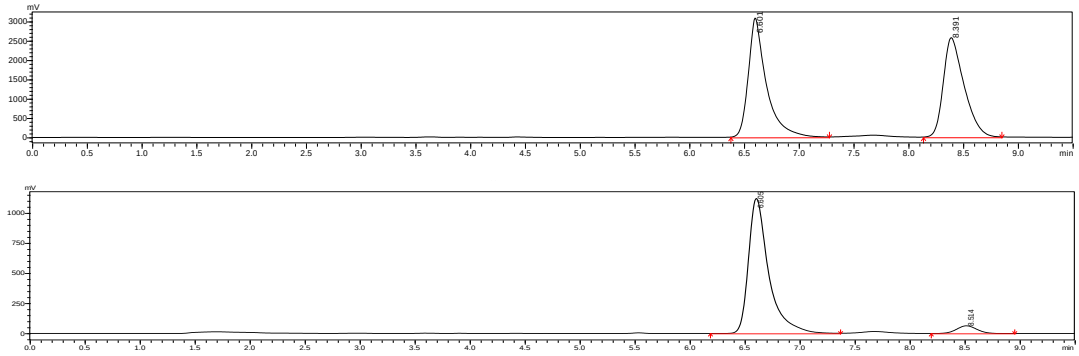
HPLC (Chiralcel IA, hexane/*i*PrOH = 70/30, flow rate 1.0 mL/min, λ = 254 nm), t_r (major) = 6.61 min, t_r (minor) = 8.51 min, *ee* = 89%, $[a]_D^{20}$ = –39.6 (c = 0.22 in EtOAc).

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.76 (d, *J* = 7.7 Hz, 1H), 7.54 (d, *J* = 8.4 Hz, 2H), 7.36 (d, *J* = 7.8 Hz, 1H), 7.31 – 7.20 (m, 7H), 7.18 (q, *J* = 7.5 Hz, 2H), 7.12 – 7.03 (m, 5H), 5.28 (s, 2H), 4.96 (s, 1H), 4.03 (dtd, *J* = 27.0, 12.9, 7.2 Hz, 2H), 3.95 – 3.85 (m, 1H), 3.40 (dtd, *J* = 33.6,

12.5, 5.0 Hz, 2H), 3.33 – 3.16 (m, 2H), 2.71 (dd, *J* = 16.3, 3.6 Hz, 1H).

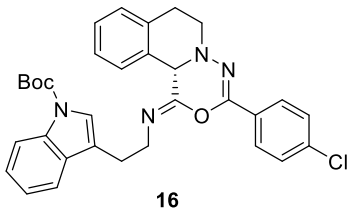
^{13}C NMR (151 MHz, $CDCl_3$) δ 147.2, 142.3, 137.6, 136.7, 135.5, 134.4, 130.6, 130.0, 129.2, 128.7, 128.7, 128.4, 128.3, 127.7, 127.5, 126.8, 126.5, 126.3, 126.2, 121.8, 119.1, 119.1, 113.6, 109.7, 58.2, 51.1, 49.9, 47.0, 26.4, 26.0.

HRMS (ESI-TOF) calcd for $C_{34}H_{30}ClN_4O^+$ ([M+H$^+$]) = 545.2103, Found 545.2094.



	Retention Time	% Area
1	6.61	94.46
2	8.51	5.54

Tetra-butyl (*S*)-3-(2-((3-(4-chlorophenyl)-7,11b-dihydro-[1,3,4]oxadiazino[5,4-a]isoquinolin-1(6H)-ylidene)amino)ethyl)-1H-indole-1-carboxylate 16



16

The reaction was performed at –50 °C for 30 min, affording product **16** in 89% yield (98.3mg) as a white solid. R_f = 0.4 (PE:EA= 4:1), m.p. 76–77 °C.

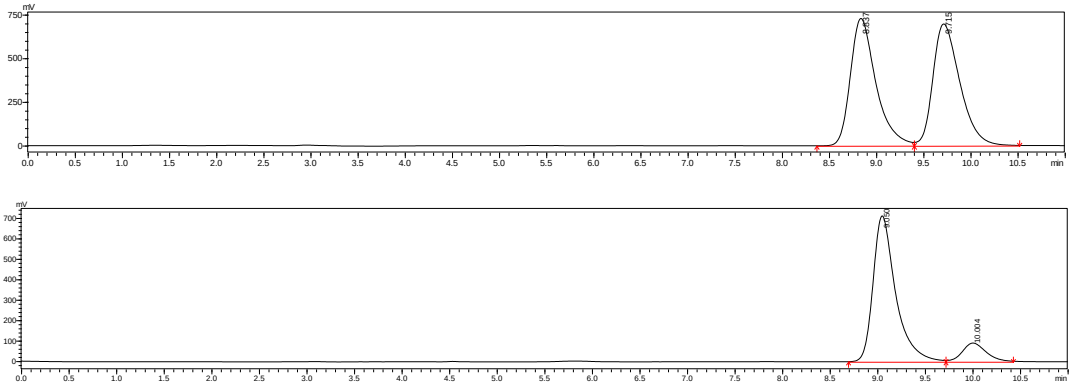
HPLC (Chiralcel IA, hexane/*i*PrOH = 95/5, flow rate 1.0 mL/min, λ = 254 nm), t_r (major) = 9.05 min, t_r (minor) = 10.00 min, *ee* = 76%, $[a]_D^{20}$ = –8.3 (c = 0.72 in EtOAc).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.13 (d, *J* = 8.1 Hz, 1H), 7.66 – 7.62 (m, 1H), 7.60 – 7.56 (m, 2H), 7.52 (s, 1H), 7.35 – 7.26 (m, 3H), 7.24 (d, *J* = 6.6 Hz, 2H), 7.20 – 7.15 (m, 1H), 7.11 – 7.05 (m, 2H), 4.96 (s, 1H), 4.06 (dt, *J* = 13.1, 7.4 Hz, 1H), 4.00 – 3.93 (m, 1H), 3.92 – 3.84 (m, 1H), 3.46 – 3.30 (m, 2H), 3.21 – 3.10 (m, 2H), 2.68 (dd, *J* = 16.2, 3.5 Hz, 1H), 1.65 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 149.8, 147.5, 142.1, 135.6, 134.4, 130.6, 129.8, 129.2, 128.6, 128.4, 127.7, 127.3, 126.5, 126.4, 124.3, 123.1, 122.4, 119.0, 118.9, 115.3, 83.4, 58.2, 51.0,

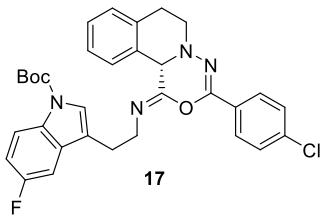
45.9, 28.2, 26.2, 25.9.

HRMS (ESI-TOF) calcd for $C_{32}H_{32}ClN_4O_3^+$ ([M+H$^+$]) = 555.2157, Found 555.2159.



	Retention Time	% Area
1	9.05	87.95
2	10.00	12.05

tert-butyl (*S*)-3-(2-((3-(4-chlorophenyl)-7,11b-dihydro-[1,3,4]oxadiazino[5,4-a]isoquinolin-1(6H)-ylidene)amino)ethyl)-5-fluoro-1H-indole-1-carboxylate 17



17

The reaction was performed at –50 °C for 30 min, affording chiral product **17** in 73% yield (83.3 mg) as a white solid. R_f = 0.2 (PE:EA = 8:1), m.p. 81–83 °C.

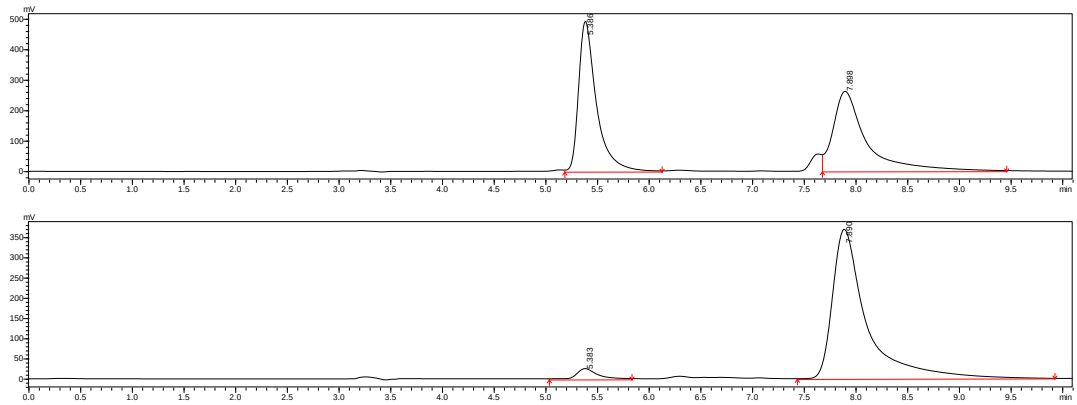
HPLC (Chiralcel IC, hexane/*i*PrOH = 90/10, flow rate 1.0 mL/min, λ = 254 nm), t_r (major) = 7.89 min, t_r (minor) = 5.38 min, *ee* = 91%, $[a]_D^{20}$ = 0.9 (c = 1.53 in DCM).

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.05 (s, 1H), 7.62 – 7.50 (m, 3H), 7.29 (dd, *J* = 9.0, 2.4 Hz, 1H), 7.27 (s, 1H), 7.26 – 7.23 (m, 2H), 7.17 (tt, *J* = 7.2, 1.2 Hz, 1H), 7.12 – 7.05 (m, 2H), 7.02 (td, *J* = 9.0, 2.4 Hz, 1H), 4.95 (s, 1H), 4.04 (dt, *J* = 13.2, 7.2 Hz, 1H), 3.97 – 3.86 (m, 2H), 3.44 – 3.30 (m, 2H), 3.15 – 3.05 (m, 2H), 2.68 (dd, *J* = 16.2, 3.6 Hz, 1H), 1.65 (s, 9H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 159.2 (d, *J* = 238.6 Hz), 149.5, 147.5, 142.0, 135.6, 134.4, 131.7 (d, *J* = 43.8 Hz), 129.7, 129.2, 128.5, 128.4, 127.7, 127.2, 126.7, 126.4, 126.3, 124.7, 118.7 (d, *J* = 30.2 Hz), 116.2 (d, *J* = 9.1 Hz), 112.0 (d, *J* = 24.2 Hz), 104.6 (d, *J* = 24.2 Hz), 83.6, 58.2, 51.0, 45.6, 28.1, 26.1, 25.9.

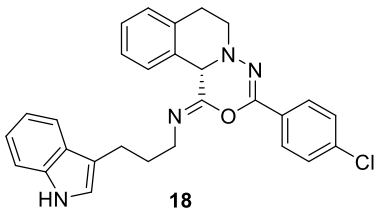
^{19}F NMR (376 MHz, $CDCl_3$) δ –120.89.

HRMS (ESI-TOF) calcd for $C_{32}H_{31}ClN_4O_3^+$ ([M+H$^+$]) = 573.2064, Found 573.2063.



	Retention Time	% Area
1	5.38	4.57
2	7.89	95.43

(*S*)-N-(3-(1H-indol-3-yl)propyl)-3-(4-chlorophenyl)-7,11b-dihydro-[1,3,4]oxadiazino[5,4-a]isoquinolin-1(6H)-imine 18



18

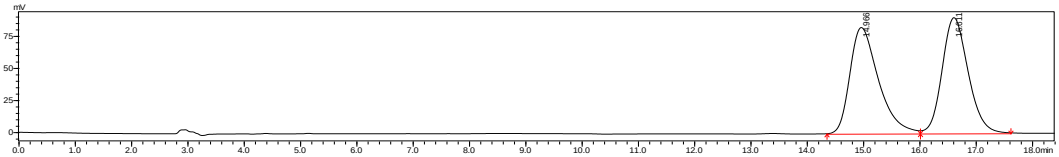
The reaction was performed at –50 °C for 30 min, affording product **18** in 90% yield (83.8 mg) as a white solid. R_f = 0.2 (PE:EA = 4:1), m.p. 67–68 °C.

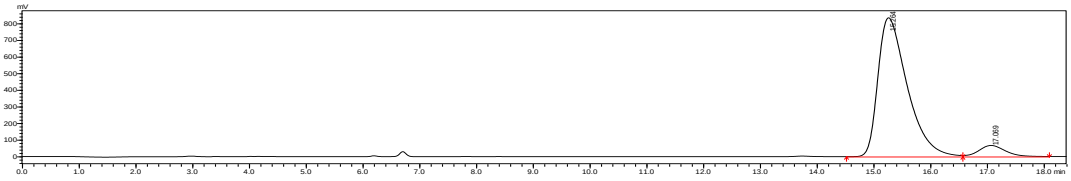
HPLC (Chiralcel IA, hexane/*i*PrOH = 90/10, flow rate 1.0 mL/min, λ = 254 nm), t_r (major) = 15.26 min, t_r (minor) = 17.07 min, *ee* = 86%, $[a]_D^{20}$ = –50.3 (c = 0.22 in EtOAc).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.99 (s, 1H), 7.68 (d, *J* = 7.8 Hz, 1H), 7.63 – 7.57 (m, 2H), 7.49 – 7.45 (m, 1H), 7.37 (d, *J* = 8.1 Hz, 1H), 7.26 (s, 1H), 7.24 (q, *J* = 1.7 Hz, 1H), 7.22 – 7.16 (m, 3H), 7.15 – 7.11 (m, 1H), 7.10 (dd, *J* = 7.1, 1.9 Hz, 1H), 7.02 (d, *J* = 2.3 Hz, 1H), 5.02 (s, 1H), 3.95 – 3.88 (m, 1H), 3.74 (t, *J* = 7.0 Hz, 2H), 3.47 – 3.33 (m, 2H), 2.99 (td, *J* = 7.3, 2.4 Hz, 2H), 2.74 – 2.65 (m, 1H), 2.23 – 2.15 (m, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 147.0, 142.3, 136.4, 135.6, 134.5, 130.0, 129.3, 128.7, 128.4, 127.7, 127.6, 127.3, 126.5, 126.4, 121.9, 121.4, 119.2, 119.0, 116.1, 111.1, 58.1, 51.0, 45.7, 30.7, 25.9, 23.0.

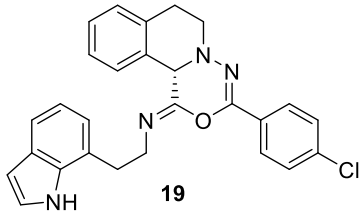
HRMS (ESI) calcd for $C_{28}H_{26}ClN_4O^+$ ([M+H$^+$]) = 469.1790, Found 469.1790.





	Retention Time	% Area
1	15.26	93.09
2	17.07	6.91

(*S*)-N-(2-(1H-indol-7-yl)ethyl)-3-(4-chlorophenyl)-7,11b-dihydro-[1,3,4]oxadiazino[5,4-a]isoquinolin-1(6H)-imine 19



19

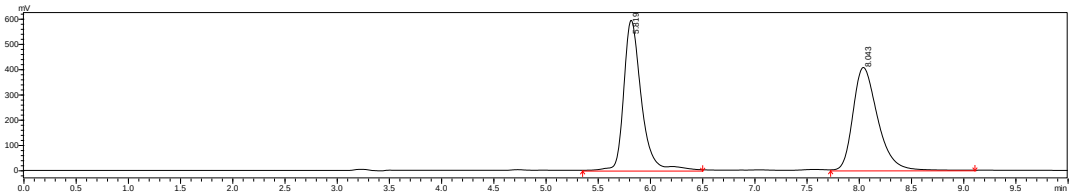
The reaction was performed at −50 °C for 30 min, affording chiral product **19** in 64% yield (57.7 mg) as a white solid. R_f = 0.3 (PE:EA = 3:1), m.p. 52–54 °C.

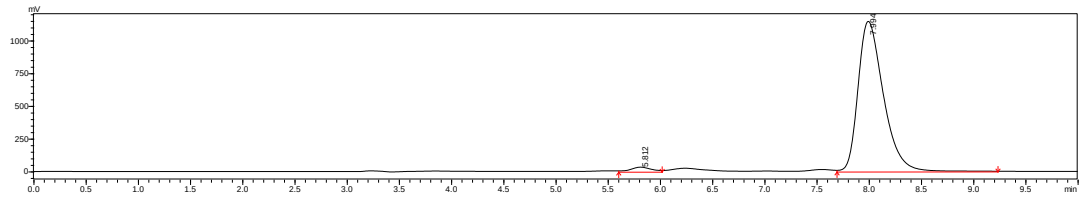
HPLC (Chiralcel IC, hexane/*i*PrOH = 90/10, flow rate 1.0 mL/min, λ = 254 nm), t_r (major) = 7.99 min, t_r (minor) = 5.81 min, *ee* = 95%, $[a]_D^{20}$ = 18.0 (c = 0.20 in DCM).

^{1}H NMR (600 MHz, $CDCl_3$) δ 9.58 (s, 1H), 7.75 – 7.70 (m, 2H), 7.55 (dt, *J* = 7.2, 1.2 Hz, 1H), 7.39 – 7.30 (m, 4H), 7.26 – 7.18 (m, 2H), 7.11 – 7.02 (m, 2H), 6.82 (dd, *J* = 3.0, 2.4 Hz, 1H), 6.50 (dd, *J* = 3.0, 1.8 Hz, 1H), 4.79 (s, 1H), 4.08 – 4.03 (m, 1H), 3.99 – 3.93 (m, 1H), 3.90-3.86 (m, 1H), 3.44 – 3.37 (m, 2H), 3.36 – 3.29 (m, 1H), 3.23 – 3.19 (m, 1H), 2.78 (dd, *J* = 16.2, 3.6 Hz, 1H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 148.3, 142.5, 135.9, 135.7, 134.9, 129.4, 129.3, 128.6, 128.5, 128.2, 128.1, 127.9, 126.6, 126.5, 124.3, 124.2, 122.3, 119.6, 119.1, 102.3, 58.6, 51.4, 47.3, 34.4, 27.3.

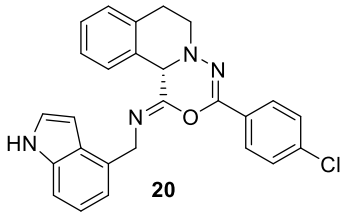
HRMS (ESI-TOF) calcd for $C_{27}H_{24}ClN_4O^+$ ([M+H$^+$]) = 455.1634, Found 455.1633.





	Retention Time	% Area
1	5.81	2.49
2	7.99	97.51

(*S*)-N-((1H-indol-4-yl)methyl)-3-(4-chlorophenyl)-7,11b-dihydro-[1,3,4]oxadiazino[5,4-a]isoquinolin-1(6H)-imine 20



20

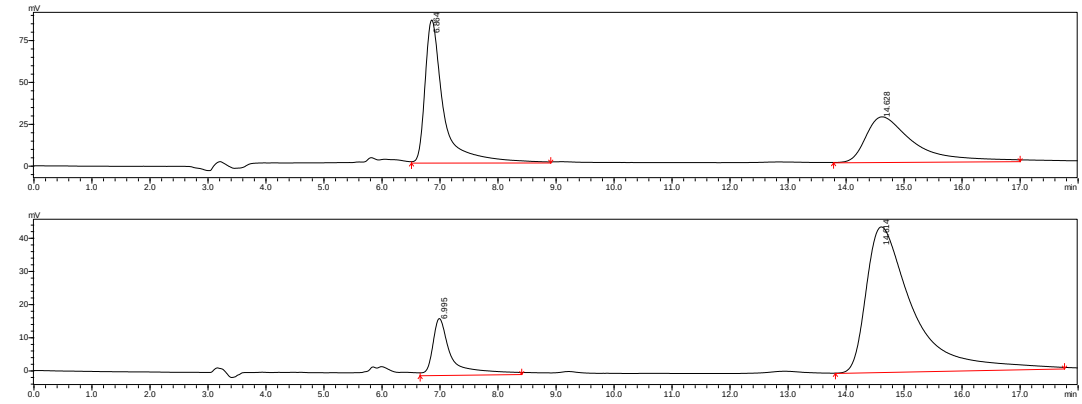
The reaction was performed at –50 °C for 30 min, affording chiral product **20** in 75% yield (66.1 mg) as a white solid. R_f = 0.2 (PE:EA = 3:1), m.p. 132–133 °C.

HPLC (Chiralcel IC, hexane/*i*PrOH = 80/10, flow rate 1.0 mL/min, λ = 254 nm), t_r (major) = 14.61 min, t_r (minor) = 7.00 min, *ee* = 73%, $[a]_D^{20}$ = –13.0 (c = 1.25 in DCM).

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.28 (s, 1H), 7.77 – 7.71 (m, 2H), 7.47 (dt, *J* = 7.8, 1.2 Hz, 1H), 7.38 – 7.34 (m, 1H), 7.33 – 7.28 (m, 2H), 7.28 – 7.26 (m, 1H), 7.26 – 7.21 (m, 2H), 7.18 (tt, *J* = 7.2, 1.2 Hz, 1H), 7.13 – 7.06 (m, 2H), 6.73 – 6.72 (m, 1H), 5.16 (s, 2H), 5.08 (s, 1H), 3.95 – 3.88 (m, 1H), 3.45 – 3.35 (m, 2H), 2.70 (dd, *J* = 16.2, 3.6 Hz, 1H).

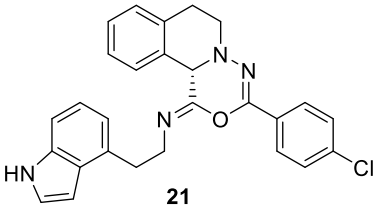
^{13}C NMR (151 MHz, $CDCl_3$) δ 147.4, 142.3, 136.0, 135.7, 134.4, 131.3, 130.0, 129.2, 128.8, 128.5, 127.7, 127.6, 126.7, 126.7, 126.4, 123.9, 122.2, 119.0, 110.1, 101.1, 58.2, 51.1, 48.4, 25.9.

HRMS (ESI-TOF) calcd for $C_{26}H_{22}ClN_4O^+$ ([M+H$^+$]) = 441.1477, Found 441.1477.



	Retention Time	% Area
1	7.00	13.54
2	14.61	86.46

(*S*)-N-(2-(1H-indol-4-yl)ethyl)-3-(4-chlorophenyl)-7,11b-dihydro-[1,3,4]oxadiazino[5,4-a]isoquinolin-1(6H)-imine 21



21

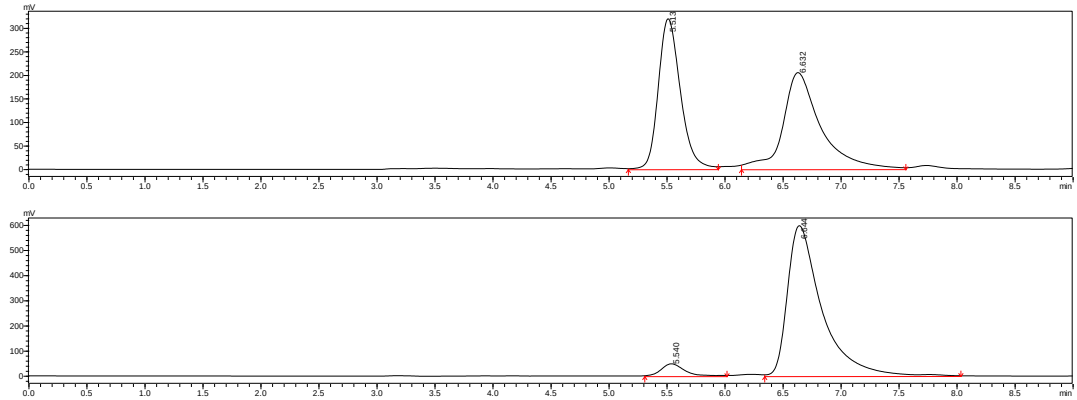
The reaction was performed at −50 °C for 30 min, affording chiral product **21** in 77% yield (70.2 mg) as a white solid. R_f = 0.2 (PE:EA = 3:1), m.p. 53–54 °C.

HPLC (Chiralcel IC, hexane/*i*PrOH = 80/10, flow rate 1.0 mL/min, λ = 254 nm), t_r (major) = 6.64 min, t_r (minor) = 5.54 min, *ee* = 89%, $[a]_D^{20}$ = 8.3 (c = 1.34 in DCM).

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.32 (s, 1H), 7.61 – 7.56 (m, 2H), 7.33 – 7.28 (m, 2H), 7.27 – 7.24 (m, 2H), 7.23 – 7.21 (m, 1H), 7.20 – 7.18 (m, 2H), 7.14 – 7.07 (m, 3H), 6.72 - 6.71 (m, 1H), 4.98 (s, 1H), 4.15 – 4.10 (m, 1H), 4.07 – 4.03 (m, 1H), 3.93 – 3.87 (m, 1H), 3.44 – 3.32 (m, 4H), 2.69 (dd, *J* = 16.2, 3.6 Hz, 1H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 147.2, 142.2, 135.8, 135.5, 134.3, 132.1, 129.8, 129.1, 128.6, 128.3, 127.6, 127.4, 127.4, 126.6, 126.3, 123.7, 122.1, 119.8, 109.4, 100.9, 58.2, 51.0, 46.9, 34.6, 25.9.

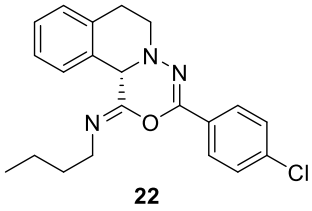
HRMS (ESI-TOF) calcd for $C_{27}H_{24}ClN_4O^+$ ([M+H$^+$]) = 455.1634, Found 455.1633.



	Retention Time	% Area
1	5.54	5.41
2	6.64	94.59

(*S*)-N-butyl-3-(4-chlorophenyl)-7,11b-dihydro-[1,3,4]oxadiazino[5,4-a]isoquinolin-1(6H)

-imine 22



22

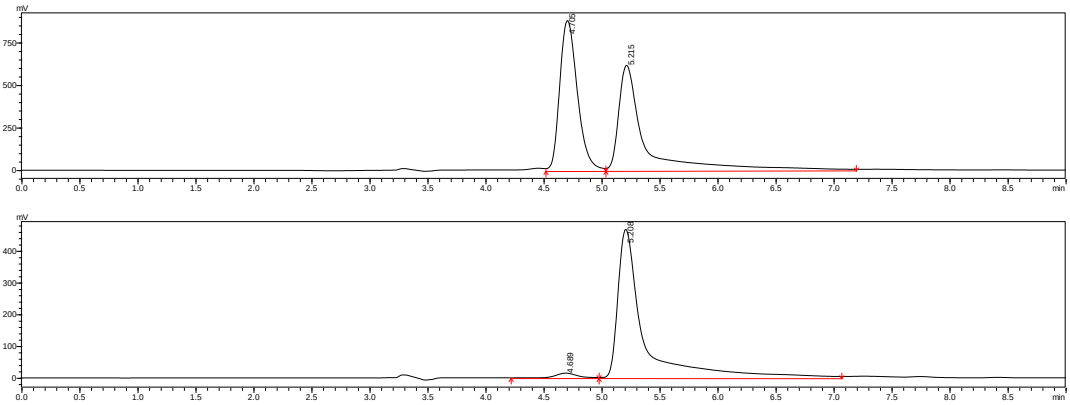
The reaction was performed at −50 °C for 30 min, affording chiral product **22** in 44% yield (32.1 mg) as a yellow solid. R_f = 0.3 (PE:EA = 20:1), m.p. 89–90 °C.

HPLC (Chiralcel IC, hexane/*i*PrOH = 95/5, flow rate 1.0 mL/min, λ = 254 nm), t_r (major) = 5.21 min, t_r (minor) = 4.69 min, *ee* = 94%, $[a]_D^{20}$ = 27.0 (c = 0.61 in DCM).

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.73 – 7.67 (m, 2H), 7.42 (dt, *J* = 7.2, 1.2 Hz, 1H), 7.32 – 7.27 (m, 2H), 7.20 – 7.14 (m, 2H), 7.08 (dd, *J* = 7.2, 1.8 Hz, 1H), 5.01 (s, 1H), 3.93 – 3.88 (m, 1H), 3.67 (t, *J* = 7.2 Hz, 2H), 3.45 – 3.40 (m, 1H), 3.39 – 3.33 (m, 1H), 2.69 (dd, *J* = 16.2, 3.6 Hz, 1H), 1.77 – 1.72 (m, 2H), 1.55 – 1.49 (m, 2H), 1.02 (t, *J* = 7.2 Hz, 3H).

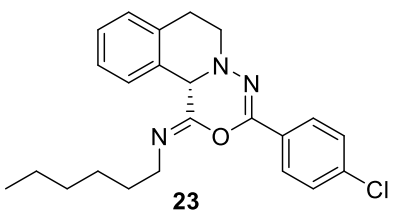
^{13}C NMR (151 MHz, $CDCl_3$) δ 146.7, 142.2, 135.6, 134.4, 130.0, 129.2, 128.8, 128.4, 127.6, 127.1, 126.5, 126.3, 58.1, 51.0, 45.8, 32.6, 25.7, 20.8, 13.9.

HRMS (ESI-TOF) calcd for $C_{21}H_{23}ClN_3O^+$ ([M+H$^+$]) = 368.1525, Found 368.1524.



	Retention Time	% Area
1	4.69	3.09
2	5.21	96.91

(*S*)-3-(4-chlorophenyl)-N-hexyl-7,11b-dihydro-[1,3,4]oxadiazino[5,4-a]isoquinolin-1(6H)-imine 23



23

The reaction was performed at −50 °C for 30 min, affording chiral product **23** in 71% yield (56.0 mg) as a yellow solid. R_f = 0.3 (PE:EA = 20:1), m.p. 106–107 °C.

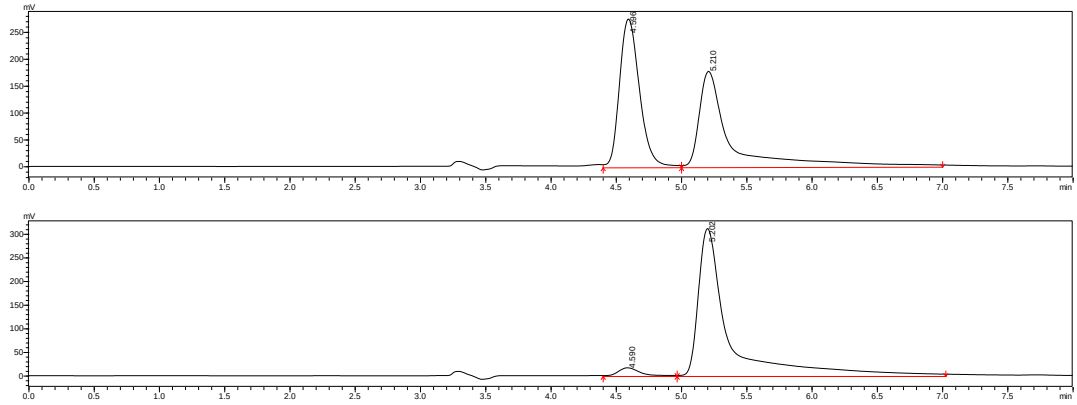
HPLC (Chiralcel IC, hexane/*i*PrOH = 95/5, flow rate 1.0

mL/min, λ = 254 nm), t_r (major) = 5.20 min, t_r (minor) = 4.59 min, *ee* = 92%, $[a]_D^{20}$ = 26.3 (c = 1.09 in DCM).

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.74 – 7.66 (m, 2H), 7.43 – 7.40 (m, 1H), 7.31 – 7.28 (m, 2H), 7.20 – 7.14 (m, 2H), 7.10 – 7.06 (m, 1H), 5.00 (s, 1H), 3.93 – 3.88 (m, 1H), 3.69 – 3.62 (m, 2H), 3.45 – 3.40 (m, 1H), 3.39 – 3.33 (m, 1H), 2.69 (dd, *J* = 16.2, 3.6 Hz, 1H), 1.77 – 1.73 (m, 2H), 1.51 – 1.46 (m, 2H), 1.41 – 1.35 (m, 4H), 0.95 – 0.90 (m, 3H).

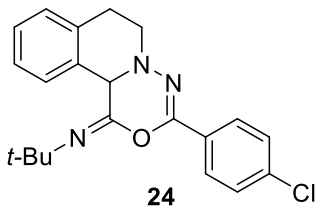
^{13}C NMR (151 MHz, $CDCl_3$) δ 146.6, 142.2, 135.6, 134.4, 130.1, 129.2, 128.8, 128.4, 127.7, 127.2, 126.5, 126.4, 58.1, 51.0, 46.2, 31.7, 30.4, 27.3, 25.8, 22.6, 14.1.

HRMS (ESI-TOF) calcd for $C_{23}H_{27}ClN_3O^+$ ([M+H$^+$]) = 396.1838, Found 396.1837.



	Retention Time	% Area
1	4.59	3.92
2	5.20	96.08

N-(tert-butyl)-3-(4-chlorophenyl)-7,11b-dihydro-[1,3,4]oxadiazino[5,4-a] isoquinoline-1(6H)-imine 24



24

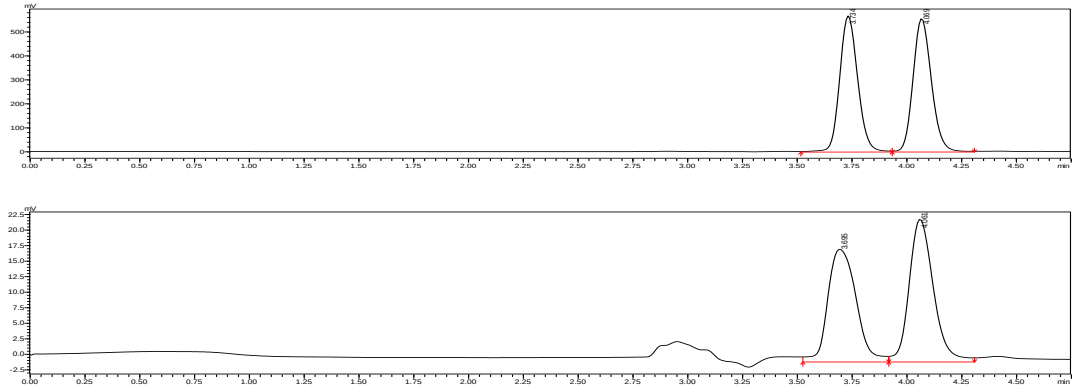
The reaction was performed at –50 °C for 30 min, affording product **24** in 33% yield (24.4 mg) as a white solid. R_f = 0.3 (PE:EA = 8:1), m.p. 99–100 °C.

HPLC (Chiralcel IA, hexane/*i*PrOH = 90/10, flow rate 1.0 mL/min, λ = 254 nm), t_r (major) = 4.06 min, t_r (minor) = 3.70 min, *ee* = 2%.

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.71 – 7.66 (m, 2H), 7.42 (d, *J* = 7.2 Hz, 1H), 7.32 – 7.27 (m, 2H), 7.19 – 7.13 (m, 2H), 7.06 (d, *J* = 7.2 Hz, 1H), 4.95 (s, 1H), 3.91 – 3.86 (m, 1H), 3.41 (td, *J* = 12.6, 4.2 Hz, 1H), 3.35 (td, *J* = 16.2, 6.0 Hz, 1H), 2.67 (dd, *J* = 16.2, 4.2 Hz, 1H), 1.50 (s, 9H).

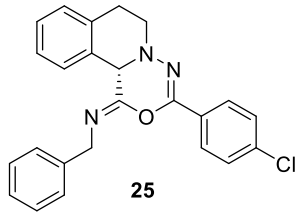
^{13}C NMR (151 MHz, $CDCl_3$) δ 143.5, 142.5, 135.6, 134.4, 130.5, 129.3, 128.9, 128.5, 127.6, 126.8, 126.6, 126.4, 58.3, 54.5, 50.9, 30.3, 25.6.

HRMS (ESI) calcd for $C_{21}H_{23}ClN_3O^+$([M+H$^+$]) = 368.1524, Found 368.1525.



	Retention Time	% Area
1	3.70	49.10
2	4.06	50.90

(*S*)-N-benzyl-3-(4-chlorophenyl)-7,11b-dihydro-[1,3,4]oxadiazino[5,4-a]isoquinolin-1(6H)-imine 25



25

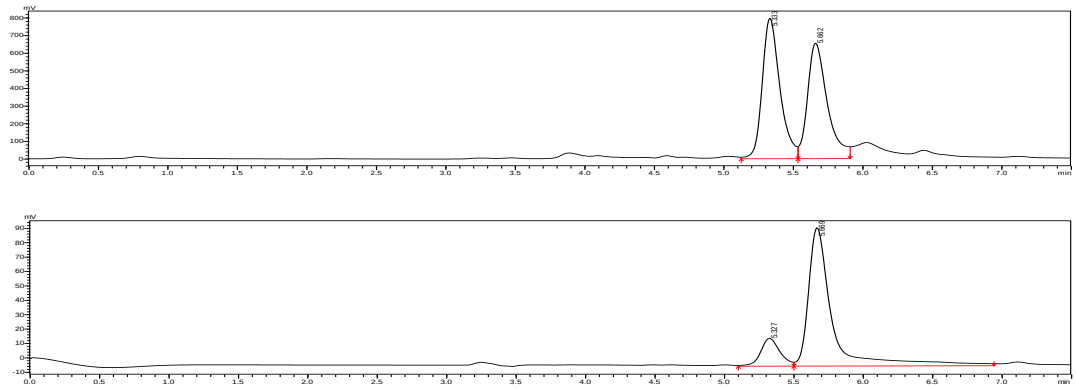
The reaction was performed at –50 °C for 30 min, affording product **25** in 64% yield (50.8 mg) as a white solid. R_f = 0.3 (PE:EA = 8:1), m.p. 102–104 °C.

HPLC (Chiralcel IC, hexane/*i*PrOH = 90/10, flow rate 1.0 mL/min, λ = 254 nm), t_r (major) = 5.67 min, t_r (minor) = 5.33 min, *ee* = 72%, $[a]_D^{20}$ = 0.5 (c = 0.61 in EtOAc).

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.77 – 7.72 (m, 2H), 7.54 – 7.49 (m, 2H), 7.48 (dt, *J* = 7.8, 1.8 Hz, 1H), 7.42 (t, *J* = 7.2 Hz, 2H), 7.36 – 7.28 (m, 3H), 7.22 (tt, *J* = 7.2, 1.2 Hz, 1H), 7.17 (td, *J* = 7.2, 1.2 Hz, 1H), 7.11 (dd, *J* = 7.2, 1.2 Hz, 1H), 5.09 (s, 1H), 4.90 (dd, *J* = 18.0, 15.6 Hz, 2H), 3.96 – 3.92 (m, 1H), 3.48 – 3.37 (m, 2H), 2.72 (dd, *J* = 16.2, 3.6 Hz, 1H).

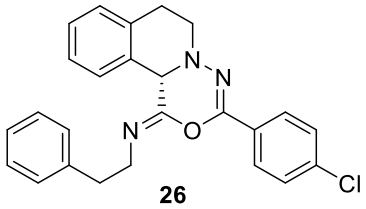
^{13}C NMR (151 MHz, $CDCl_3$) δ 147.5, 142.1, 139.5, 135.7, 134.4, 129.8, 129.2, 128.6, 128.5, 128.5, 127.8, 127.7, 127.4, 126.9, 126.6, 126.3, 58.1, 51.0, 50.0, 25.9.

HRMS (ESI) calcd for $C_{24}H_{21}ClN_3O^+$ ([M+H$^+$]) = 402.1368, Found 402.1368.



	Retention Time	% Area
1	5.33	13.98
2	5.67	86.02

(*S*)-3-(4-chlorophenyl)-N-phenethyl-7,11b-dihydro-[1,3,4]oxadiazino[5,4-a]isoquinolin-1 (6H)-imine 26



26

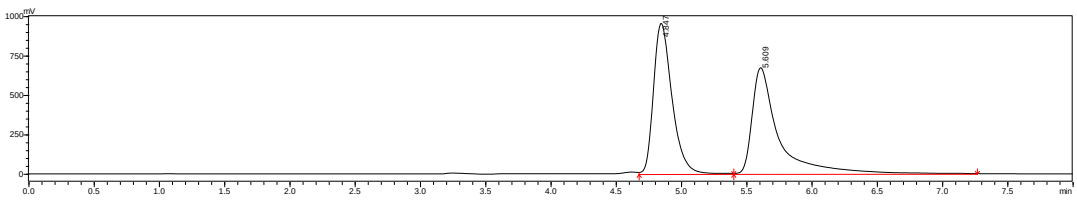
The reaction was performed at –50 °C for 30 min, affording chiral product **26** in 77% yield (64.1 mg) as a white solid. R_f = 0.3 (PE:EA = 10:1), m.p. 96–98 °C.

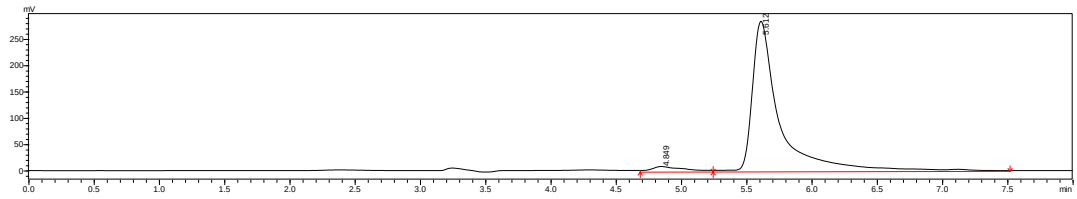
HPLC (Chiralcel IC, hexane/*i*PrOH = 90/10, flow rate 1.0 mL/min, λ = 254 nm), t_r (major) = 5.61 min, t_r (minor) = 4.85 min, *ee* = 92%, $[a]_D^{20}$ = 10.4 (c = 1.17 in DCM).

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.69 – 7.65 (m, 2H), 7.37 – 7.32 (m, 4H), 7.31 – 7.28 (m, 2H), 7.26 – 7.23 (m, 1H), 7.22 (dt, *J* = 7.8, 1.2 Hz, 1H), 7.18 (tt, *J* = 7.2, 1.2 Hz, 1H), 7.11 – 7.06 (m, 2H), 4.95 (s, 1H), 3.97 (dt, *J* = 13.2, 7.8 Hz, 1H), 3.92 – 3.86 (m, 2H), 3.44 – 3.38 (m, 1H), 3.37 – 3.31 (m, 1H), 3.11 – 3.05 (m, 2H), 2.69 (dd, *J* = 16.2, 3.6 Hz, 1H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 147.2, 142.2, 140.2, 135.6, 134.4, 129.8, 129.2, 128.9, 128.7, 128.4, 128.4, 127.6, 127.4, 126.6, 126.3, 126.2, 58.1, 51.0, 47.6, 36.9, 25.9.

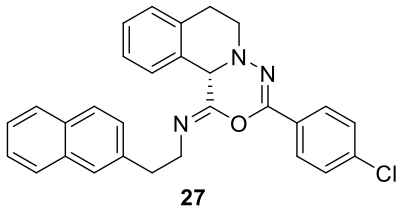
HRMS (ESI-TOF) calcd for $C_{25}H_{23}ClN_3O^+$ ([M+H$^+$]) = 416.1525, Found 416.1524.





	Retention Time	% Area
1	4.85	3.99
2	5.61	96.01

(*S*)-3-(4-chlorophenyl)-N-(2-(naphthalen-2-yl)ethyl)-7,11b-dihydro-[1,3,4]oxadiazino[5,4-a]isoquinolin-1(6H)-imine 27



27

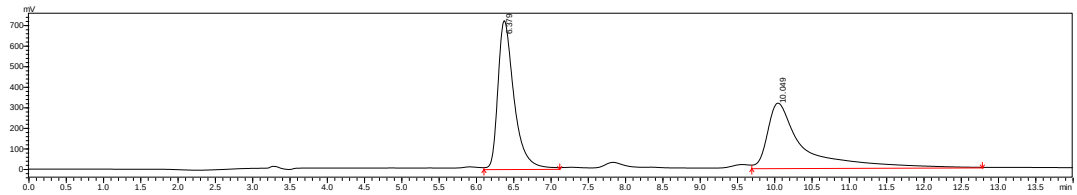
The reaction was performed at –50 °C for 30 min, affording chiral product **27** in 68% yield (62.9 mg) as a white solid. R_f = 0.3 (PE:EA = 6:1), m.p. 59–61 °C.

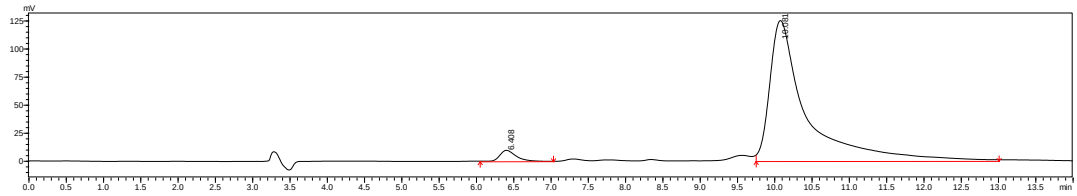
HPLC (Chiralcel IC, hexane/*i*PrOH = 95/5, flow rate 1.0 mL/min, λ = 254 nm), t_r (major) = 10.08 min, t_r (minor) = 6.41 min, *ee* = 93%, $[a]_D^{20}$ = –17.9 (c = 1.20 in DCM).

^{1}H NMR (601 MHz, $CDCl_3$) δ 7.85 – 7.81 (m, 4H), 7.66 (d, *J* = 8.4 Hz, 2H), 7.51 – 7.45 (m, 3H), 7.28 (d, *J* = 8.4 Hz, 2H), 7.14 – 7.08 (m, 2H), 7.05 (d, *J* = 7.8 Hz, 1H), 6.81 (t, *J* = 7.2 Hz, 1H), 4.95 (s, 1H), 4.13 – 4.08 (m, 1H), 4.00 – 3.95 (m, 1H), 3.88 (dd, *J* = 12.6, 6.0 Hz, 1H), 3.40 (td, *J* = 12.6, 3.6 Hz, 1H), 3.36 – 3.30 (m, 1H), 3.29 – 3.24 (m, 2H), 2.67 (dd, *J* = 16.2, 3.6 Hz, 1H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 147.3, 142.1, 137.7, 135.6, 134.3, 133.6, 132.2, 129.7, 129.1, 128.6, 128.4, 128.0, 127.6, 127.6, 127.5, 127.4, 127.3, 127.2, 126.5, 126.2, 125.9, 125.3, 58.1, 51.0, 47.4, 37.0, 25.9.

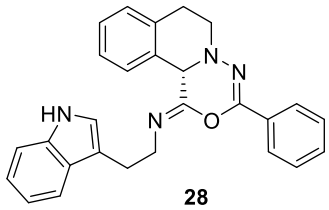
HRMS (ESI-TOF) calcd for $C_{29}H_{25}ClN_3O^+$ ([M+H$^+$]) =466.1681, Found 466.1681.





	Retention Time	% Area
1	6.41	3.33
2	10.08	96.67

(*S*)-N-(2-(1H-indol-3-yl)ethyl)-3-phenyl-7,11b-dihydro-[1,3,4]oxadiazino[5,4-a]isoquinolin-1(6H)-imine 28



28

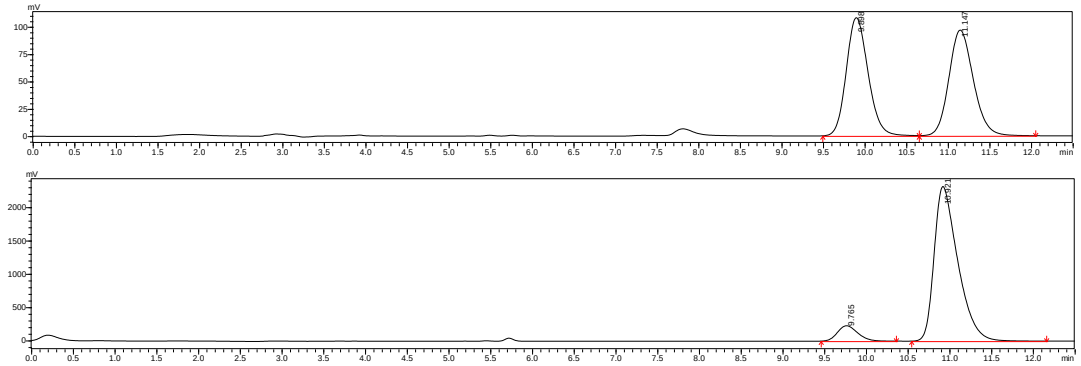
The reaction was performed at –50 °C for 30 min, affording chiral product **28** in 74% yield (62.2 mg) as a white solid. R_f = 0.2 (PE:EA = 3:1), m.p. 84–85 °C.

(Chiralcel IA, hexane/*i*PrOH = 85/15, flow rate 1.0 mL/min, λ = 254 nm), t_r (major) = 10.92 min, t_r (minor) = 9.77 min, *ee* = 84%. $[a]_D^{20}$ = –50.2 (c = 0.17 in EtOAc).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.07 (s, 1H), 7.72 – 7.67 (m, 3H), 7.32 – 7.24 (m, 5H), 7.20 – 7.09 (m, 3H), 7.07 – 7.02 (m, 3H), 4.96 (s, 1H), 4.09 – 3.95 (m, 2H), 3.92 – 3.82 (m, 1H), 3.41 – 3.28 (m, 2H), 3.26 – 3.15 (m, 2H), 2.70 – 2.60 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 147.5, 143.1, 136.3, 134.5, 130.2, 130.0, 129.6, 129.1, 128.2, 127.61, 127.56, 127.3, 126.3, 125.3, 121.93, 121.86, 119.2, 119.0, 114.4, 111.1, 58.2, 51.0, 46.8, 26.5, 25.8.

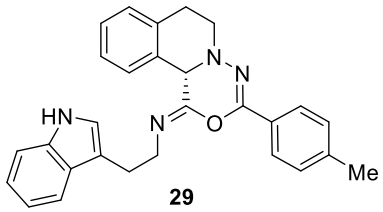
HRMS (ESI-TOF) calcd for $C_{27}H_{25}N_4O^+$([M+H$^+$]) = 421.2023, Found 421.2024.



	Retention Time	% Area
1	9.77	8.00

2	10.92	92.00

(*S*)-N-(2-(1H-indol-3-yl)ethyl)-3-(p-tolyl)-7,11b-dihydro-[1,3,4]oxadiazino[5,4-a]isoquinolin-1(6H)-imine 29



29

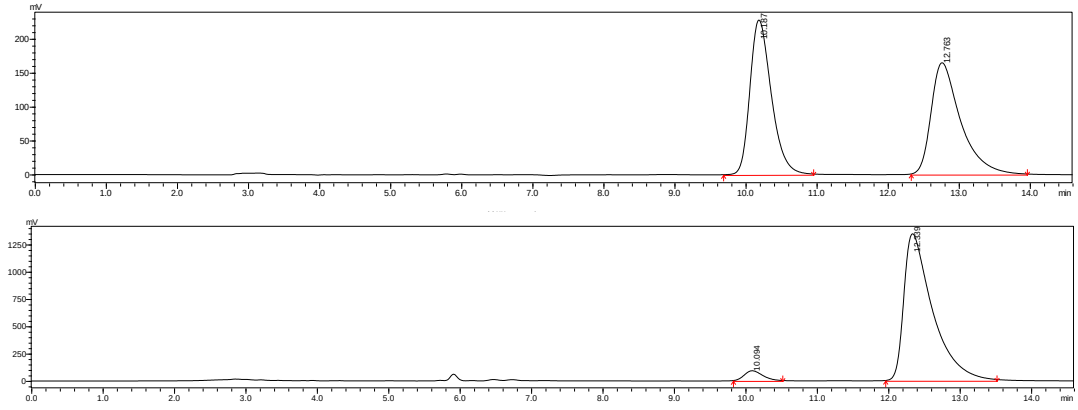
The reaction was performed at –50 °C for 30 min, affording chiral product **29** in 72% yield (62.7 mg) as a white solid. R_f = 0.2 (PE:EA = 3:1), m.p. 65–66 °C.

HPLC (Chiralcel IA, hexane/*i*PrOH = 85/15, flow rate 1.0 mL/min, λ = 254 nm), t_r (major) = 12.34 min, t_r (minor) = 10.09 min, *ee* = 91%. $[a]_D^{20}$ = –56.1 (c = 0.11 in EtOAc).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.11 (s, 1H), 7.75 (d, *J* = 8.0 Hz, 1H), 7.63 – 7.61 (m, 2H), 7.38 – 7.32 (m, 2H), 7.23 (td, *J* = 8.0, 1.2 Hz, 1H), 7.20 – 7.14 (m, 2H), 7.13 – 7.11 (m, 3H), 7.09 – 7.05 (m, 2H), 4.99 (s, 1H), 4.13 – 3.98 (m, 2H), 3.94 – 3.90 (m, 1H), 3.45 – 3.34 (m, 2H), 3.32 – 3.19 (m, 2H), 2.70 – 2.66 (m, 1H), 2.35 (s, 3H).

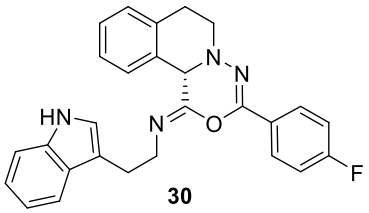
^{13}C NMR (101 MHz, $CDCl_3$) δ 147.7, 143.3, 139.8, 136.3, 134.5, 130.1, 129.1, 128.9, 127.6, 127.5, 127.4, 127.3, 126.2, 125.3, 122.9, 121.8, 119.2, 119.0, 114.4, 111.1, 58.2, 51.0, 46.8, 26.5, 25.8, 21.3.

HRMS (ESI-TOF) calcd for $C_{28}H_{27}N_4O^+$ ([M+H$^+$]) = 435.2179, Found 435.2179.



	Retention Time	% Area
1	10.09	4.40
2	12.34	95.60

(*S*)-N-(2-(1H-indol-3-yl)ethyl)-3-(4-fluorophenyl)-7,11b-dihydro-[1,3,4]oxadiazino[5,4-a]isoquinolin-1(6H)-imine 30



30

The reaction was performed at –50 °C for 30 min, affording chiral product **30** in 76% yield (66.0 mg) as a white solid. R_f = 0.2 (PE:EA = 3:1), m.p. 61–63 °C.

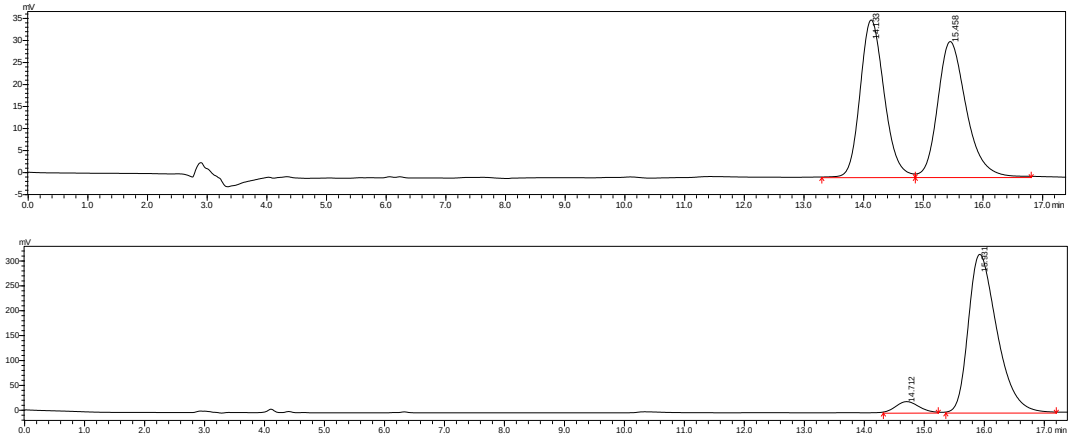
HPLC (Chiralcel IA, hexane/*i*PrOH = 90/10, flow rate 1.0 mL/min, λ = 254 nm), t_r (major) = 15.93 min, t_r (minor) = 14.71 min, *ee* = 89%. $[a]_D^{20}$ = –5.9 (c = 0.25 in EtOAc).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.04 (s, 1H), 7.72 (dd, *J* = 8.0, 1.2 Hz, 1H), 7.64 – 7.60 (m, 2H), 7.38 – 7.31 (m, 2H), 7.23 – 7.14 (m, 3H), 7.12 (d, *J* = 1.6 Hz, 1H), 7.10 – 7.06 (m, 2H), 6.97 – 6.93 (m, 2H), 4.97 (s, 1H), 4.10 – 3.94 (m, 2H), 3.93 – 3.84 (m, 1H), 3.44 – 3.32 (m, 2H), 3.29 – 3.17 (m, 2H), 2.73 – 2.64 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 163.7 (d, *J* = 248.0 Hz), 147.3, 142.4, 136.3, 134.5, 130.0, 129.2, 127.7, 127.6, 127.4, 127.3, 126.4, 126.3, 122.1, 121.9, 119.3, 119.0, 115.3 (d, *J* = 22.0 Hz), 114.4, 111.2, 58.2, 51.1, 46.8, 26.5, 25.8.

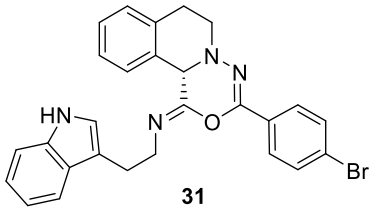
^{19}F NMR (376 MHz, $CDCl_3$) δ -110.91.

HRMS (ESI-TOF) calcd for $C_{27}H_{24}FN_4O^+$ ([M+H$^+$]) = 439.1929, Found 439.1926.



	Retention Time	% Area
1	14.71	5.40
2	15.93	94.60

(*S*)-N-(2-(1H-indol-3-yl)ethyl)-3-(4-bromophenyl)-7,11b-dihydro-[1,3,4]oxadiazino[5,4-a] isoquinolin-1(6H)-imine 31



31

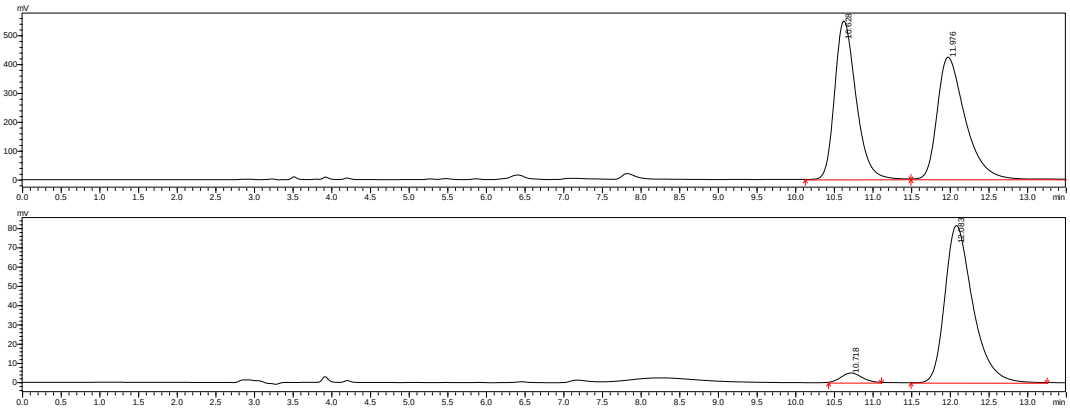
The reaction was performed at –50 °C for 30 min, affording chiral product **31** in 75% yield (74.2 mg) as a white solid. R_f = 0.2 (PE:EA = 4:1), m.p. 77–78 °C.

HPLC (Chiralcel IA, hexane/*i*PrOH = 85/15, flow rate 1.0 mL/min, λ = 254 nm), t_r (major) = 12.08 min, t_r (minor) = 10.72 min, *ee* = 91%. $[a]_D^{20}$ = 23.3 (c = 0.46 in EtOAc).

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.06 (s, 1H), 7.73 (d, *J* = 7.9 Hz, 1H), 7.50 (d, *J* = 8.4 Hz, 2H), 7.39 (d, *J* = 8.4 Hz, 2H), 7.35 (d, *J* = 8.1 Hz, 1H), 7.32 (d, *J* = 7.7 Hz, 1H), 7.21 (t, *J* = 7.5 Hz, 1H), 7.17 (dt, *J* = 15.5, 7.4 Hz, 2H), 7.11 (d, *J* = 2.2 Hz, 1H), 7.08 (dd, *J* = 9.8, 7.5 Hz, 2H), 4.98 (s, 1H), 4.05 (dt, *J* = 12.9, 7.5 Hz, 1H), 3.99 (dt, *J* = 13.2, 7.3 Hz, 1H), 3.89 (dt, *J* = 12.2, 6.1 Hz, 1H), 3.48 – 3.31 (m, 2H), 3.24 (dq, *J* = 18.9, 7.1 Hz, 2H), 2.68 (dd, *J* = 16.3, 3.8 Hz, 1H).

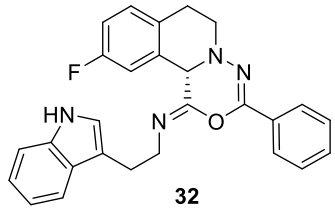
^{13}C NMR (151 MHz, $CDCl_3$) δ 147.1, 142.4, 136.4, 134.5, 131.4, 130.0, 129.3, 129.2, 127.7, 127.6, 127.4, 126.8, 126.4, 123.9, 122.1, 121.9, 119.6, 118.9, 114.4, 111.2, 58.2, 51.1, 46.9, 26.5, 25.9.

HRMS (ESI-TOF) calcd for $C_{27}H_{24}BrN_4O^+$ ([M+H$^+$]) = 499.1128, Found 499.1124.



	Retention Time	% Area
1	10.72	4.56
2	12.08	95.44

(*S*)-N-(2-(1H-indol-3-yl)ethyl)-10-fluoro-3-phenyl-7,11b-dihydro-[1,3,4]oxadiazino[5,4-a]isoquinolin-1(6H)-imine 32



32

The reaction was performed at –50 °C for 30 min, affording chiral product **32** in 73% yield (64.2 mg) as a white solid. R_f = 0.3 (PE:EA = 3:1), m.p. 67–68 °C.

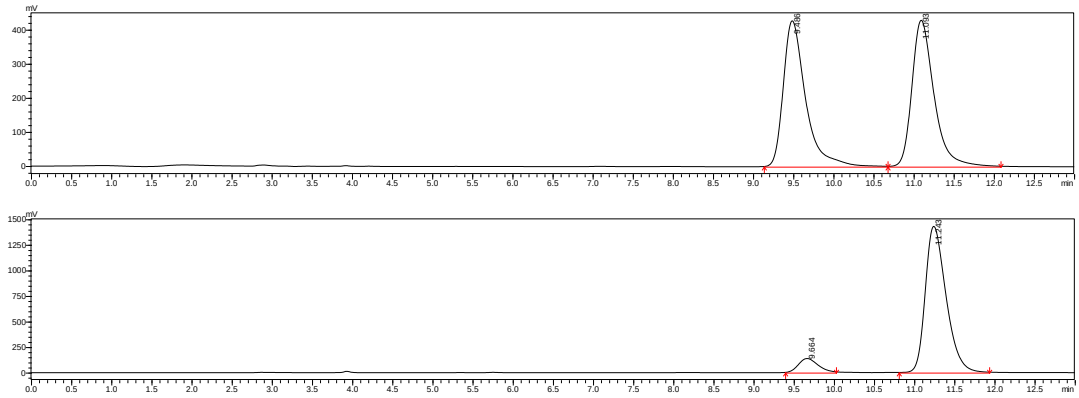
HPLC (Chiralcel IA, hexane/*i*PrOH = 85/15, flow rate 1.0 mL/min, λ = 254 nm), t_r (major) = 11.24 min, t_r (minor) = 9.66 min, *ee* = 83%. $[a]_D^{20}$ = –14.3 (c = 0.62 in EtOAc).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.10 (s, 1H), 7.75 (dd, *J* = 7.6, 1.2 Hz, 1H), 7.69 – 7.66 (m, 2H), 7.38 – 7.28 (m, 4H), 7.22 (td, *J* = 7.2, 1.6 Hz, 1H), 7.17 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.15 (d, *J* = 2.0 Hz, 1H), 7.13 – 7.10 (m, 1H), 7.03 (dd, *J* = 8.4, 5.6 Hz, 1H), 6.93 – 6.86 (m, 1H), 4.94 (s, 1H), 4.11 (dt, *J* = 13.2, 7.2 Hz, 1H), 3.99 (dt, *J* = 13.2, 7.2 Hz, 1H), 3.95 – 3.89 (m, 1H), 3.41 – 3.21 (m, 4H), 2.65 (dd, *J* = 16.0, 3.6 Hz, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 161.0 (d, *J* = 243.0 Hz), 147.1, 143.2, 136.4, 131.9 (d, *J* = 7.0 Hz), 130.6 (d, *J* = 7.0 Hz), 130.02 (d, *J* = 3.0 Hz), 130.01, 129.8, 128.2, 127.5, 125.3, 122.01, 121.94, 119.2, 118.9, 114.8 (d, *J* = 21.0 Hz), 114.2 (d, *J* = 2.0 Hz), 114.0, 111.3, 58.1, 51.0, 46.7, 26.5, 25.1.

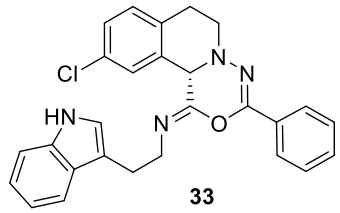
^{19}F NMR (376 MHz, $CDCl_3$) δ -115.41.

HRMS (ESI-TOF) calcd for $C_{27}H_{24}FN_4O^+$ ($[M+H^+]$) = 439.1929, Found 439.1926.



	Retention Time	% Area
1	9.66	8.51
2	11.24	91.49

(*S*)-N-(2-(1H-indol-3-yl)ethyl)-10-chloro-3-phenyl-7,11b-dihydro-[1,3,4]oxadiazino[5,4-a]isoquinolin-1(6H)-imine 33



33

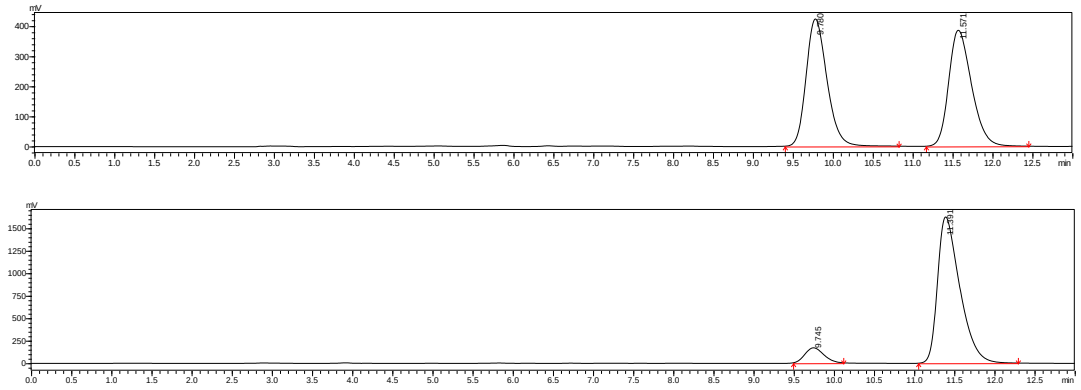
The reaction was performed at –50 °C for 30 min, affording chiral product **33** in 64% yield (58.1 mg) as a white solid. R_f = 0.3 (PE:EA = 3:1), m.p. 67–68 °C.

HPLC (Chiralcel IA, hexane/*i*PrOH = 85/15, flow rate 1.0 mL/min, λ = 254 nm), t_r (major) = 11.39 min, t_r (minor) = 9.75 min, *ee* = 83%. $[a]_D^{20}$ = –8.2 (c = 0.66 in EtOAc).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.10 (s, 1H), 7.74 (dd, *J* = 8.0, 1.2 Hz, 1H), 7.65 – 7.62 (m, 2H), 7.44 (dd, *J* = 2.4, 1.2 Hz, 1H), 7.37 – 7.32 (m, 2H), 7.31 – 7.26 (m, 2H), 7.24 – 7.20 (m, 1H), 7.19 – 7.15 (m, 3H), 7.03 (d, *J* = 8.4 Hz, 1H), 4.93 (s, 1H), 4.11 (dt, *J* = 13.2, 7.2 Hz, 1H), 4.00 (dt, *J* = 13.2, 6.8 Hz, 1H), 3.93 – 3.88 (m, 1H), 3.40 – 3.28 (m, 2H), 3.27 – 3.23 (m, 2H), 2.69 – 2.60 (m, 1H).

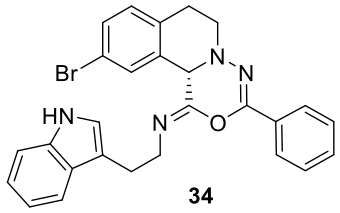
^{13}C NMR (101 MHz, $CDCl_3$) δ 147.0, 143.3, 136.4, 133.0, 131.8, 131.7, 130.5, 129.9, 129.8, 128.2, 127.9, 127.5, 127.4, 125.3, 122.1, 121.9, 119.2, 118.9, 114.2, 111.2, 57.9, 50.8, 46.7, 26.4, 25.3.

HRMS (ESI-TOF) calcd for $C_{27}H_{24}ClN_4O^+$ ([M+H$^+$]) = 455.1633, Found 455.1626.



	Retention Time	% Area
1	9.75	8.52
2	11.39	91.48

(*S*)-N-(2-(1H-indol-3-yl)ethyl)-10-bromo-3-phenyl-7,11bdihydro-[1,3,4]oxadiazino[5,4-a] isoquinolin-1(6H)-imine 34



34

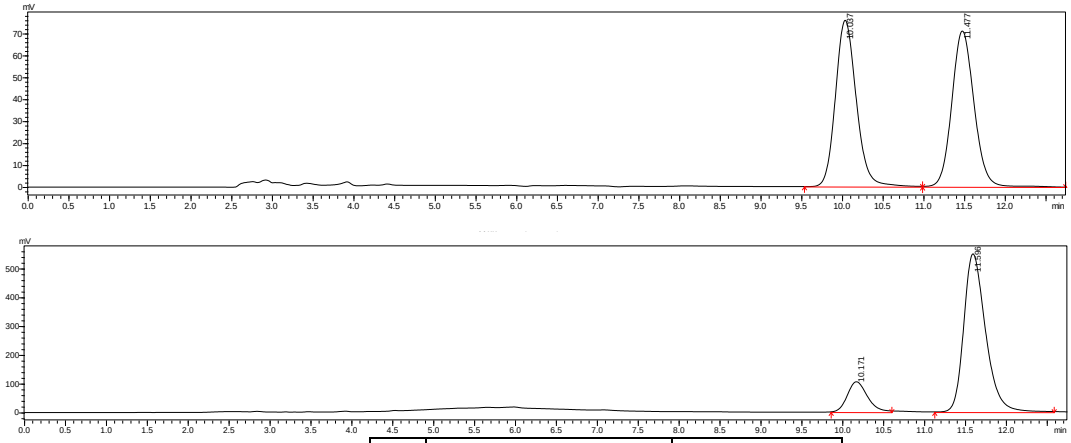
The reaction was performed at –50 °C for 30 min, affording chiral product **34** in 55% yield (54.6 mg) as a white solid. R_f = 0.3 (PE:EA = 3:1), m.p. 77–78 °C.

HPLC (Chiralcel IA, hexane/*i*PrOH = 85/15, flow rate 1.0 mL/min, λ = 254 nm), t_r (major) = 11.60 min, t_r (minor) = 10.17 min, *ee* = 70%. $[a]_D^{20}$ = –7.5 (c = 0.52 in EtOAc).

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.10 (s, 1H), 7.76 – 7.74 (m, 1H), 7.65 – 7.63 (m, 2H), 7.62 – 7.61 (m, 1H), 7.38 – 7.35 (m, 1H), 7.34 – 7.28 (m, 4H), 7.24 – 7.21 (m, 1H), 7.22 (d, *J* = 2.4 Hz, 1H), 7.19 – 7.16 (m, 1H), 6.95 (d, *J* = 8.4 Hz, 1H), 4.93 (s, 1H), 4.11 (dt, *J* = 12.6, 7.2 Hz, 1H), 4.00 (dt, *J* = 12.6, 7.2 Hz, 1H), 3.92 – 3.89 (m, 1H), 3.38 (td, *J* = 12.6, 7.2 Hz, 1H), 3.31 – 3.28 (m, 1H), 3.27 – 3.24 (m, 2H), 2.65 (dd, *J* = 16.8, 4.2 Hz, 1H).

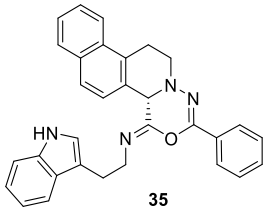
^{13}C NMR (151 MHz, $CDCl_3$) δ 147.0, 143.3, 136.4, 133.6, 132.3, 130.82, 130.76, 130.3, 129.9, 129.7, 128.2, 127.5, 125.3, 122.1, 122.0, 119.7, 119.2, 118.9, 114.3, 111.2, 57.8, 50.8, 46.7, 26.4, 25.4.

HRMS (ESI-TOF) calcd for $C_{27}H_{24}BrN_4O^+$ ([M+H$^+$]) = 499.1128, Found 499.1123.



	Retention Time	% Area
1	10.17	15.07
2	11.60	84.93

(*S*)-N-(2-(1H-indol-3-yl)ethyl)-2-phenyl-11,12-dihydrobenzo[f][1,3,4]oxadiazino[5,4-a] isoquinolin-4(4aH)-imine 35



35

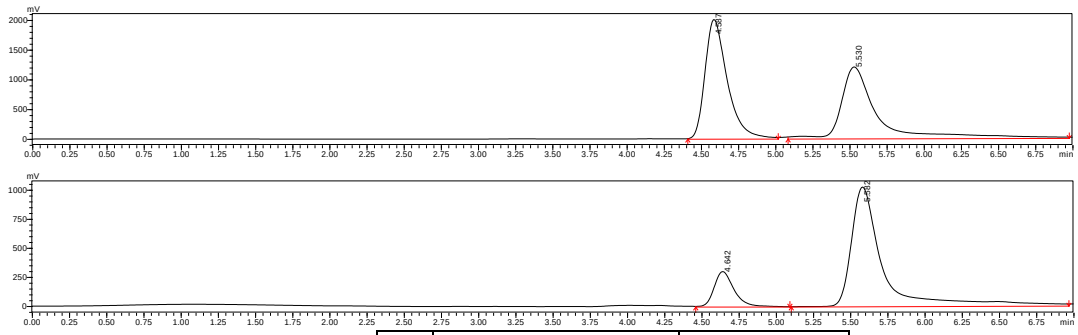
The reaction was performed at –50 °C for 30 min, affording chiral product **35** in 57% yield (53.2 mg) as a white solid. R_f = 0.2 (PE:EA = 4:1), m.p. 91–92 °C.

HPLC (Chiralcel IC, hexane/*i*PrOH = 60/40, flow rate 1.0 mL/min, λ = 254 nm), t_r (major) = 5.58 min, t_r (minor) = 4.64 min, *ee* = 69%, $[a]_D^{20}$ = –92.4 (c = 0.12 in EtOAc).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.02 (s, 1H), 7.98 (d, *J* = 8.8 Hz, 1H), 7.78 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.75 (d, *J* = 8.0 Hz, 1H), 7.68 – 7.65 (m, 2H), 7.58 (d, *J* = 8.7 Hz, 1H), 7.54 – 7.45 (m, 3H), 7.40 (d, *J* = 8.2 Hz, 1H), 7.32 – 7.27 (m, 1H), 7.26 – 7.24 (m, 1H), 7.23 – 7.19 (m, 1H), 7.16 – 7.12 (m, 2H), 5.17 (s, 1H), 4.14 – 3.99 (m, 3H), 3.61 – 3.48 (m, 2H), 3.33 – 3.20 (m, 2H), 3.20 – 3.11 (m, 1H).

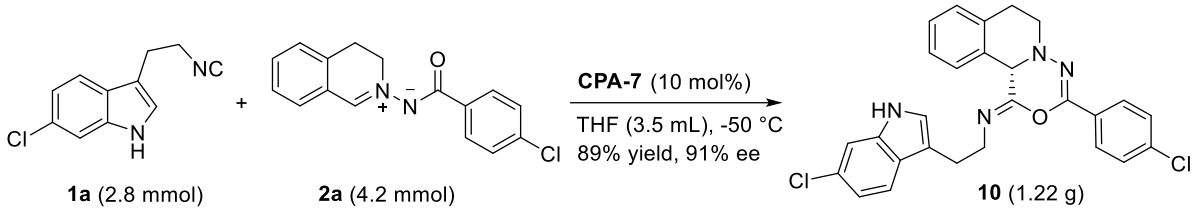
^{13}C NMR (101 MHz, $CDCl_3$) δ 143.2, 136.4, 132.6, 131.8, 130.4, 130.1, 129.7, 128.5, 128.2, 127.7, 127.0, 126.6, 126.3, 125.9, 125.3, 124.8, 122.9, 122.1, 121.9, 119.4, 119.0, 114.5, 111.1, 58.7, 50.9, 46.9, 26.5, 23.0.

HRMS (ESI) calcd for $C_{31}H_{27}N_4O^+$ ([M+H$^+$]) = 471.2179, Found 471.2181.



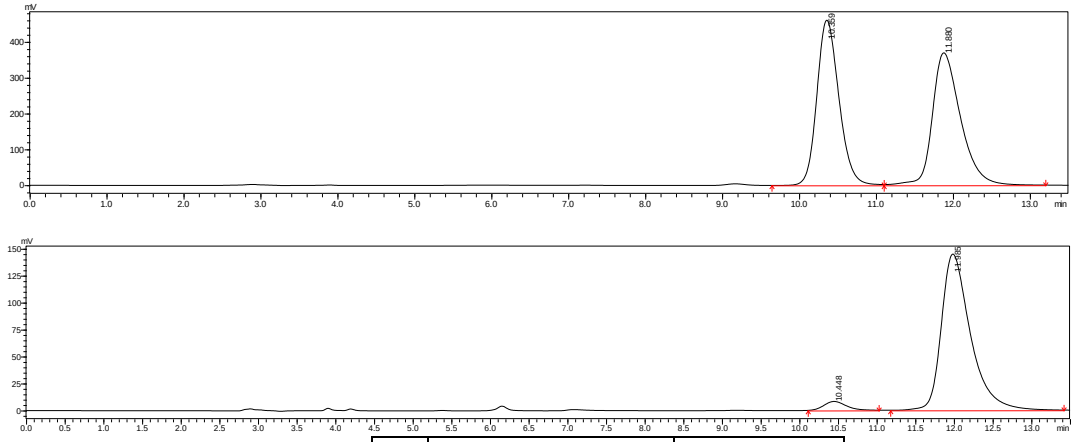
	Retention Time	% Area
1	4.64	15.63
2	5.58	84.37

4. Experimental procedure for the scale-up reaction



1a (2.8 mmol) **2a** (4.2 mmol) **10** (1.22 g)

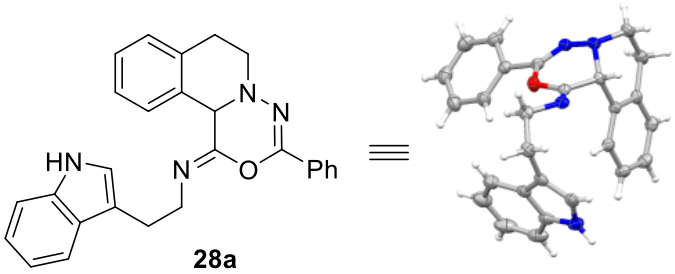
Procedure: A dry reaction tube was charged with *C,N'*-cyclic azomethine imine **2a** (4.2 mmol, 1.5 equiv.) and chiral phosphoric acid **CPA-7** (0.28 mmol, 10 mol%). Under N_2 atmosphere, dry THF (3.5 mL, 0.8 M) was added. The reaction mixture was cooled to -50 ºC, isocyanide **1a** (2.8 mmol, 1.0 equiv.) was added under stirring and the reaction mixture continued stirring at -50 ºC for 30 min. The solvent was removed under reduced pressure and the residue was directly purified by flash chromatography on silica gel using petroleum ether/ethyl acetate = 3/1 as eluent. The chiral [5+1] cycloaddition product **10** was obtained in 89% yield (1.22 g) with 91% *ee*.



	Retention Time	% Area
1	10.45	4.40
2	11.99	95.60

5. X-ray Crystallographic Data

5.1 X-ray crystallographic data for **28a**



The single crystal for compound **28a** was obtained by vaporization of a mixture solvent of hexane and MeOH (v/v = 1:3). The data were collected on a Xcalibur Eos diffractometer equipped with MoKα X-ray sources (λ = 0.71073 Å).

X-ray derived ORTEP of **28a** with thermal ellipsoids shown at the 30% probability level.

Structure deposited at the Cambridge Crystallographic Data Centre. CCDC 2111851 contains the supplementary crystallographic data which can be obtained free of charge from the Cambridge Crystallographic Data Center via https://www.ccdc.cam.ac.uk/structures/.

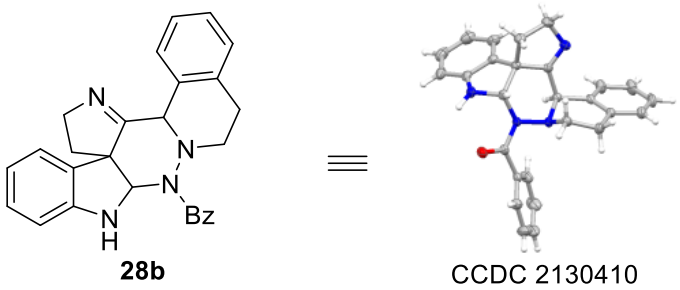
Crystal data and structure refinement for CCDC 2111851.

Crystal data

Empirical formula	$C_{27}H_{24}N_4O$
Formula weight	420.50
Temperature/K	293.15
Crystal system	orthorhombic
Space group	Pbcn
a/Å	26.264(2)
b/Å	9.4519(8)
c/Å	18.6059(14)
α/°	90
β/°	90
γ/°	90
Volume/Å^3	4618.8(7)
Z	8
ρcalcg/cm^3	1.209
μ/mm^{-1}	0.076
F(000)	1776.0

Crystal size/mm^3	0.3 × 0.2 × 0.2
Radiation	MoKα (λ = 0.71073)
2Θ range for data collection/°	6.204 to 52.744
Reflections collected	4710
Independent reflections	4710 [R_{int} = 0.0173, R_{sigma} = 0.0567]
Data/restraints/parameters	4710/0/293
Goodness-of-fit on F2	1.006
Final R indexes [I>=2σ (I)]	R_1 = 0.0606, wR_2 = 0.1332
Final R indexes [all data]	R_1 = 0.1108, wR_2 = 0.1528
Largest diff. peak/hole / e Å^{-3}	0.18/-0.26

5.2 X-ray crystallographic data for **28b**:



28b ≡ CCDC 2130410

The single crystal for compound **28b** was obtained by vaporization of a mixture solvent of hexane and MeOH (v/v = 1:3). The data were collected on a Xcalibur Eos diffractometer equipped with MoKα X-ray sources (λ = 0.71073 Å).

X-ray derived ORTEP of **28b** with thermal ellipsoids shown at the 30% probability level.

Structure deposited at the Cambridge Crystallographic Data Centre. CCDC 2130410 contains the supplementary crystallographic data which can be obtained free of charge from the Cambridge Crystallographic Data Center via https://www.ccdc.cam.ac.uk/structures/.

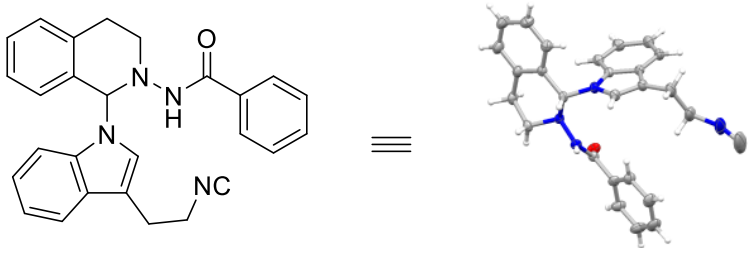
Crystal data and structure refinement for CCDC 2130410.

Crystal data

Empirical formula	$C_{27}H_{26}N_4O_2$
Formula weight	438.52
Temperature/K	293.15
Crystal system	monoclinic
Space group	$P2_1/c$
a/Å	11.5424(5)
b/Å	10.3573(4)

c/Å	19.1023(9)
α/°	90
β/°	90.669(4)
γ/°	90
Volume/Å^3	2283.50(17)
Z	4
ρ_{calc}g/cm^3	1.276
μ/mm^{-1}	0.082
F(000)	928.0
Crystal size/mm^3	0.35 × 0.3 × 0.25
Radiation	MoKα (λ = 0.71073)
2Θ range for data collection/	6.766 to 52.74
Index ranges	-14 ≤ h ≤ 14, -12 ≤ k ≤ 10, -22 ≤ l ≤ 23
Reflections collected	10551
Independent reflections	4659 [R_{int} = 0.0197, R_{sigma} = 0.0356]
Data/restraints/parameters	4659/0/310
Goodness-of-fit on F^2	1.016
Final R indexes [I>=2σ (I)]	R_1 = 0.0499, wR_2 = 0.1081
Final R indexes [all data]	R_1 = 0.0758, wR_2 = 0.1217
Largest diff. peak/hole / e Å^{-3}	0.19/-0.21

5.3 X-ray crystallographic data for **28c**:



28c ≡ CCDC 2150401

The single crystal for compound **28c** was obtained by vaporization of a mixture solvent of hexane and MeOH (v/v = 1:3). The data were collected on a Xcalibur Eos diffractometer equipped with CuKα X-ray sources (λ = 1.54178 Å).

X-ray derived ORTEP of **28c** with thermal ellipsoids shown at the 30% probability level.

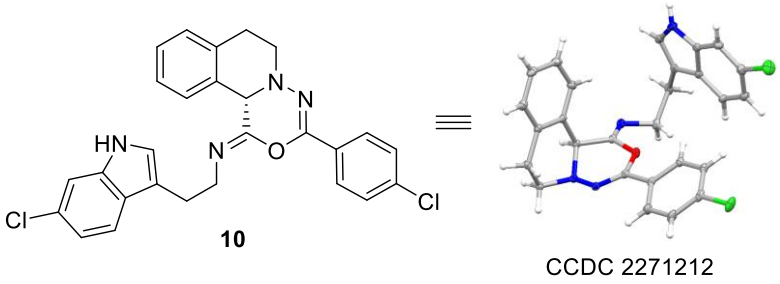
Structure deposited at the Cambridge Crystallographic Data Centre. CCDC 2150401 contains the supplementary crystallographic data which can be obtained free of charge from the Cambridge Crystallographic Data Center via https://www.ccdc.cam.ac.uk/structures/.

Crystal data and structure refinement for CCDC 2150401.

Crystal data

Empirical formula	$C_{27}H_{24}N_4O$
Formula weight	420.50
Temperature/K	173
Crystal system	tetragonal
Space group	I 41/a
a/Å	24.3936(8)
b/Å	24.3936(8)
c/Å	16.9622(8)
α/°	90
β/°	90
γ/°	90
Volume/Å3	10093.3(8)
Z	16
ρcalcg/cm3	1.107
μ/mm 1	0.545
F(000)	3552
Crystal size/mm3	0.398 × 0.363 × 0.356
Radiation	CuKα (λ = 1.54178)
2Θ range for data collection/	6.346 to 136.712
Index ranges	-29 ≤ h ≤ 25, -29 ≤ k ≤ 29, -16 ≤ l ≤ 20
Reflections collected	36996
Independent reflections	36996 [Rint = 0.0557, Rsigma = 0.0324]
Data/restraints/parameters	4529/4/301
Goodness-of-fit on F2	1.052
Final R indexes [I>=2σ (I)]	R_1 = 0.0664, wR_2 = 0.1629
Final R indexes [all data]	R_1 = 0.0795, wR_2 = 0.1736
Largest diff. peak/hole / e $Å^{-3}$	0.36/-0.21

5.4 X-ray crystallographic data for **10**:



10

CCDC 2271212

The single crystal for compound **10** was obtained by vaporization of a mixture solvent of hexane and MeOH (v/v = 1:3). The data were collected on a Xcalibur Eos diffractometer equipped with CuKα X-ray sources (λ = 1.54178 Å).

X-ray derived ORTEP of **10** with thermal ellipsoids shown at the 30% probability level.

Structure deposited at the Cambridge Crystallographic Data Centre. CCDC 2271212 contains the supplementary crystallographic data which can be obtained free of charge from the Cambridge Crystallographic Data Center via https://www.ccdc.cam.ac.uk/structures/.

Crystal data and structure refinement for CCDC 2271212.

Crystal data

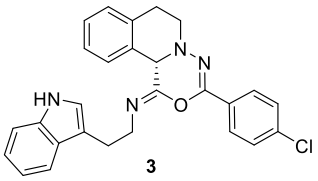
Empirical formula	$C_{27}H_{22}Cl_2N_4O$
Formula weight	489.38
Temperature/K	173
Crystal system	monoclinic
Space group	P21
a/Å	10.1692(2)
b/Å	9.7507(2)
c/Å	23.6934(5)
α/°	90
β/°	101.6860(10)
γ/°	90
Volume/Å^3	2300.67(8)
Z	4
ρ_{calc}g/cm^3	1.413
μ/mm^{-1}	2.767
F(000)	1016
Crystal size/mm^3	0.549 × 0.107 × 0.101
Radiation	CuKα (λ = 1.54178)
2Θ range for data collection/	7.620 to 136.496
Index ranges	-12 ≤ h ≤ 12, -10 ≤ k ≤ 11, -28 ≤ l ≤ 28
Reflections collected	42371
Independent reflections	42371 [R_{int} = 0.0561, R_{sigma} = 0.0443]
Data/restraints/parameters	8210/3/621
Goodness-of-fit on F^2	1.059
Final R indexes [I>=2σ (I)]	R_1 = 0.0329, wR_2 = 0.0759
Final R indexes [all data]	R_1 = 0.0368, wR_2 = 0.0783
Largest diff. peak/hole / e Å^{-3}	0.15/-0.26

6. References

1. a) H. Liu and A. Domling, *J. Org. Chem.*, **2009**, *74*, 6895; b) J. F. Zheng, L. Yang, X. Dai, L. L. Chen, L. H. Tang, Y. Q. Zhou, and W.-D. Z. Li, *Org. Lett.*, **2023**, *25*, 3829.

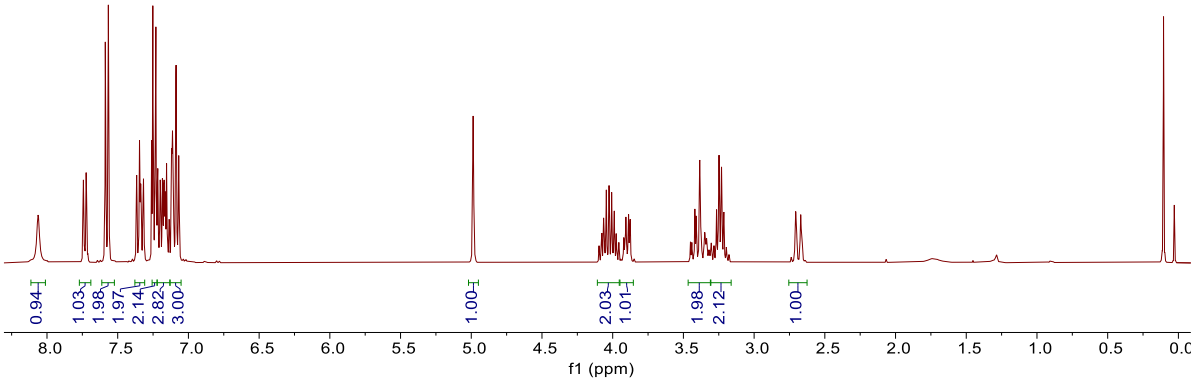
2. T. Hashimoto, Y. Maeda, M. Omote, H. Nakatsu and K. Maruoka, *J. Am. Chem. Soc.*, **2010**, *132*, 4076.

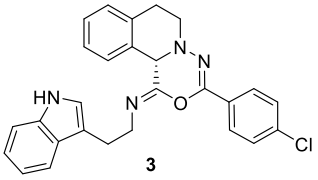
7. Copy of ^{1}H NMR and ^{13}C NMR Spectra



3

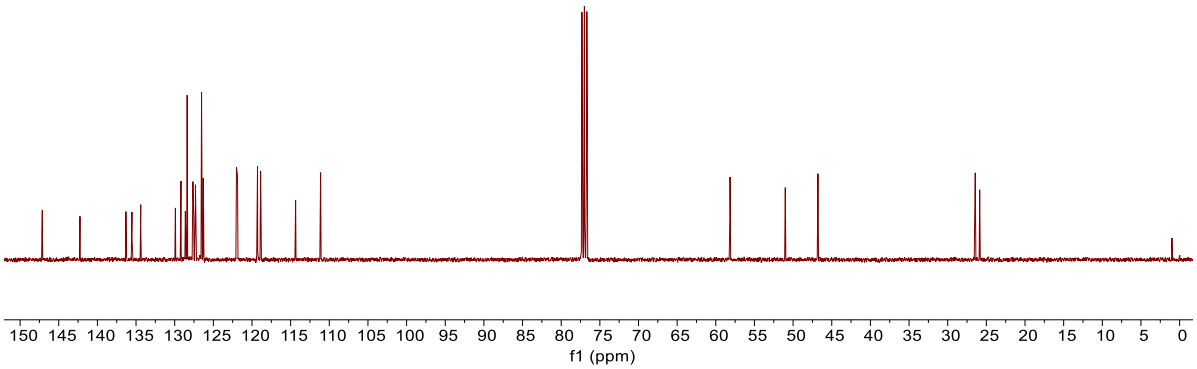
^{1}H NMR (400 MHz, $CDCl_3$)

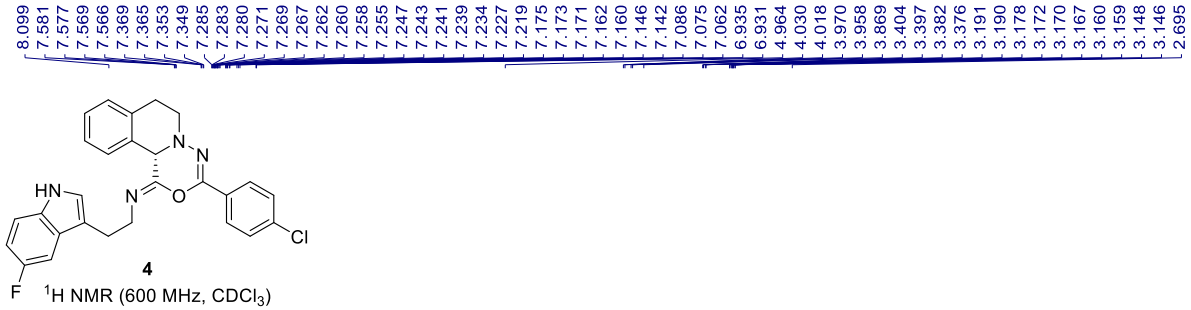




3

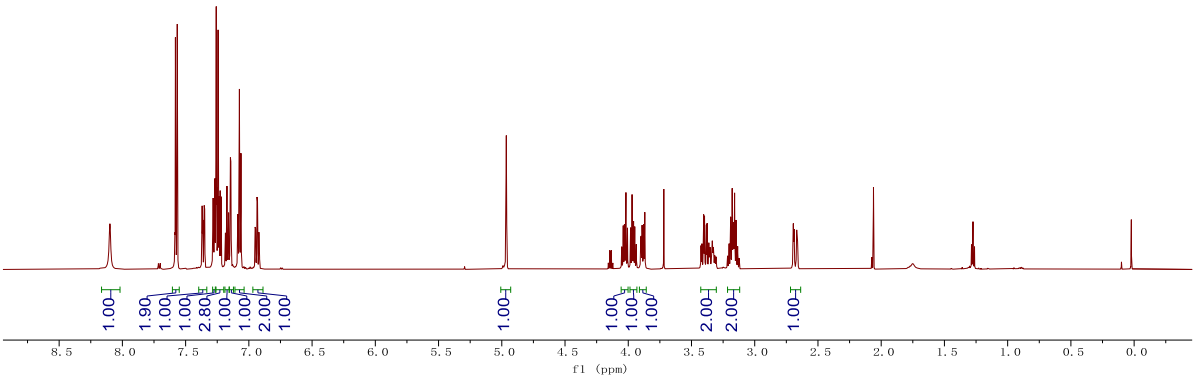
^{13}C NMR (101 MHz, $CDCl_3$)

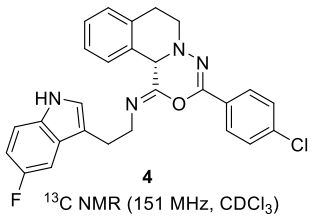




4

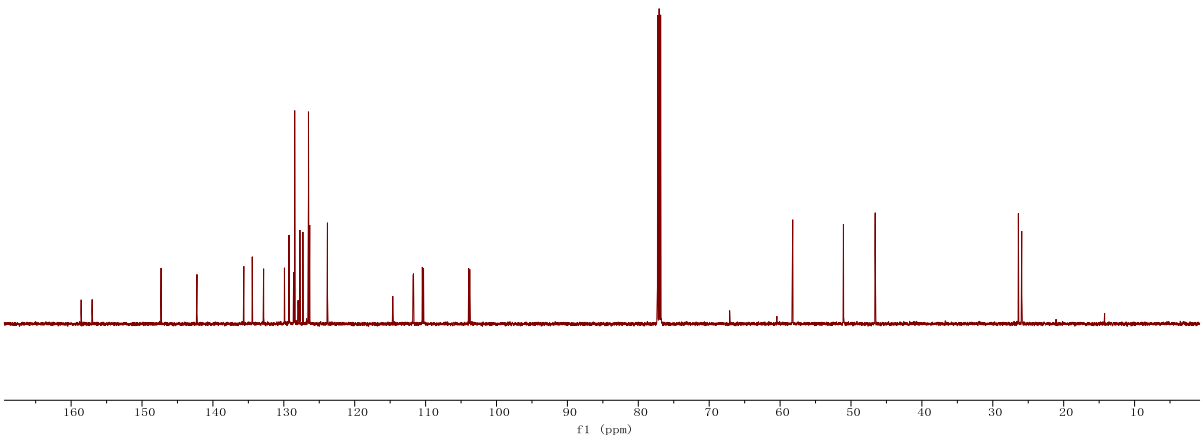
^{1}H NMR (600 MHz, $CDCl_3$)

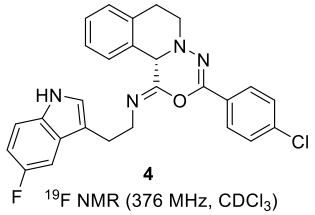




4

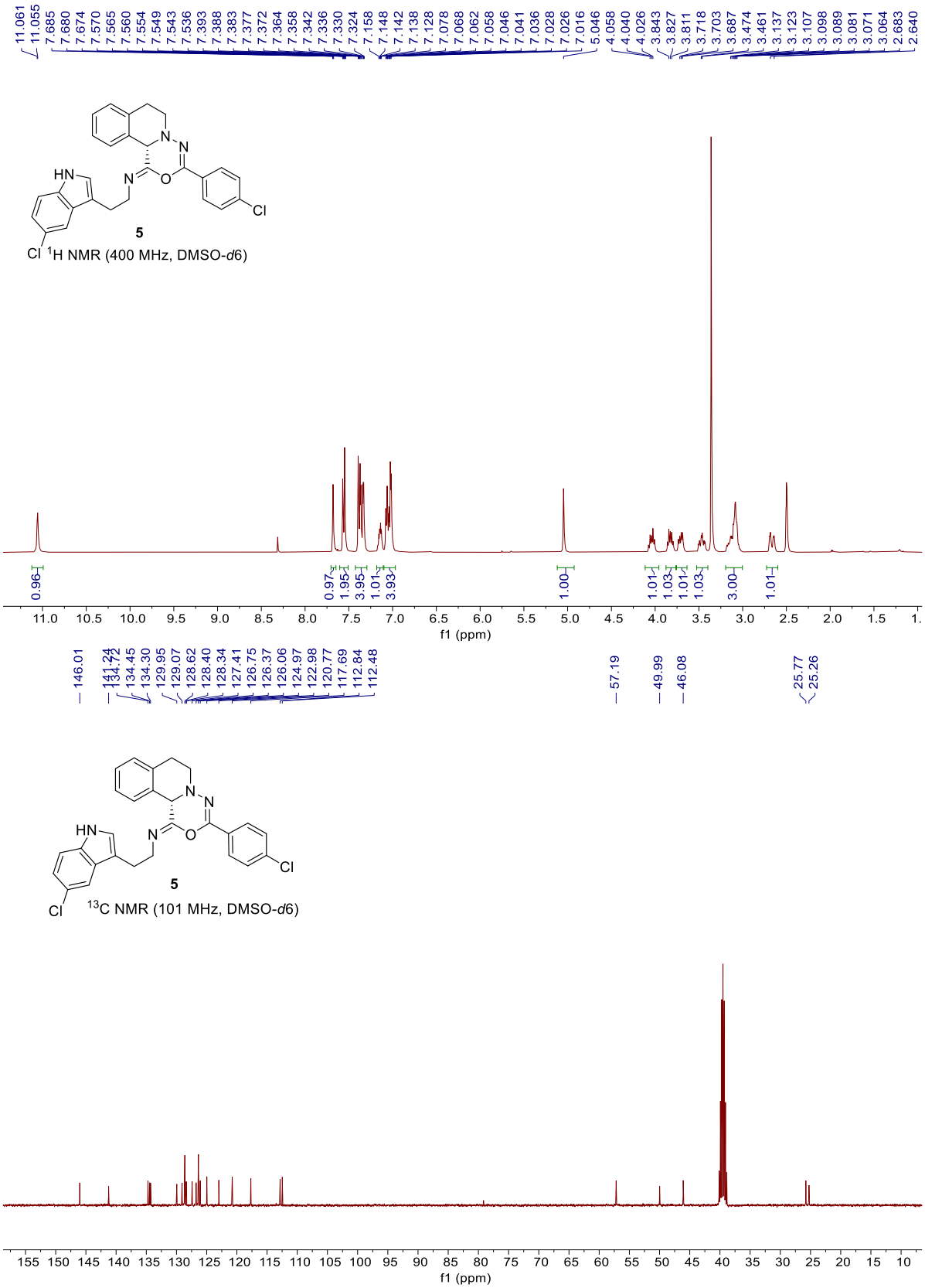
^{13}C NMR (151 MHz, $CDCl_3$)

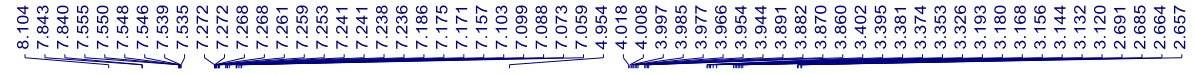


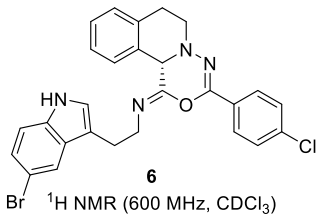


4

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

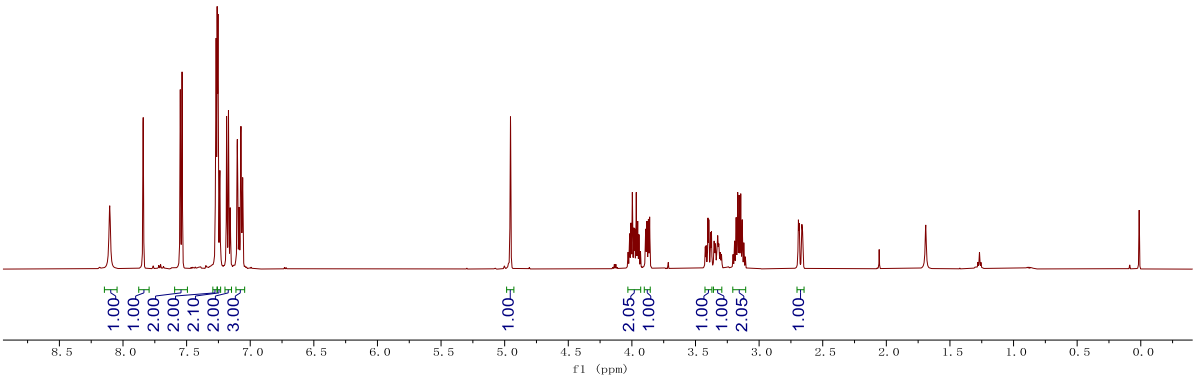

11.061
11.055
7.685
7.680
7.674
7.570
7.565
7.560
7.554
7.549
7.543
7.536
7.393
7.388
7.383
7.377
7.372
7.364
7.358
7.342
7.336
7.330
7.324
7.158
7.148
7.142
7.138
7.128
7.078
7.068
7.062
7.058
7.046
7.041
7.036
7.028
7.026
7.016
5.046
4.058
4.040
4.026
3.843
3.827
3.811
3.718
3.703
3.687
3.474
3.461
3.137
3.123
3.107
3.098
3.089
3.081
3.071
3.064
2.683
2.640
HN
N
N
O
Cl
Cl
5
^{1}H NMR (400 MHz, DMSO-d6)
0.96
0.97
1.95
3.95
1.01
3.93
1.00
1.01
1.03
1.01
1.03
3.00
1.01
f1 (ppm)
146.01
141.24
134.72
134.45
134.30
129.95
129.07
128.62
128.40
128.34
127.41
126.75
126.37
126.06
124.97
122.98
120.77
117.69
112.84
112.48
57.19
49.99
46.08
25.77
25.26
HN
N
N
O
Cl
Cl
5
^{13}C NMR (101 MHz, DMSO-d6)
f1 (ppm)

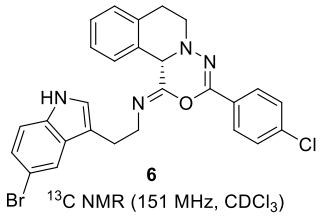




6

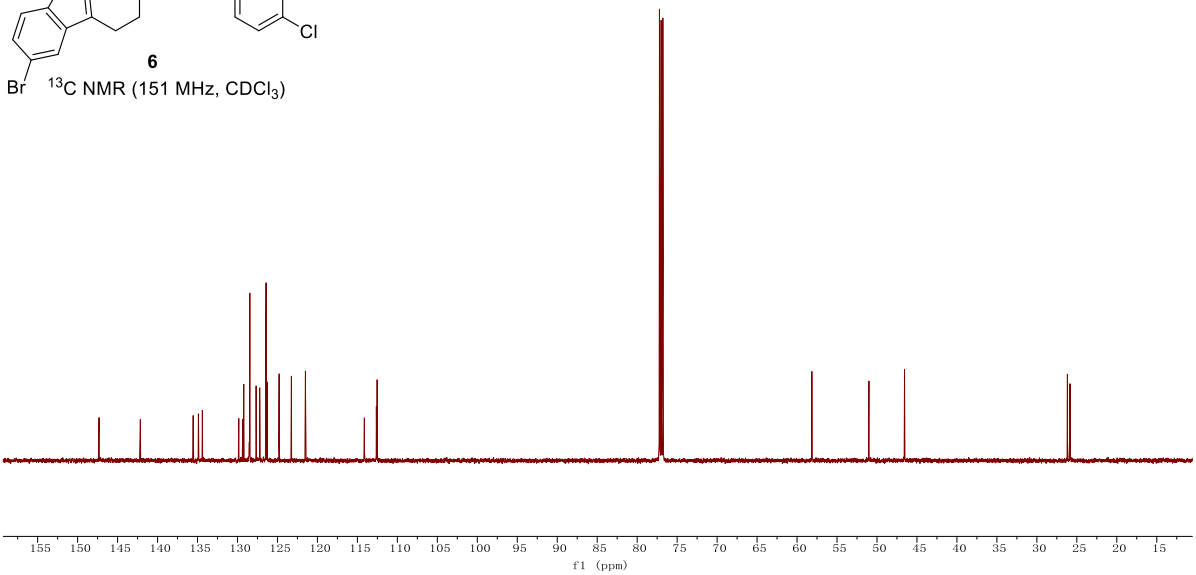
^{1}H NMR (600 MHz, $CDCl_3$)

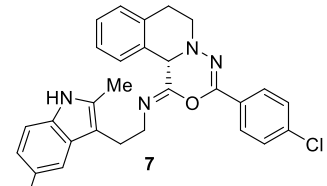




6

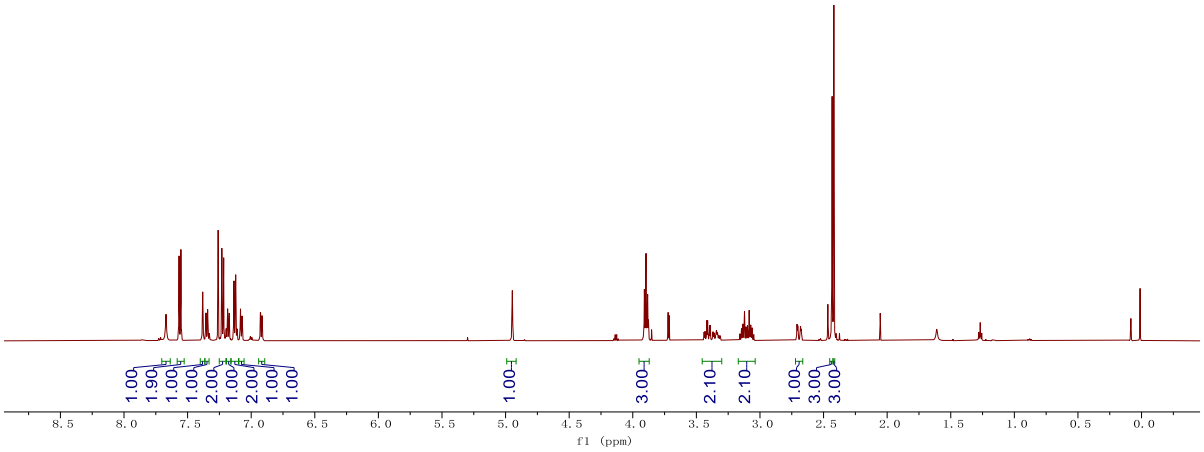
^{13}C NMR (151 MHz, $CDCl_3$)

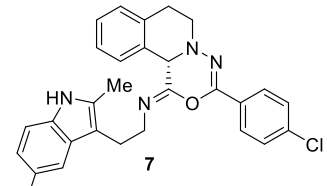




7

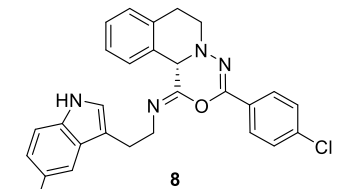
^{1}H NMR (600 MHz, $CDCl_3$)





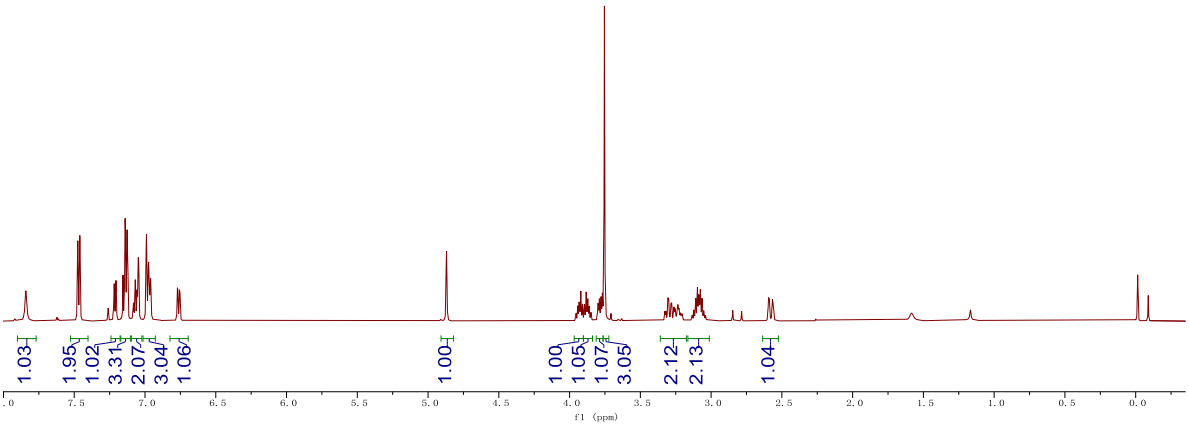
7

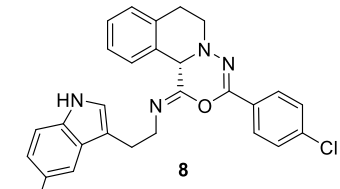
^{13}C NMR (151 MHz, $CDCl_3$)



8

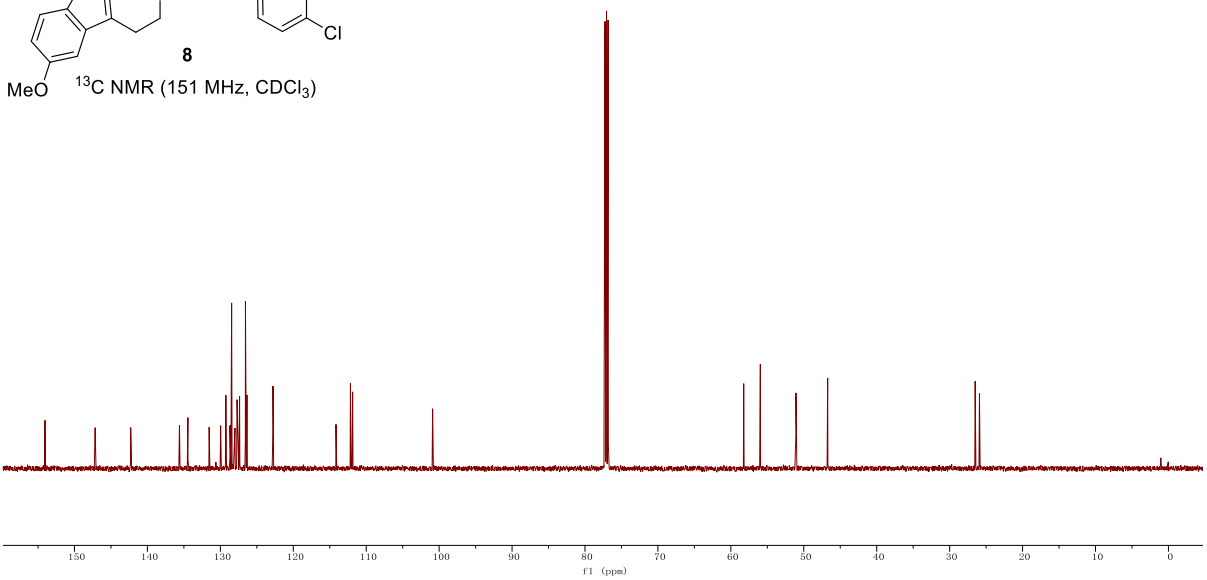
^{1}H NMR (600 MHz, $CDCl_3$)

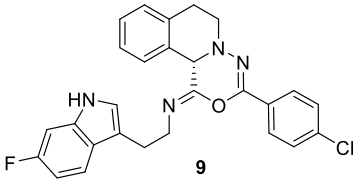




8

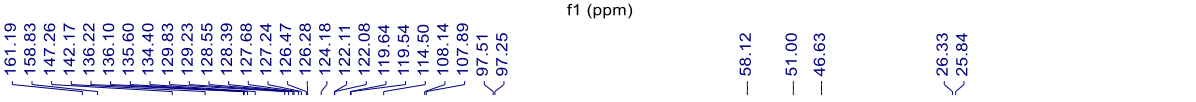
^{13}C NMR (151 MHz, $CDCl_3$)

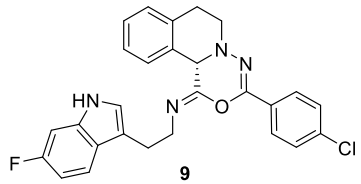




9

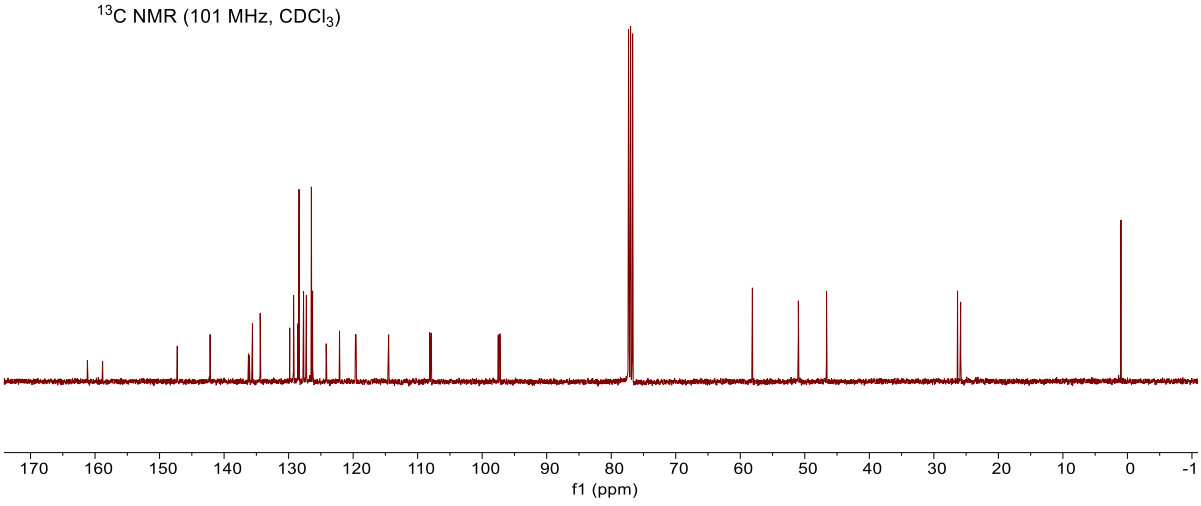
^{1}H NMR (400 MHz, $CDCl_3$)

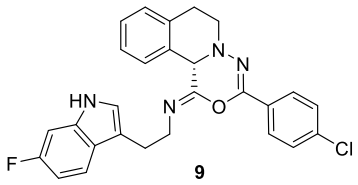




9

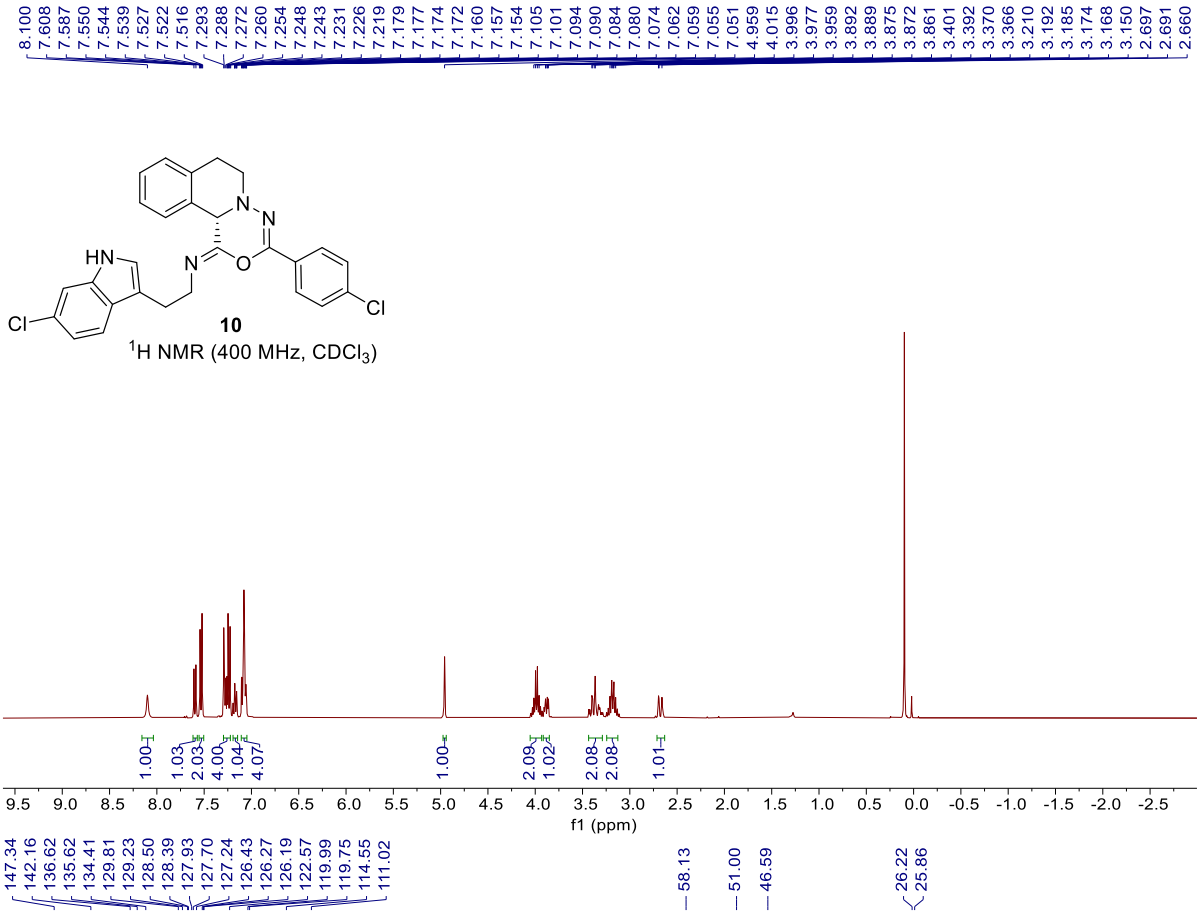
^{13}C NMR (101 MHz, $CDCl_3$)

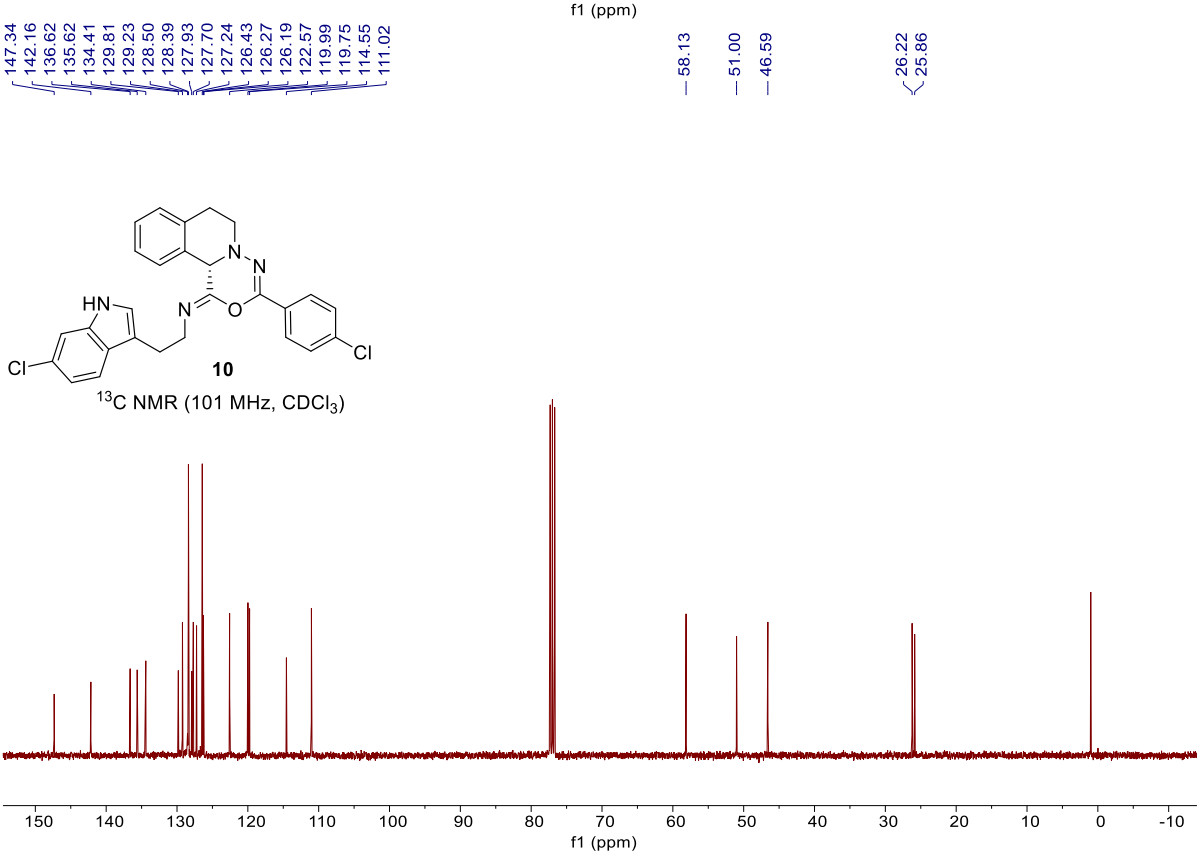




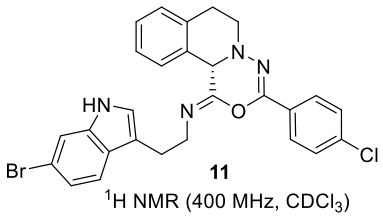
9

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


8.100
7.608
7.587
7.550
7.544
7.539
7.527
7.522
7.516
7.293
7.288
7.272
7.260
7.254
7.248
7.243
7.231
7.226
7.219
7.179
7.177
7.174
7.172
7.160
7.157
7.154
7.105
7.101
7.094
7.090
7.084
7.080
7.074
7.062
7.059
7.055
7.051
4.959
4.015
3.996
3.977
3.959
3.892
3.889
3.875
3.872
3.861
3.401
3.392
3.370
3.366
3.210
3.192
3.185
3.174
3.168
3.150
2.697
2.691
2.660
HN
N
N
O
Cl
Cl
10
1H NMR (400 MHz, CDCl3)
1.00
1.03
2.03
4.00
1.04
4.07
1.00
2.09
1.02
2.08
2.08
1.01
f1 (ppm)

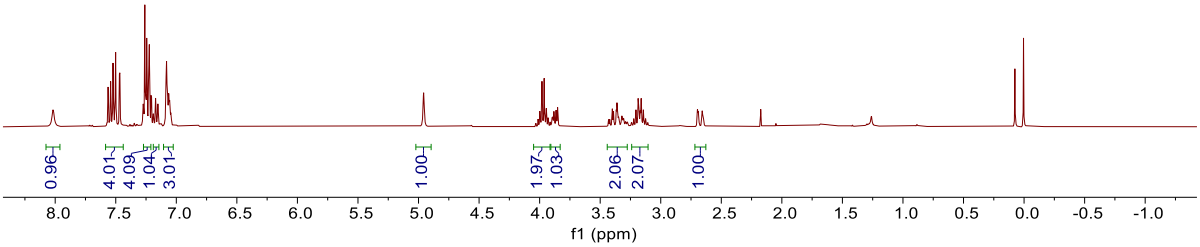

147.34
142.16
136.62
135.62
134.41
129.81
129.23
128.50
128.39
127.93
127.70
127.24
126.43
126.27
126.19
122.57
119.99
119.75
114.55
111.02
58.13
51.00
46.59
26.22
25.86
f1 (ppm)

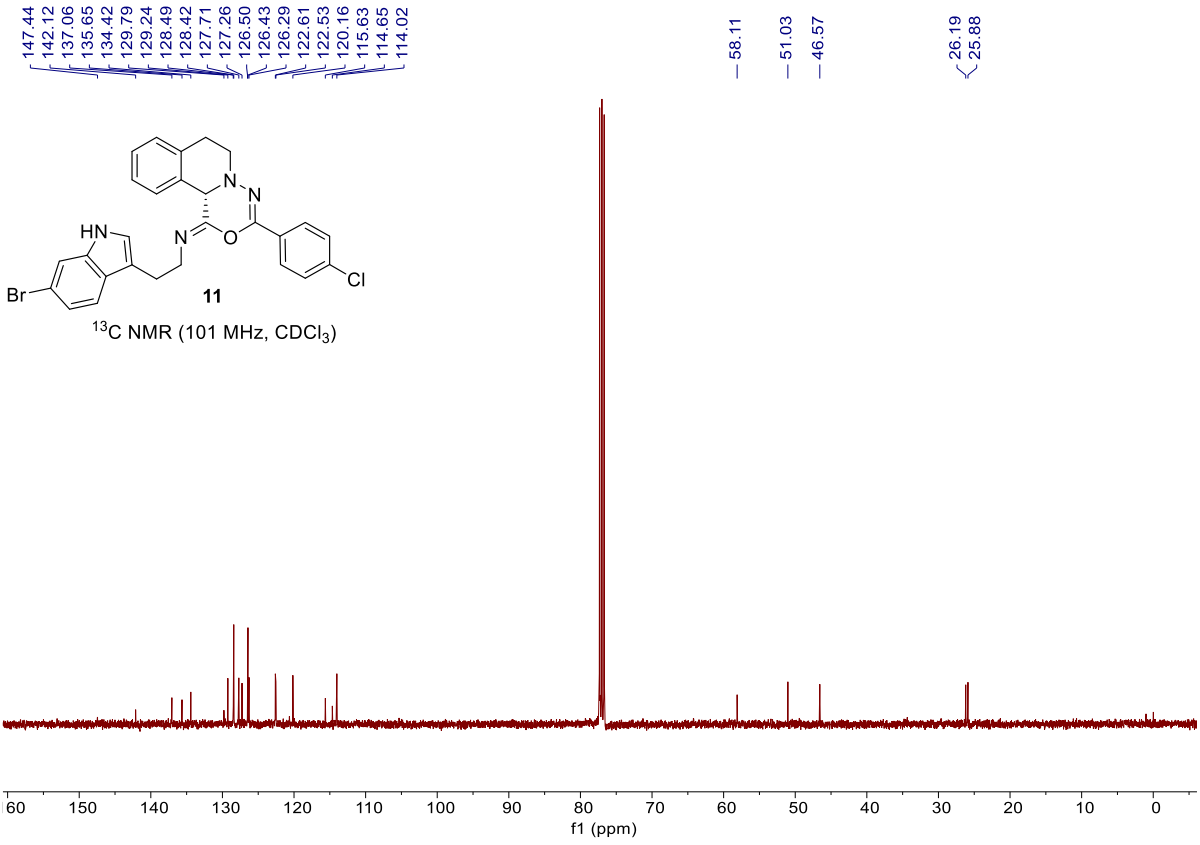
HN
N
N
O
Cl
Cl
10
13C NMR (101 MHz, CDCl3)
f1 (ppm)



11

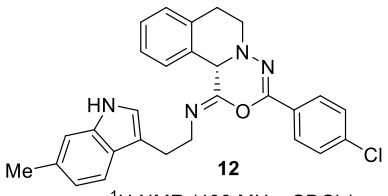
^{1}H NMR (400 MHz, $CDCl_3$)





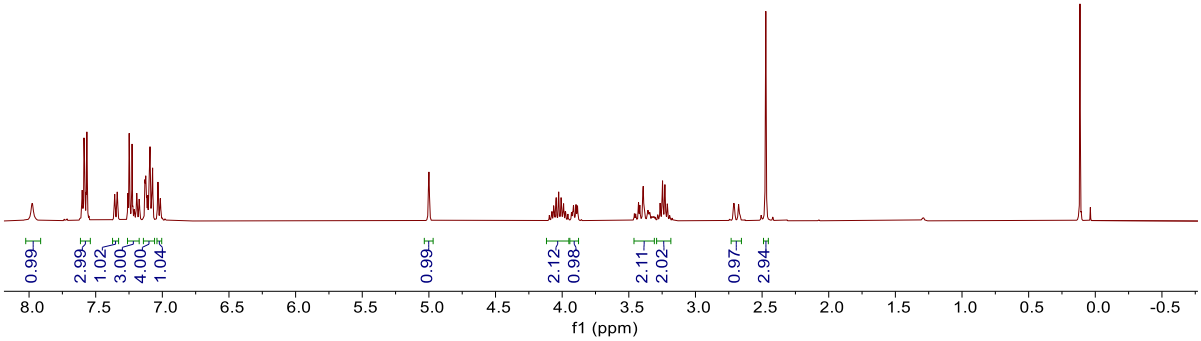
11

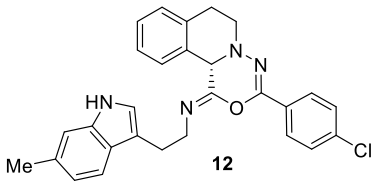
^{13}C NMR (101 MHz, $CDCl_3$)



12

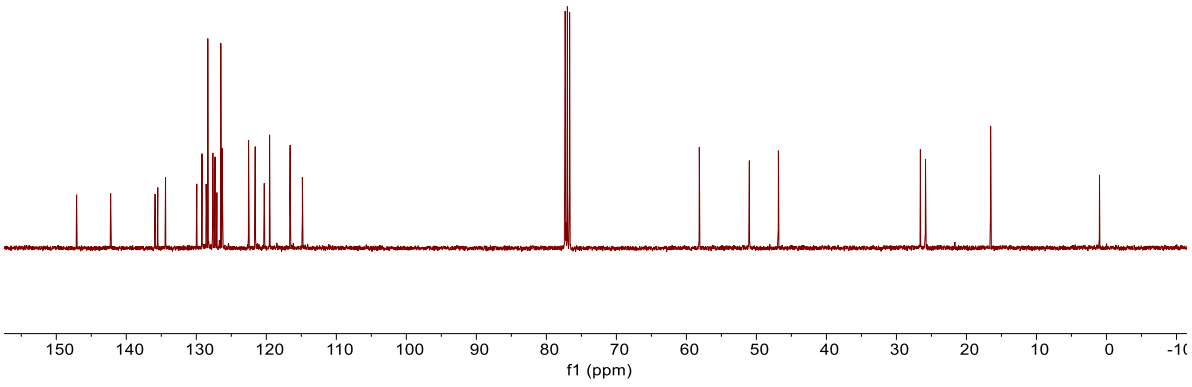
^{1}H NMR (400 MHz, $CDCl_3$)

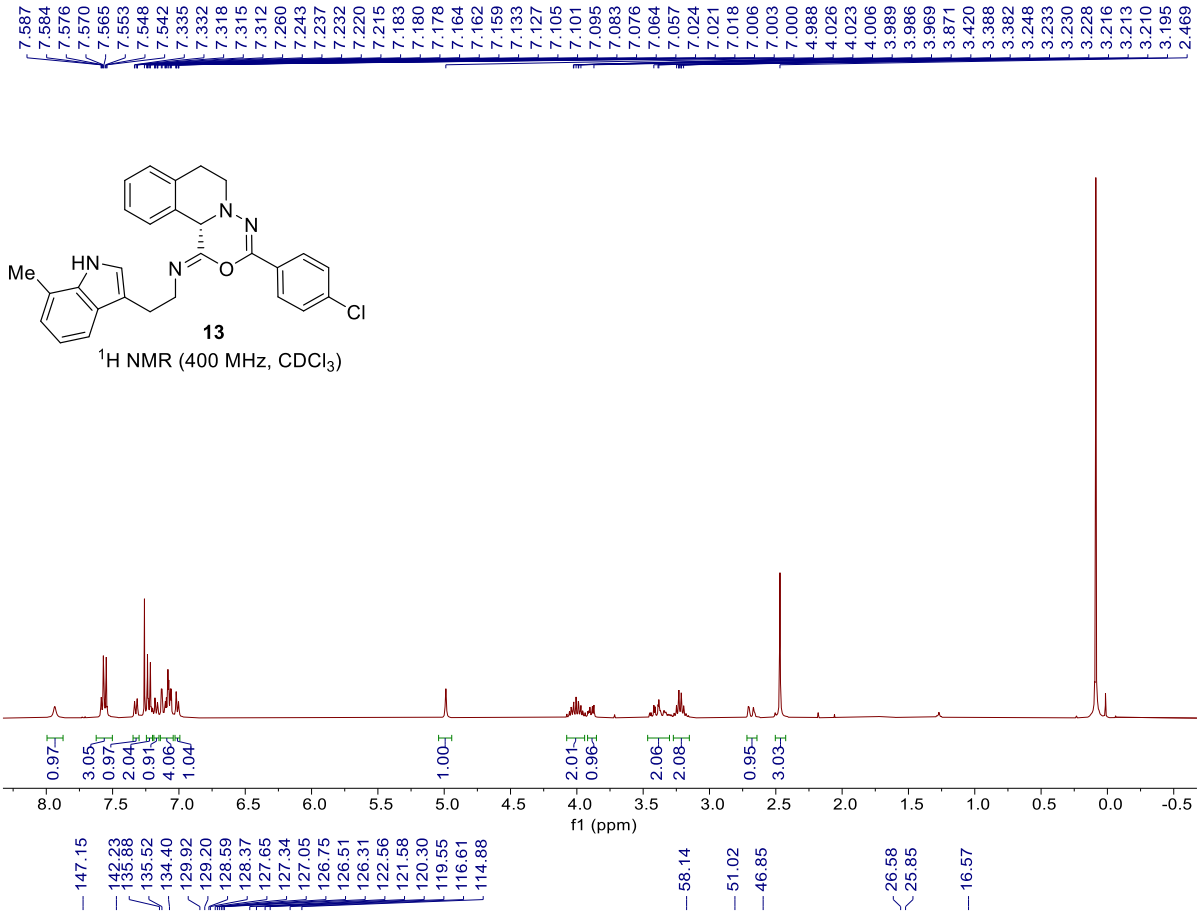


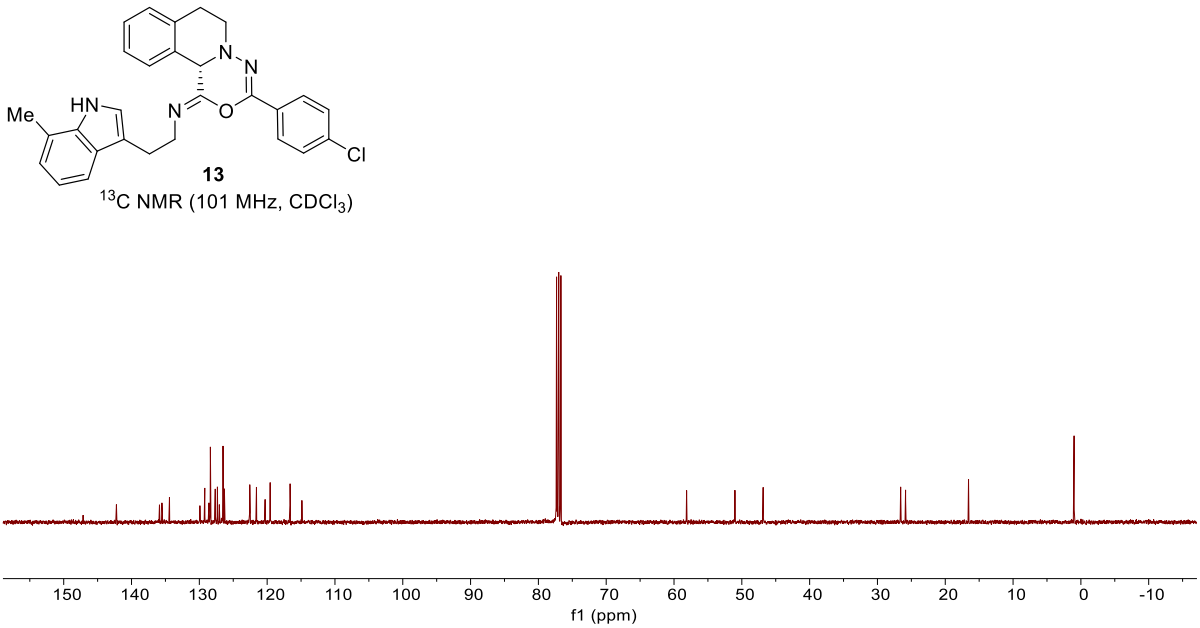


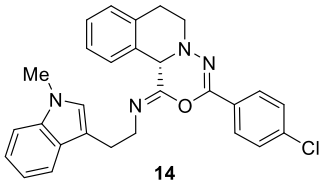
12

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



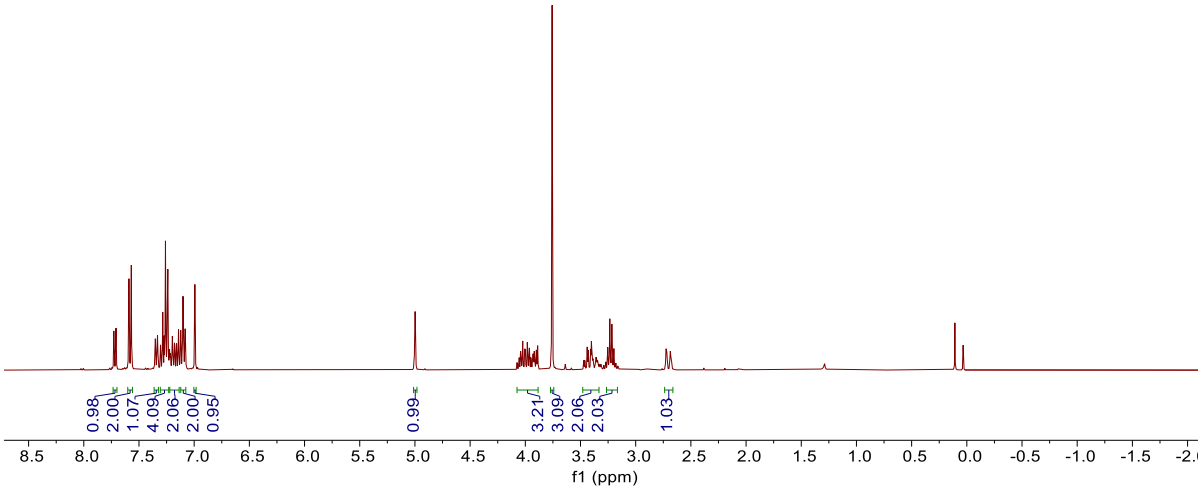

7.587
7.584
7.576
7.570
7.565
7.553
7.548
7.542
7.335
7.332
7.318
7.315
7.312
7.260
7.243
7.237
7.232
7.220
7.215
7.183
7.180
7.178
7.164
7.162
7.159
7.133
7.127
7.105
7.101
7.095
7.083
7.076
7.064
7.057
7.024
7.021
7.018
7.006
7.003
7.000
4.988
4.026
4.023
4.006
3.989
3.986
3.969
3.871
3.420
3.388
3.382
3.248
3.233
3.230
3.228
3.216
3.213
3.210
3.195
2.469
Me
HN
N
N
O
Cl
13
1H NMR (400 MHz, CDCl3)
0.97
3.05
0.97
2.04
0.91
4.06
1.04
1.00
2.01
0.96
2.06
2.08
0.95
3.03
f1 (ppm)

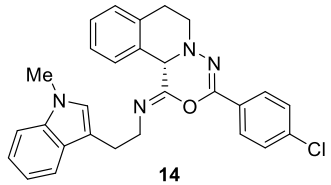

147.15
142.23
135.88
135.52
134.40
129.92
129.20
128.59
128.37
127.65
127.34
127.05
126.75
126.51
126.31
122.56
121.58
120.30
119.55
116.61
114.88
58.14
51.02
46.85
26.58
25.85
16.57
Me
HN
N
N
O
Cl
13
13C NMR (101 MHz, CDCl3)
f1 (ppm)



14

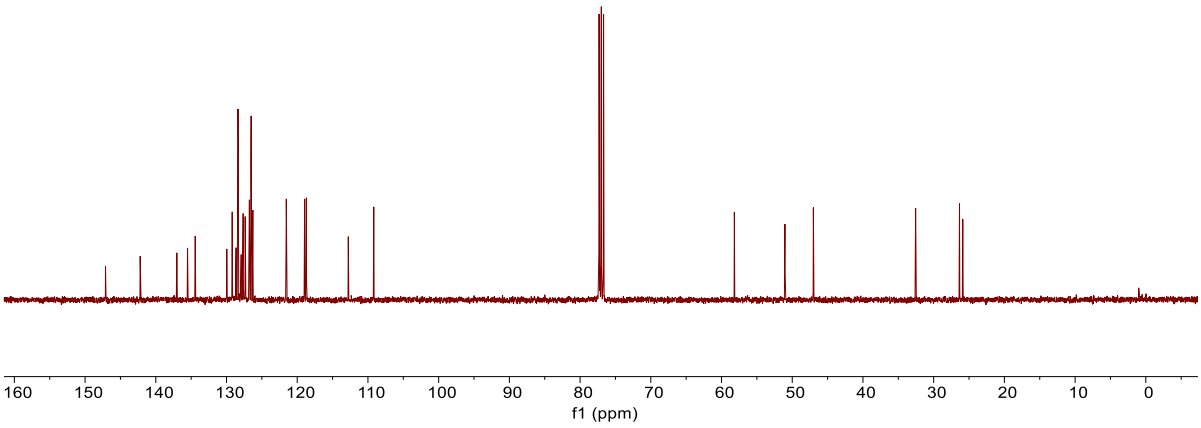
^{1}H NMR (400 MHz, $CDCl_3$)

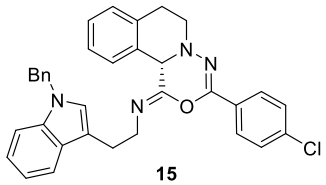




14

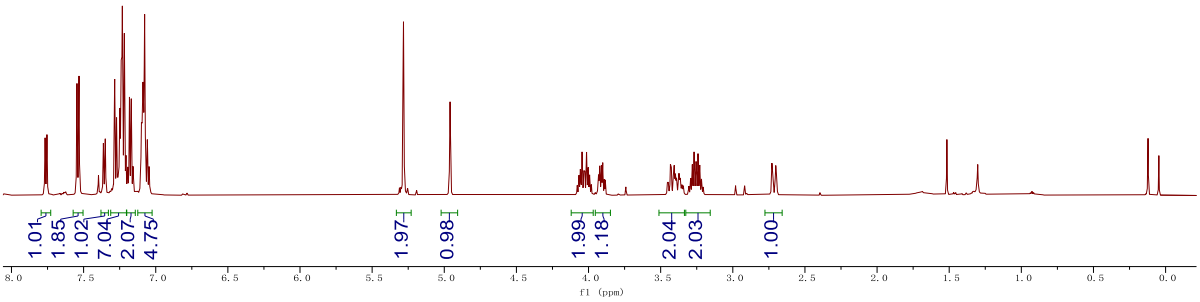
^{13}C NMR (101 MHz, $CDCl_3$)

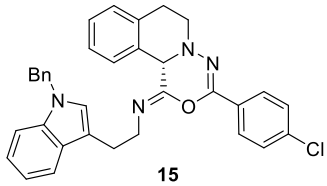




15

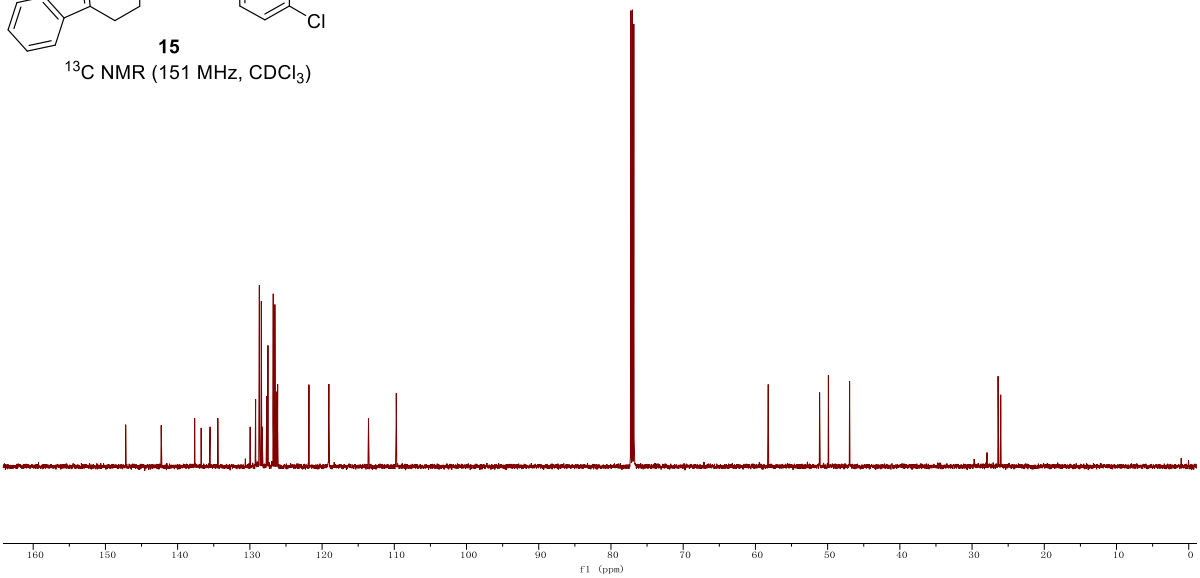
^{1}H NMR (600 MHz, $CDCl_3$)

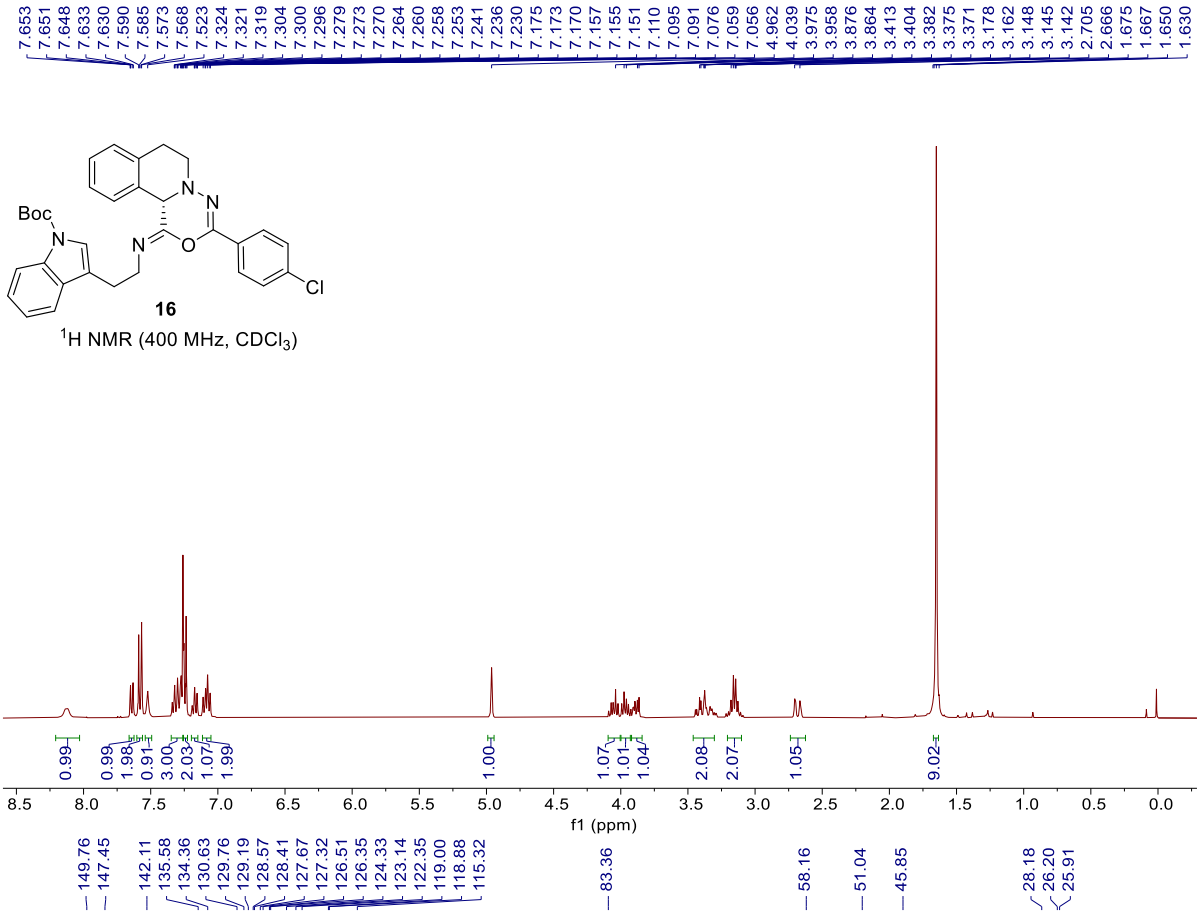


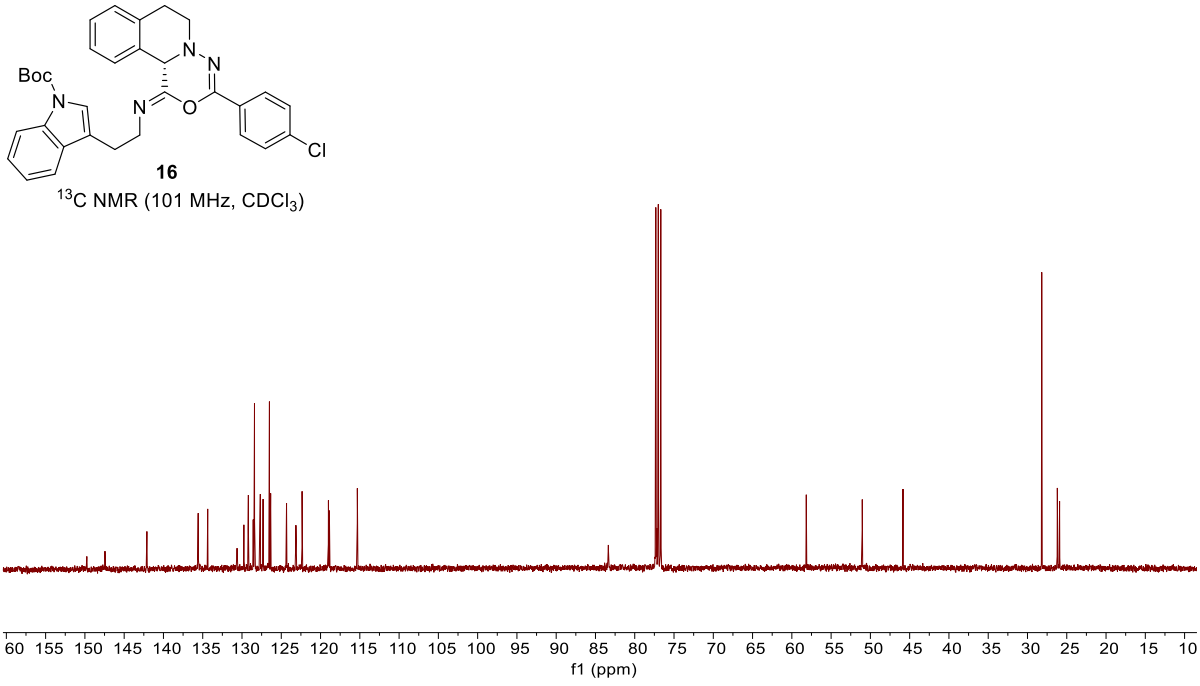


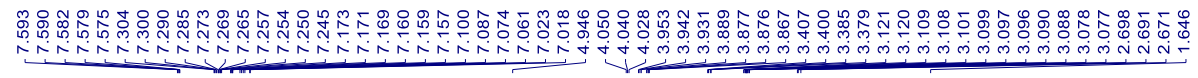
15

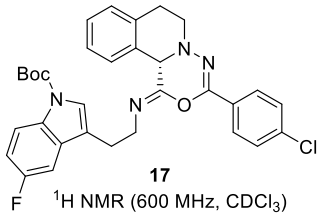
^{13}C NMR (151 MHz, $CDCl_3$)




7.653
7.651
7.648
7.633
7.630
7.590
7.585
7.573
7.568
7.523
7.324
7.321
7.319
7.304
7.300
7.296
7.279
7.273
7.270
7.264
7.260
7.258
7.253
7.241
7.236
7.230
7.175
7.173
7.170
7.157
7.155
7.151
7.110
7.095
7.091
7.076
7.059
7.056
4.962
4.039
3.975
3.958
3.876
3.864
3.413
3.404
3.382
3.375
3.371
3.178
3.162
3.148
3.145
3.142
2.705
2.666
1.675
1.667
1.650
1.630
Boc
N
N
N
O
Cl
16
1H NMR (400 MHz, CDCl3)
0.99
0.99
1.98
0.91
3.00
2.03
1.07
1.99
1.00
1.07
1.01
1.04
2.08
2.07
1.05
9.02
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)
149.76
147.45
142.11
135.58
134.36
130.63
129.76
129.19
128.57
128.41
127.67
127.32
126.51
126.35
124.33
123.14
122.35
119.00
118.88
115.32
83.36
58.16
51.04
45.85
28.18
26.20
25.91

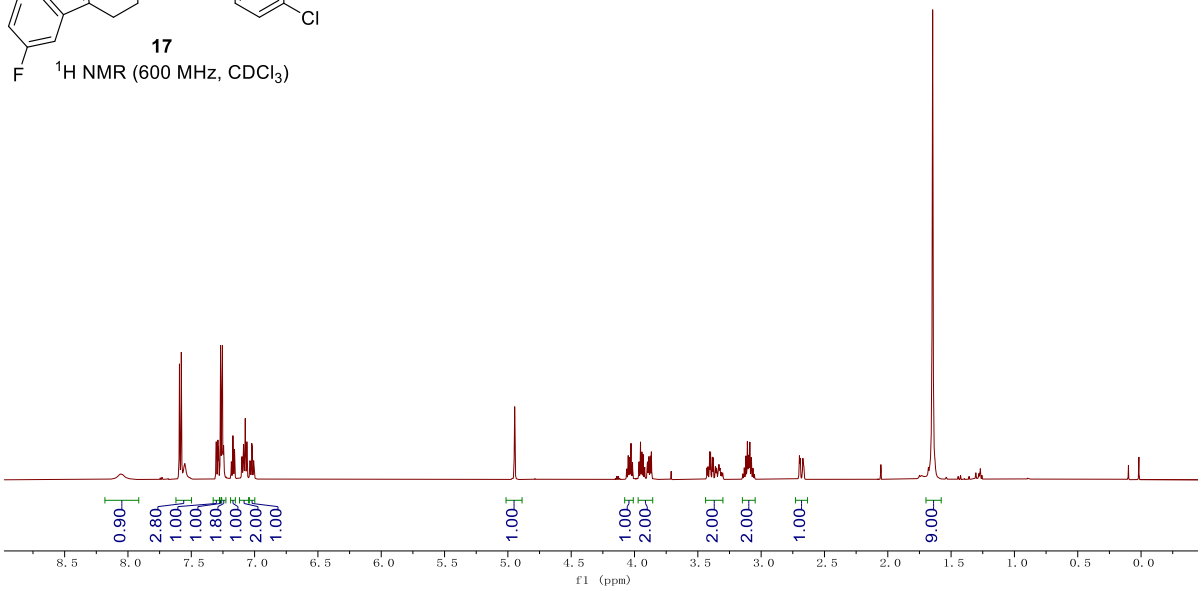

Boc
N
N
N
O
Cl
16
13C NMR (101 MHz, CDCl3)
60 155 150 145 140 135 130 125 120 115 110 105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10
f1 (ppm)

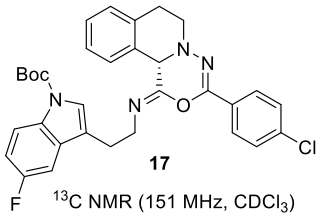




17

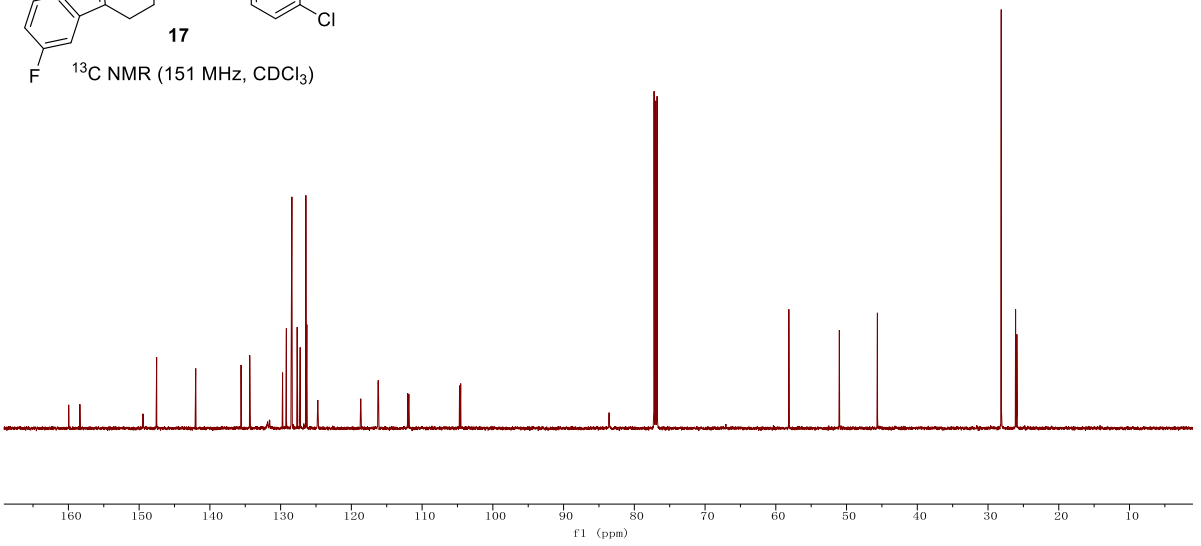
^{1}H NMR (600 MHz, $CDCl_3$)

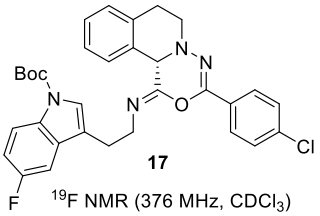




17

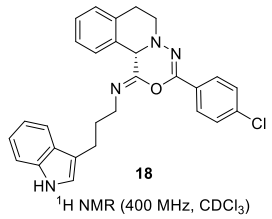
^{13}C NMR (151 MHz, $CDCl_3$)





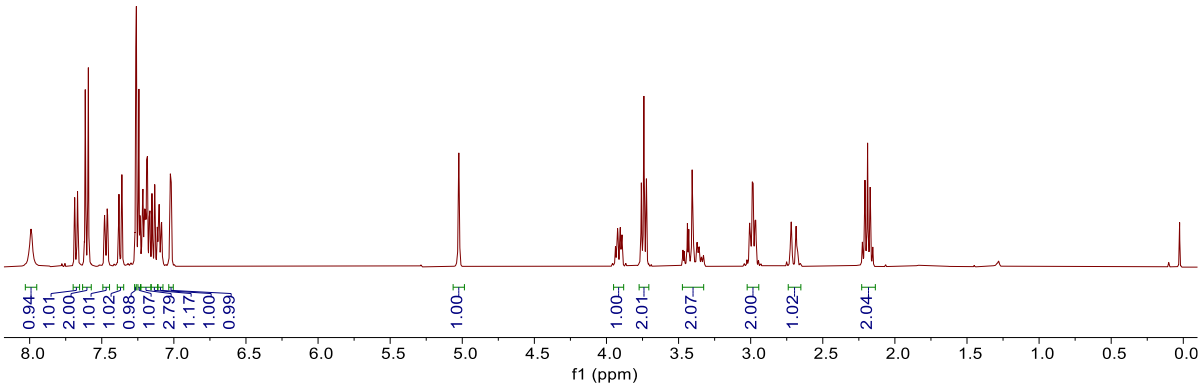
17

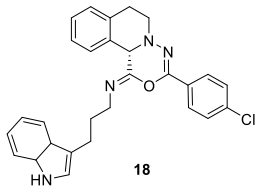
^{19}F NMR (376 MHz, $CDCl_3$)



18

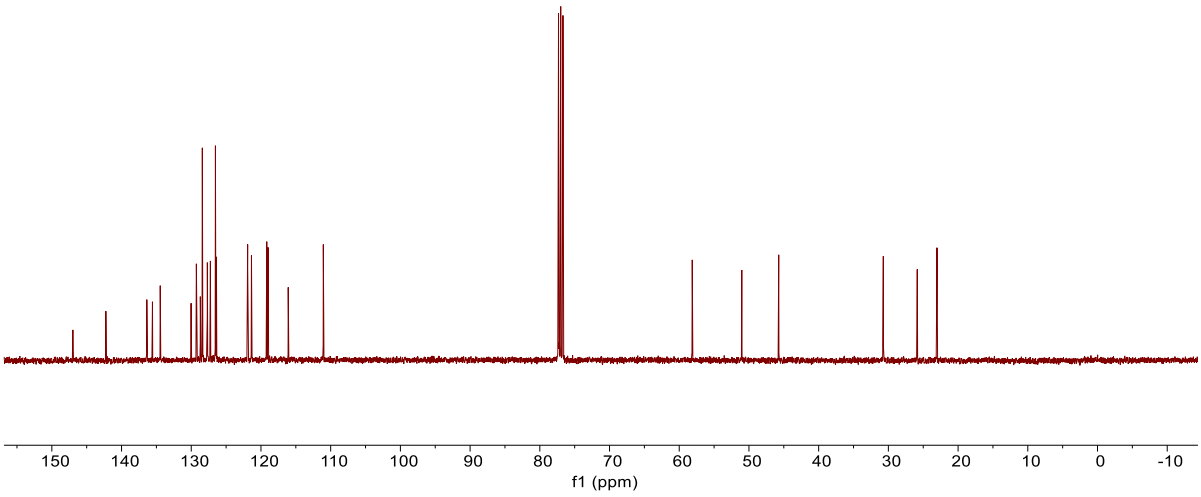
^{1}H NMR (400 MHz, $CDCl_3$)

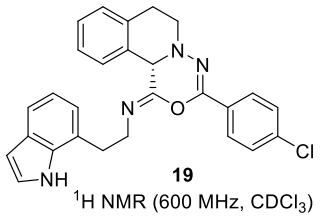




18

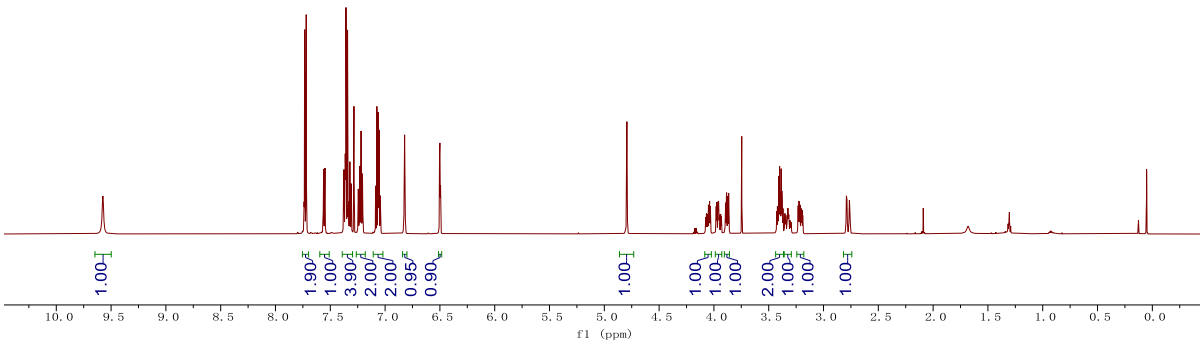
^{13}C NMR (101 MHz, $CDCl_3$)

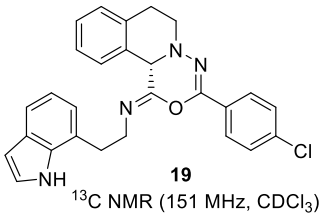




19

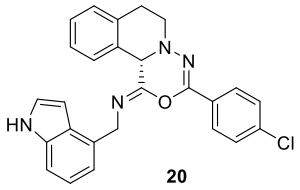
^{1}H NMR (600 MHz, $CDCl_3$)





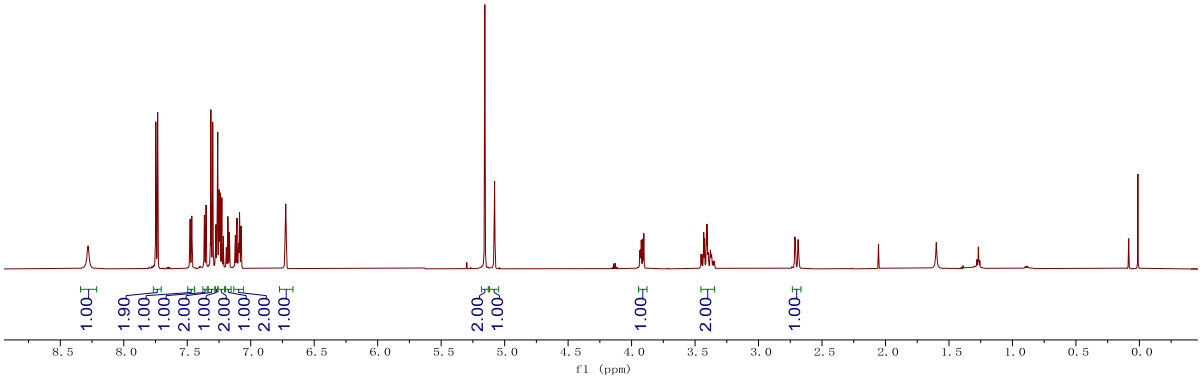
19

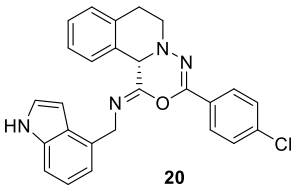
^{13}C NMR (151 MHz, $CDCl_3$)



20

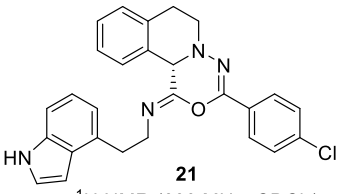
^{1}H NMR (600 MHz, $CDCl_3$)





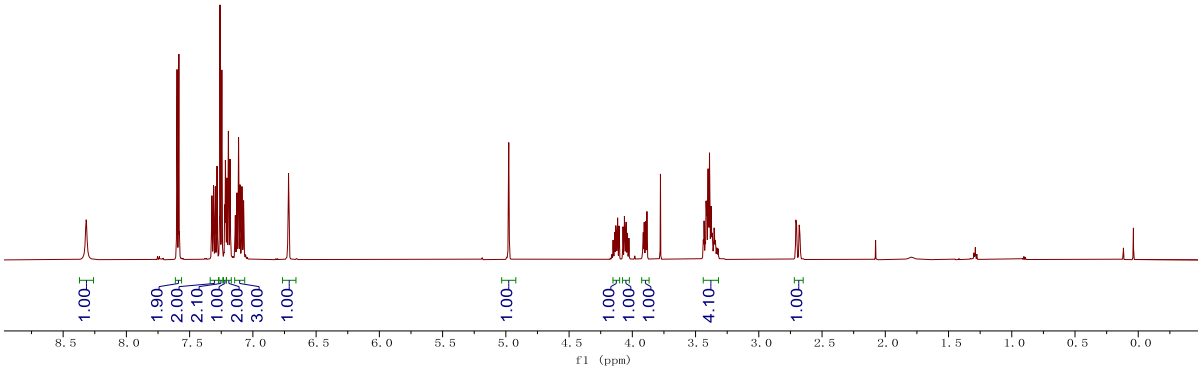
20

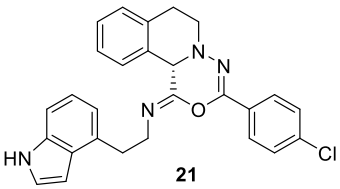
^{13}C NMR (151 MHz, $CDCl_3$)



21

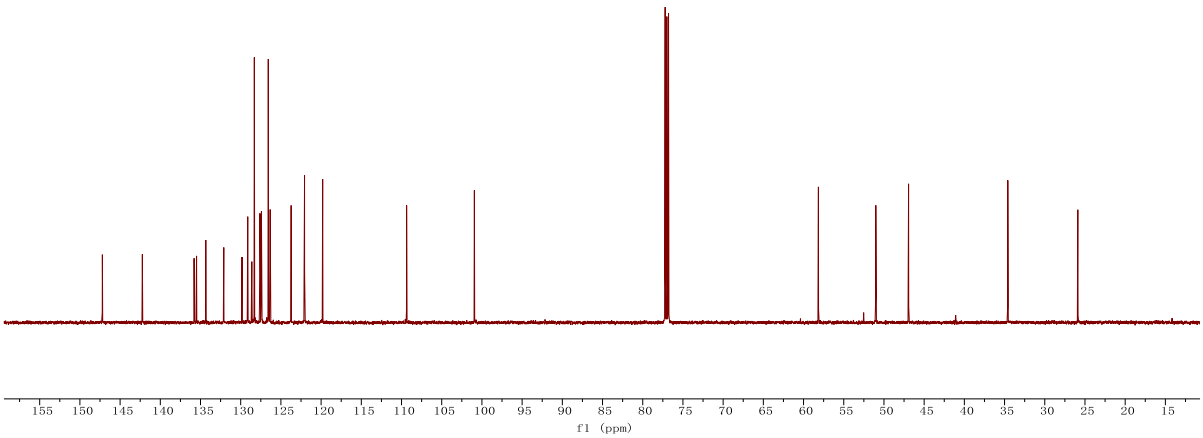
^{1}H NMR (600 MHz, $CDCl_3$)

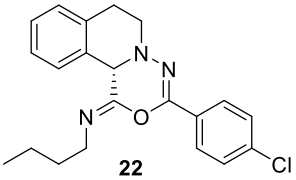




21

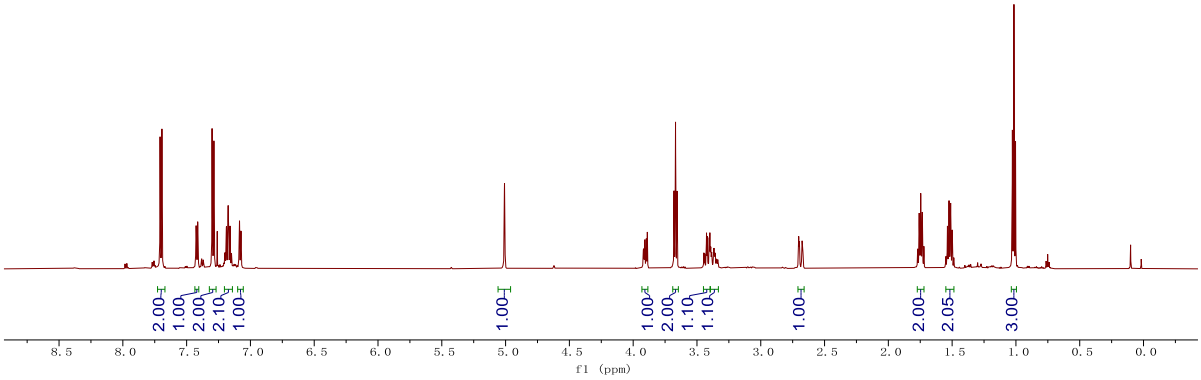
^{13}C NMR (151 MHz, $CDCl_3$)

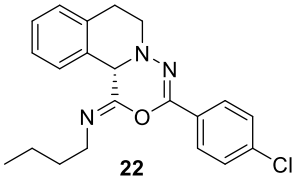




22

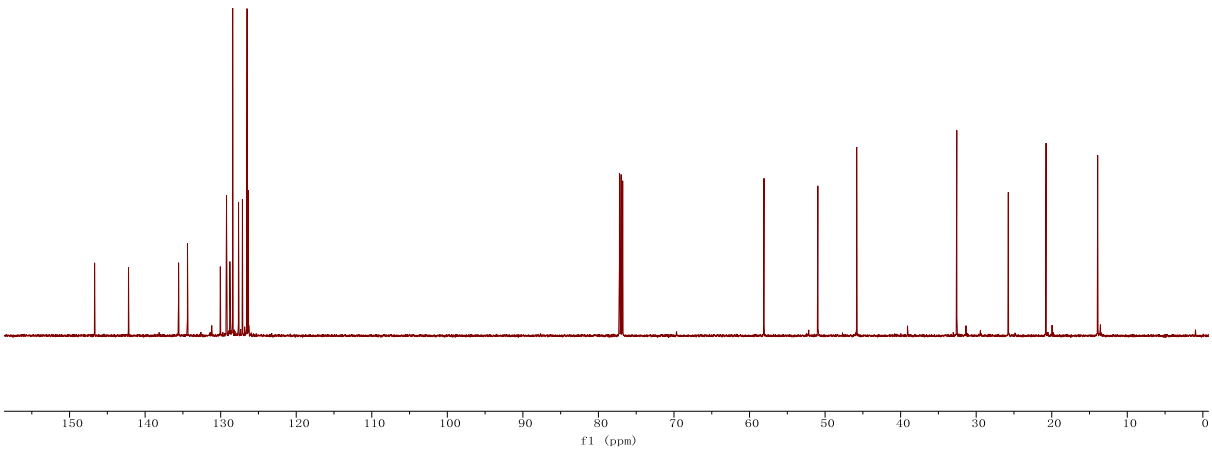
^{1}H NMR (600 MHz, $CDCl_3$)

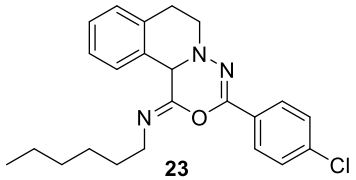




22

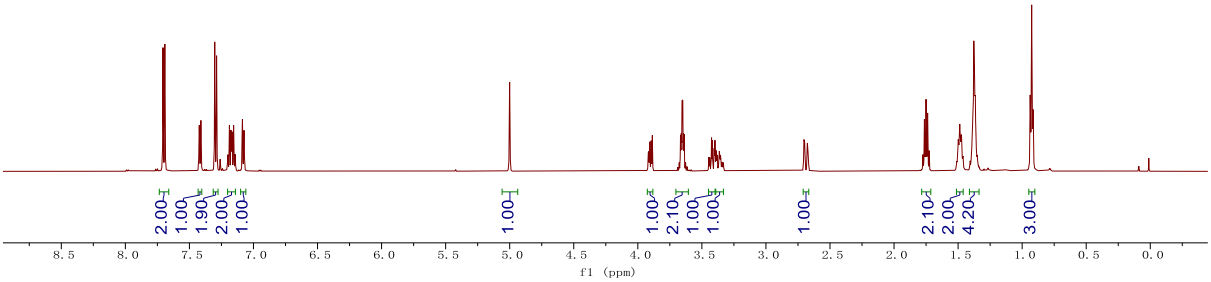
^{13}C NMR (151 MHz, $CDCl_3$)

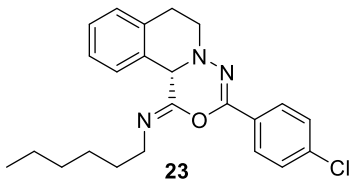




23

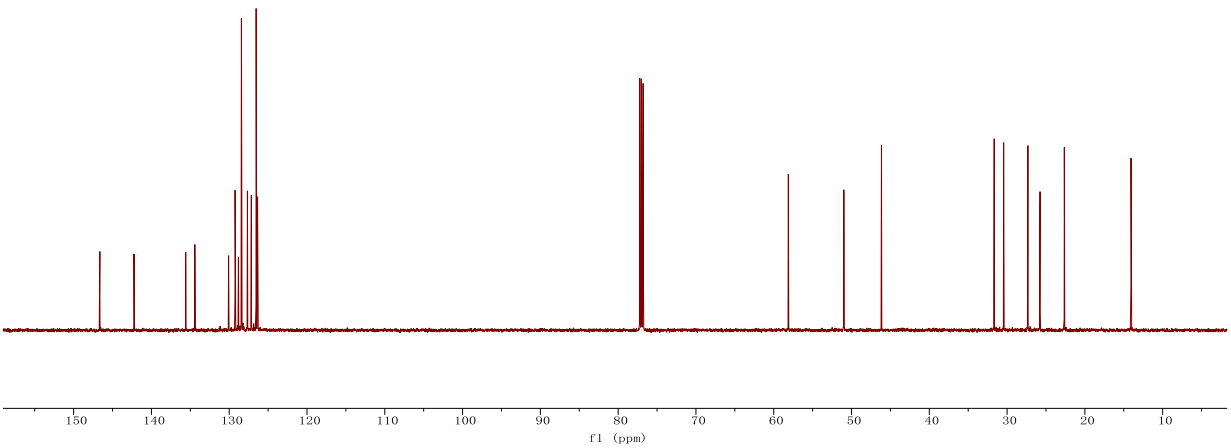
^{1}H NMR (600 MHz, $CDCl_3$)

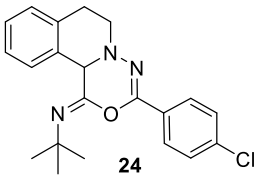




23

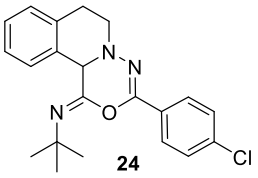
^{13}C NMR (151 MHz, $CDCl_3$)





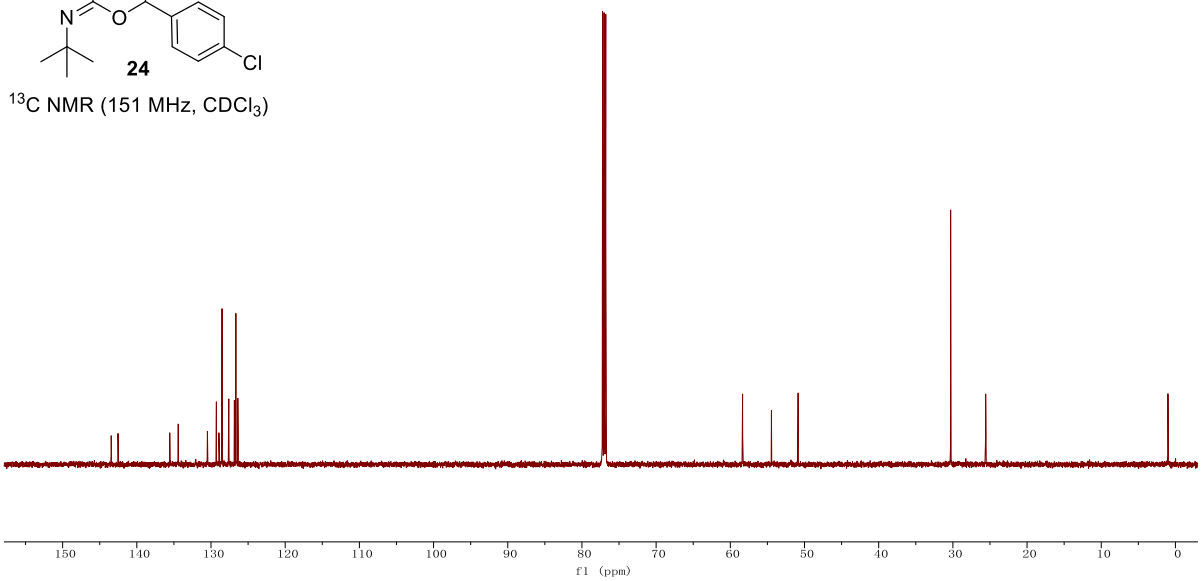
24

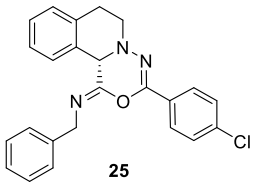
^{1}H NMR (600 MHz, $CDCl_3$)



24

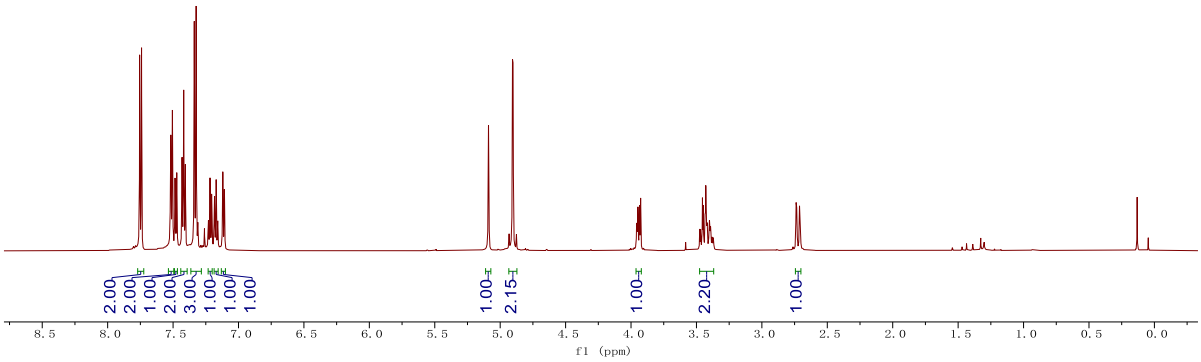
^{13}C NMR (151 MHz, $CDCl_3$)

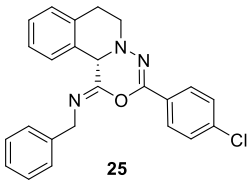




25

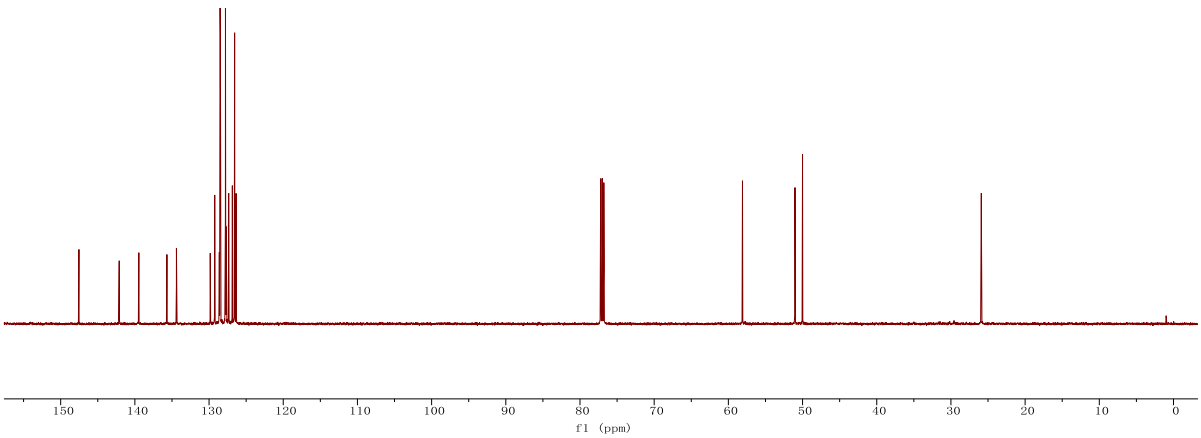
^{1}H NMR (600 MHz, $CDCl_3$)

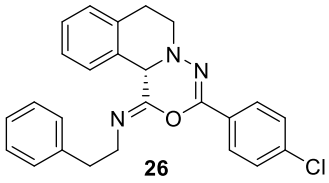




25

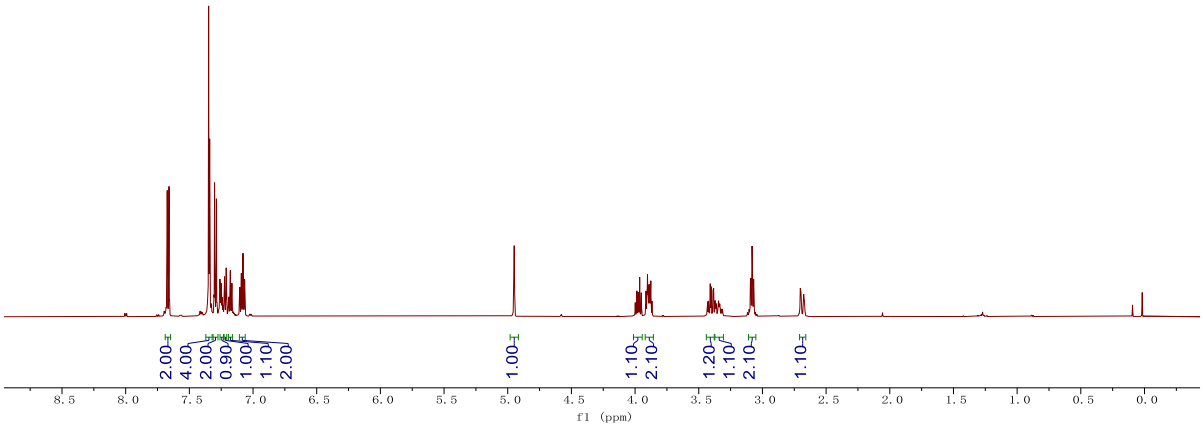
^{13}C NMR (151 MHz, $CDCl_3$)

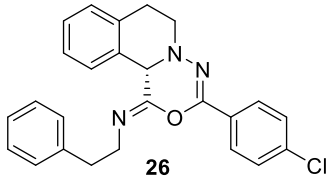




26

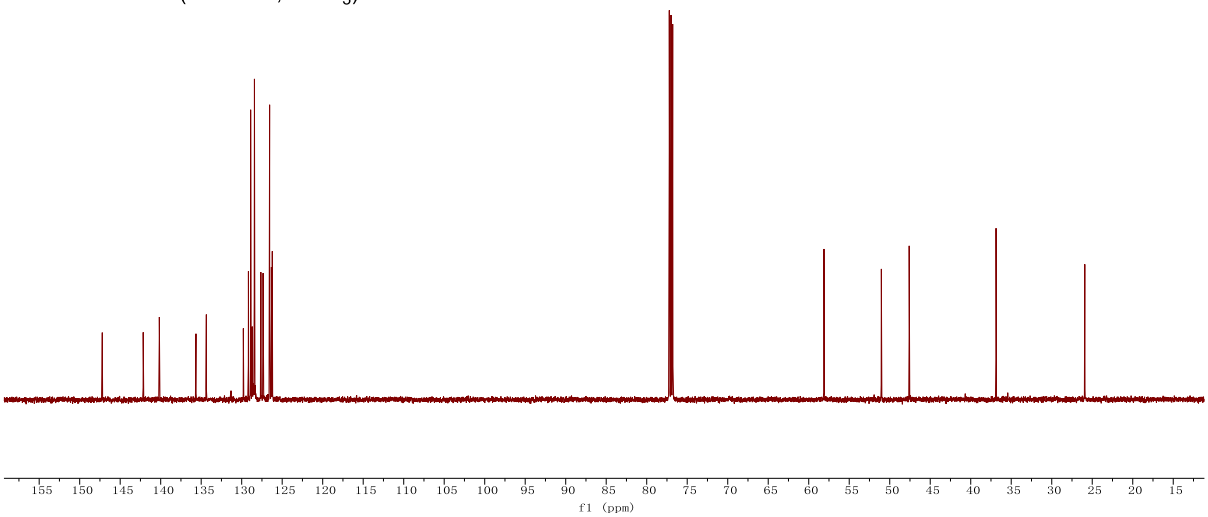
^{1}H NMR (600 MHz, $CDCl_3$)

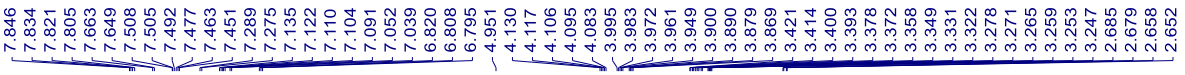


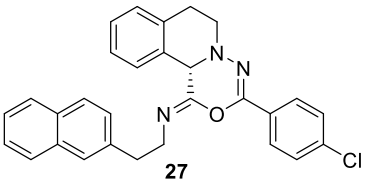


26

^{13}C NMR (151 MHz, $CDCl_3$)

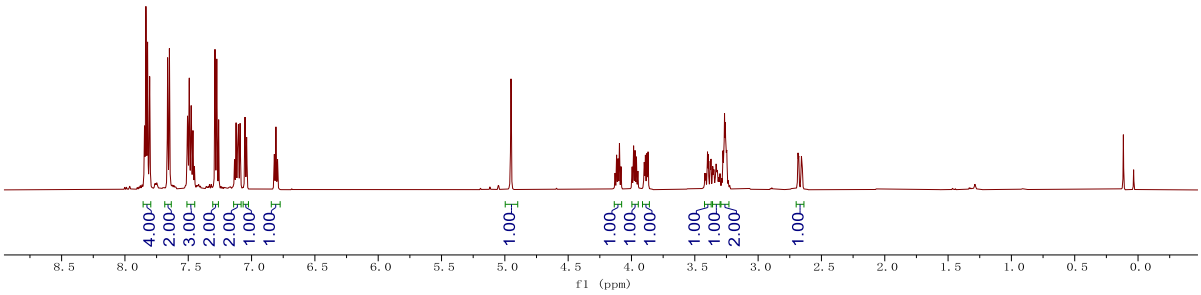


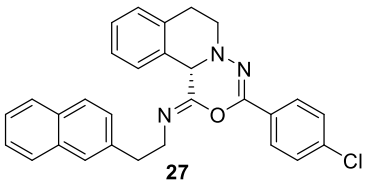




27

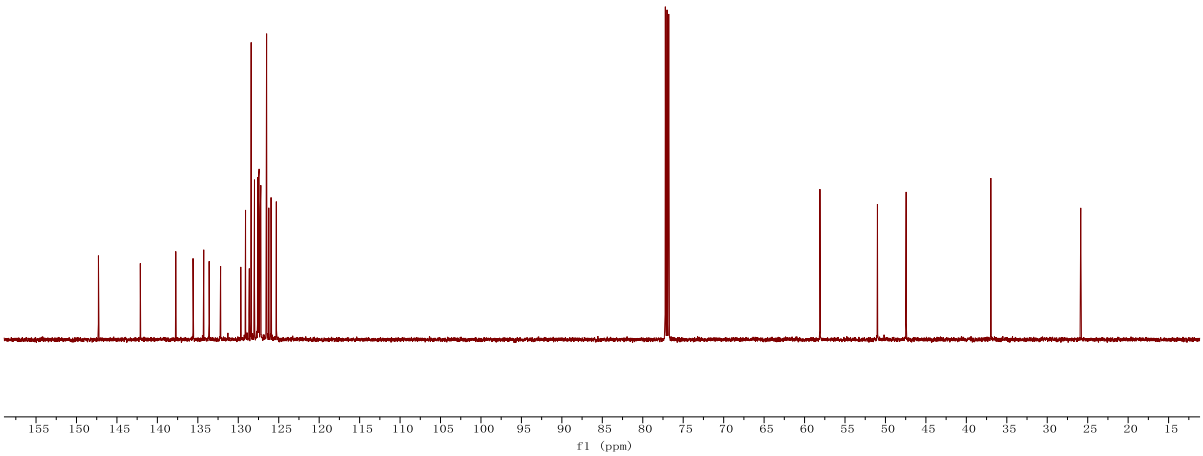
^{1}H NMR (600 MHz, $CDCl_3$)

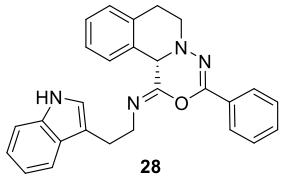




27

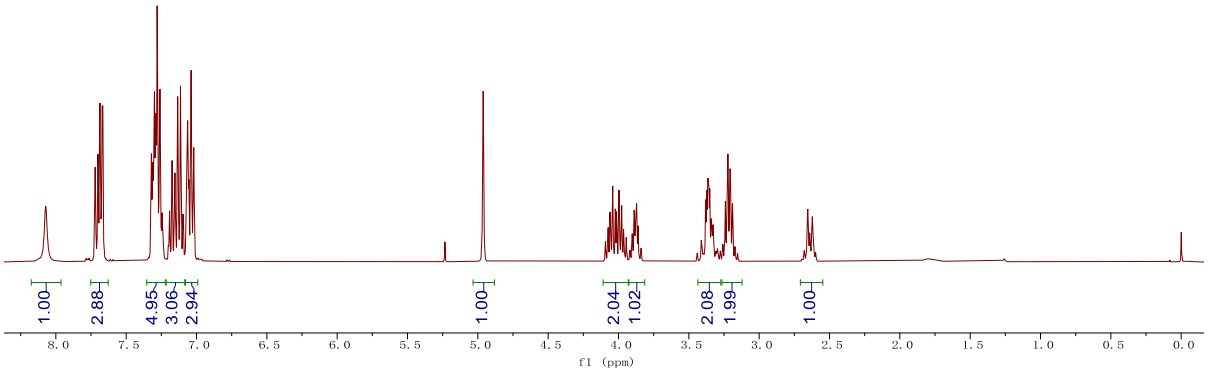
^{13}C NMR (151 MHz, $CDCl_3$)

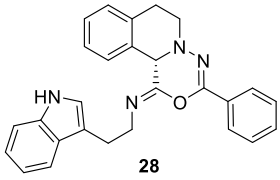




28

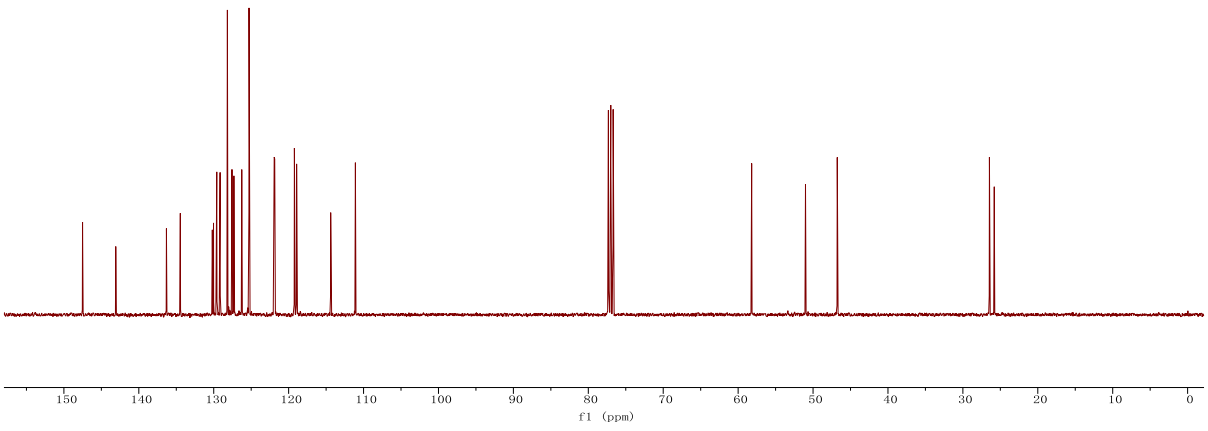
^{1}H NMR (400 MHz, $CDCl_3$)

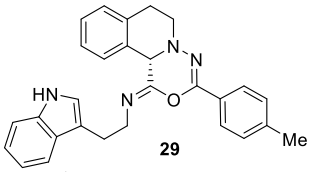




28

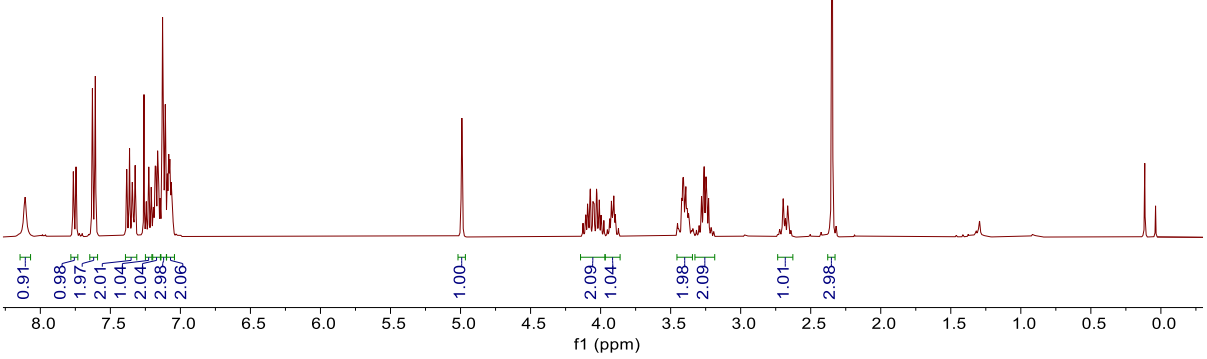
^{13}C NMR (101 MHz, $CDCl_3$)

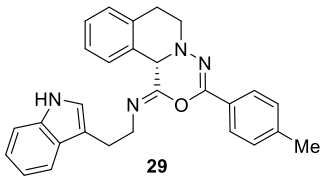




29

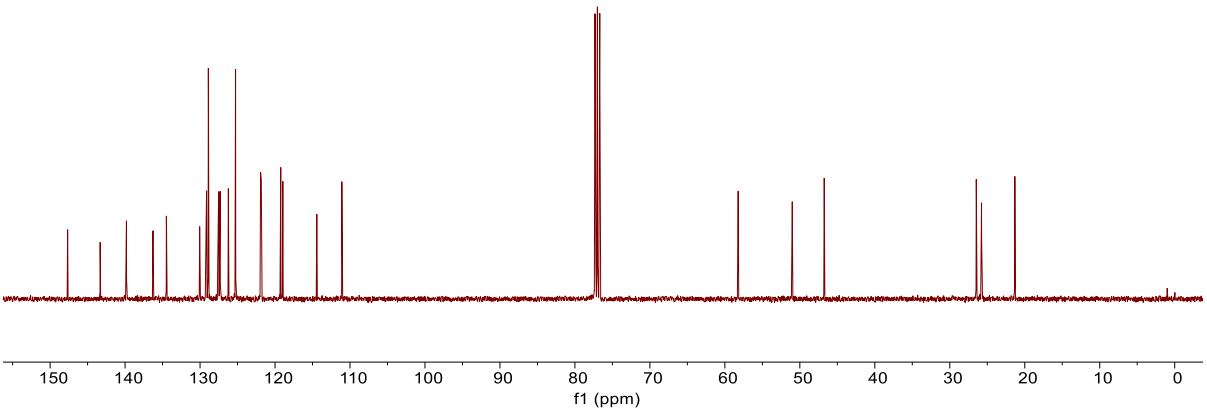
^{1}H NMR (400 MHz, $CDCl_3$)

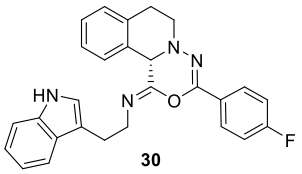




29

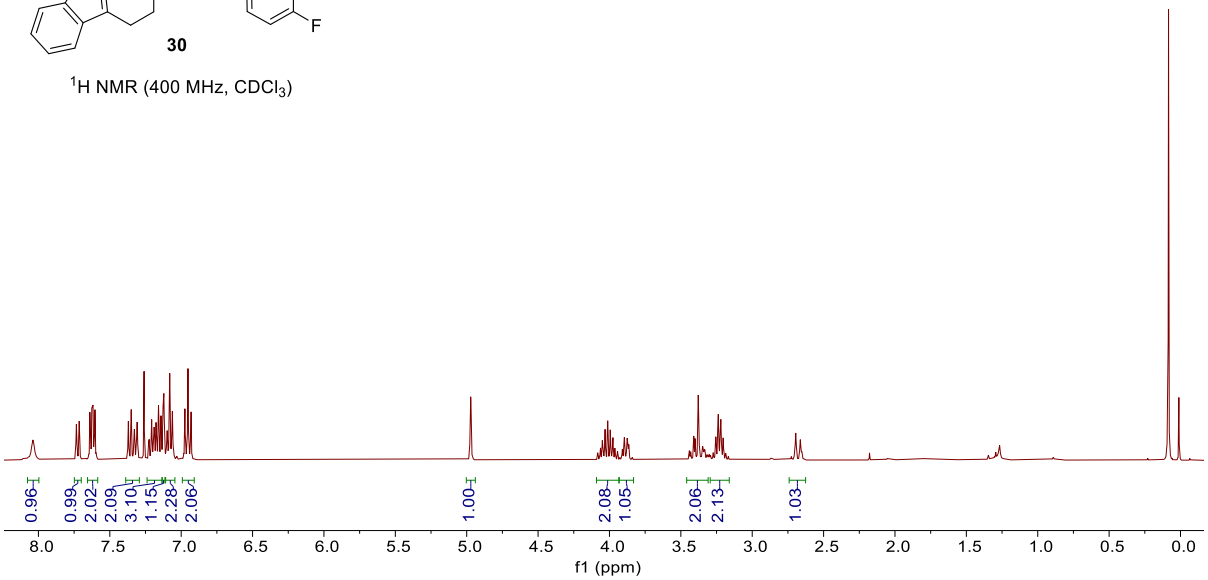
^{13}C NMR (101 MHz, $CDCl_3$)

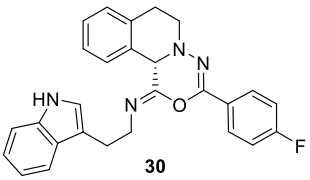




30

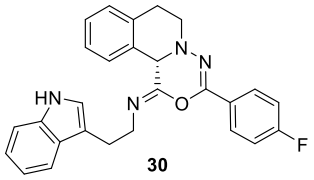
^{1}H NMR (400 MHz, $CDCl_3$)





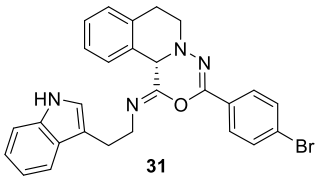
30

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



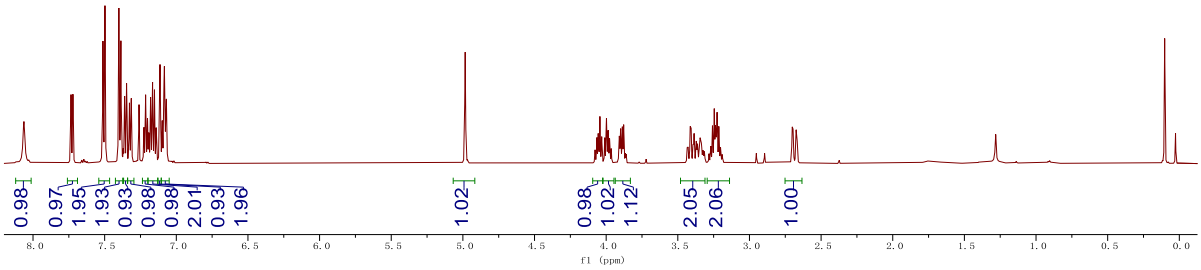
30

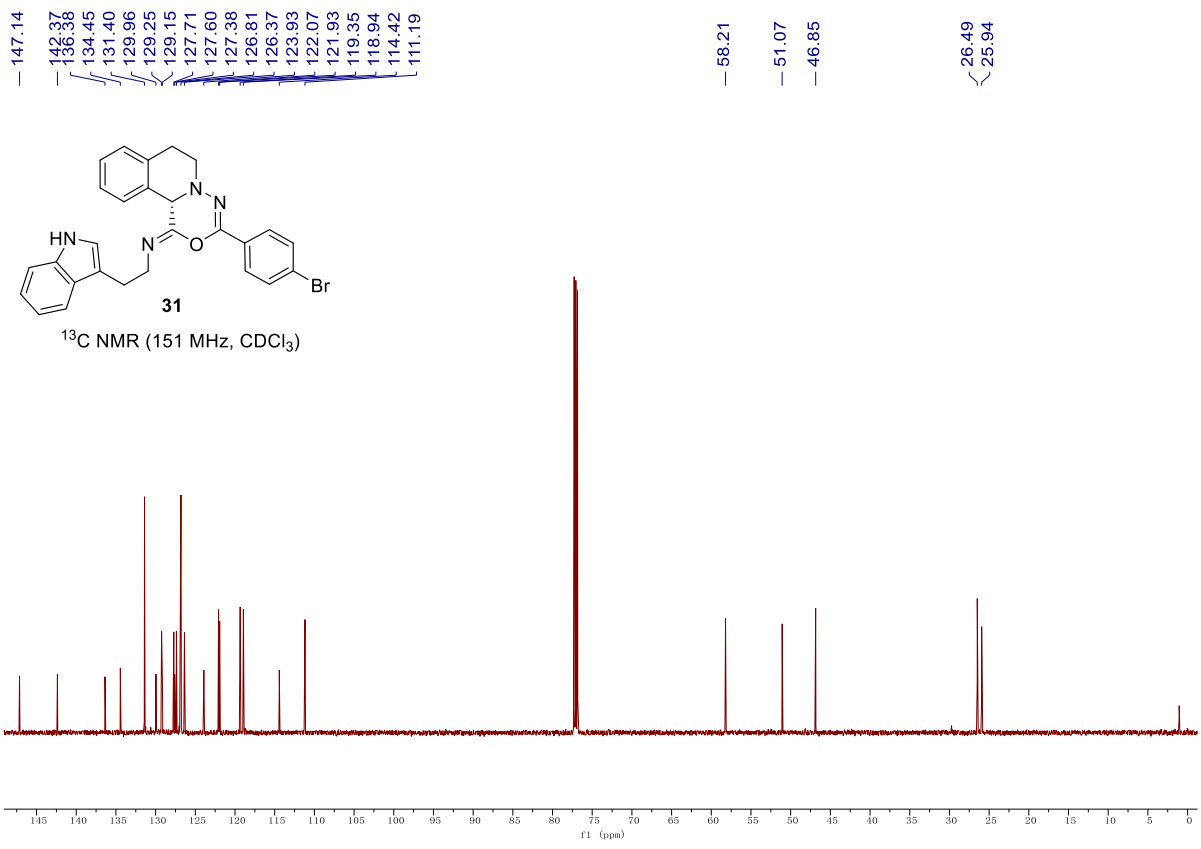
^{19}F NMR (376 MHz, $CDCl_3$)



31

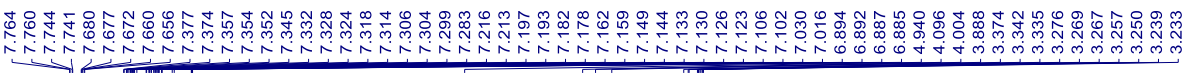
^{1}H NMR (600 MHz, $CDCl_3$)

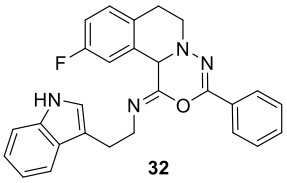




31

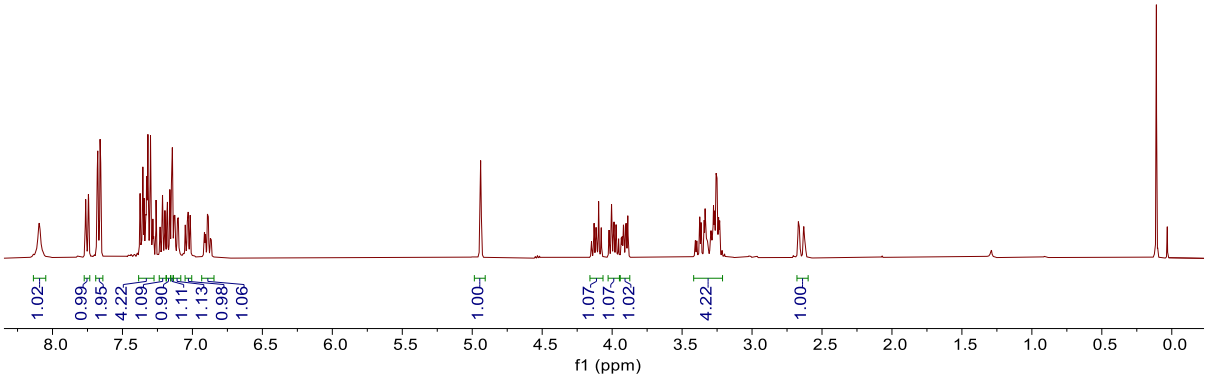
^{13}C NMR (151 MHz, $CDCl_3$)

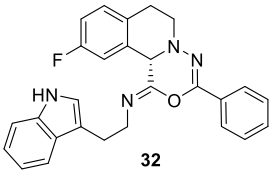




32

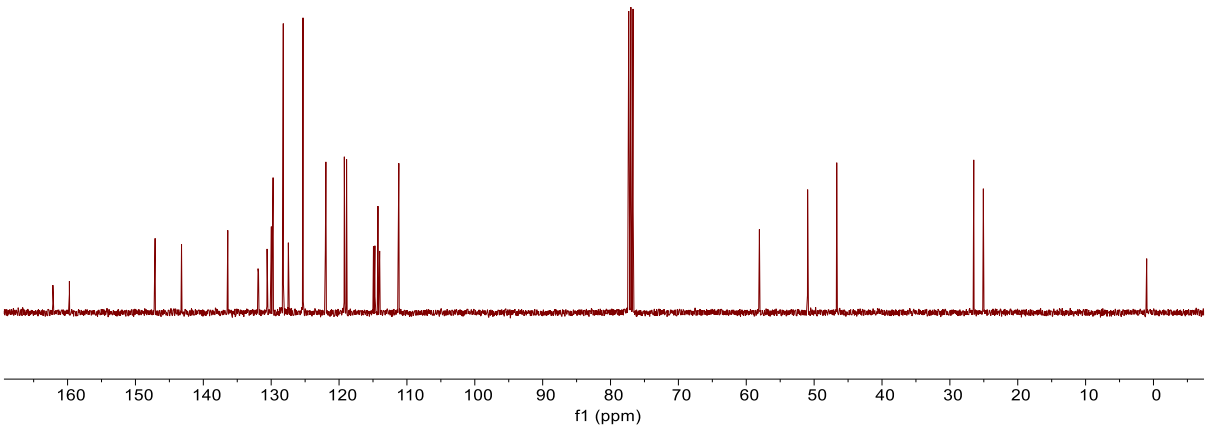
^{1}H NMR (400 MHz, $CDCl_3$)

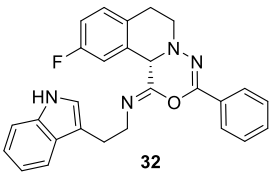




32

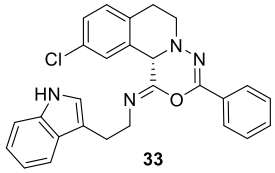
^{13}C NMR (101 MHz, $CDCl_3$)





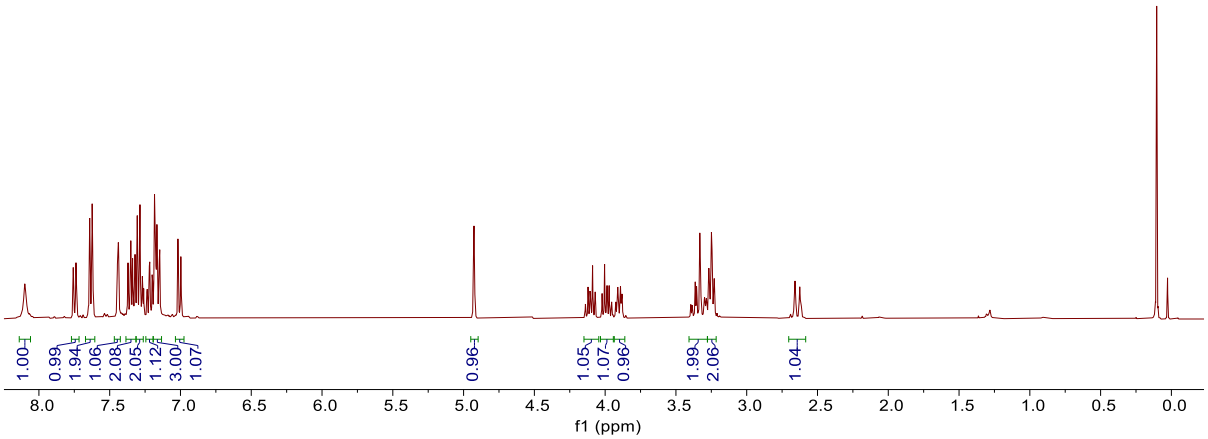
32

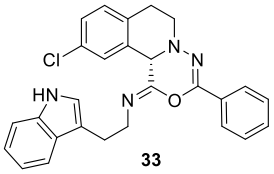
^{19}F NMR (376 MHz, $CDCl_3$)



33

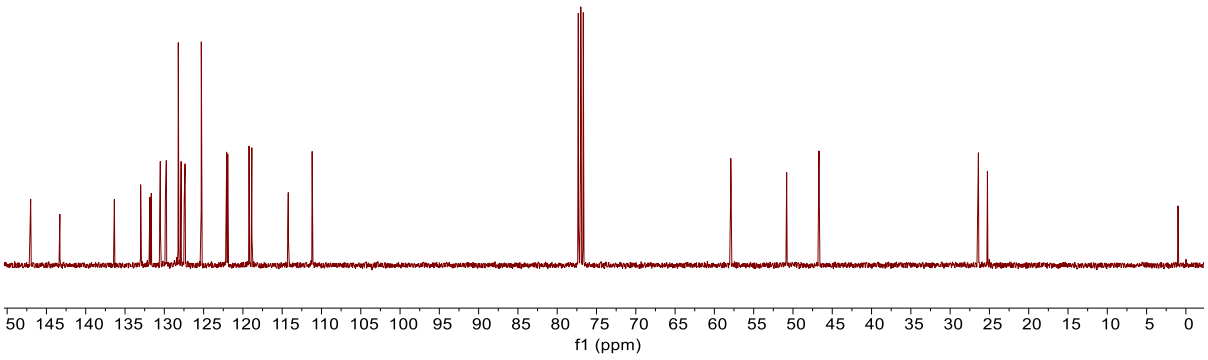
^{1}H NMR (400 MHz, $CDCl_3$)

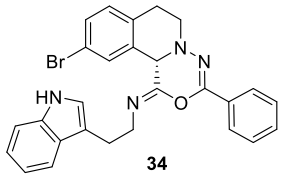




33

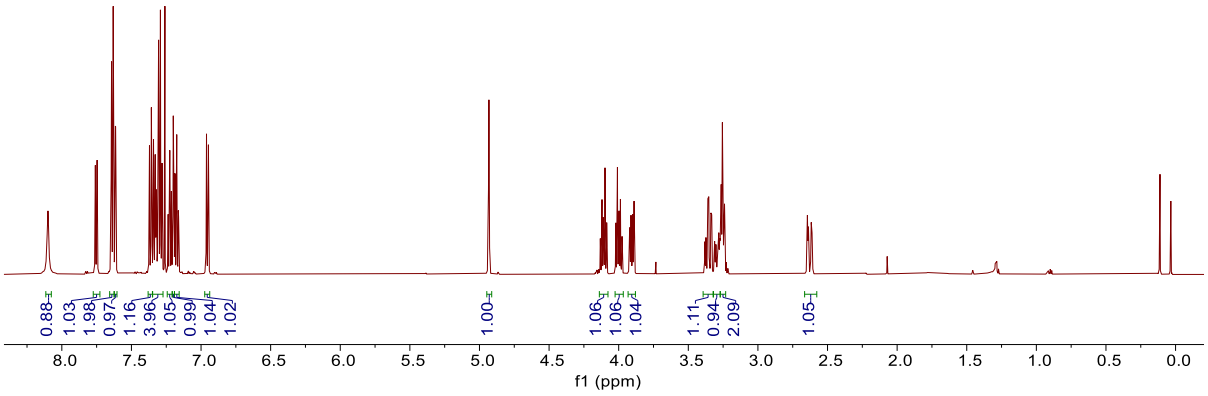
^{13}C NMR (101 MHz, $CDCl_3$)

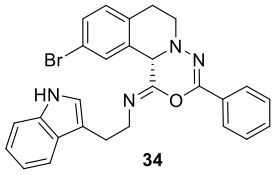




34

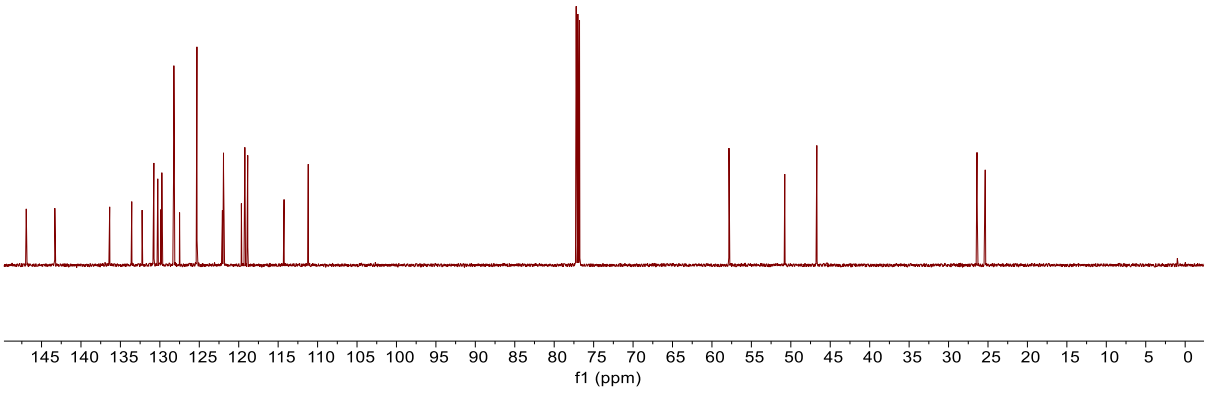
^{1}H NMR (600 MHz, $CDCl_3$)

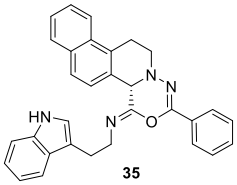




34

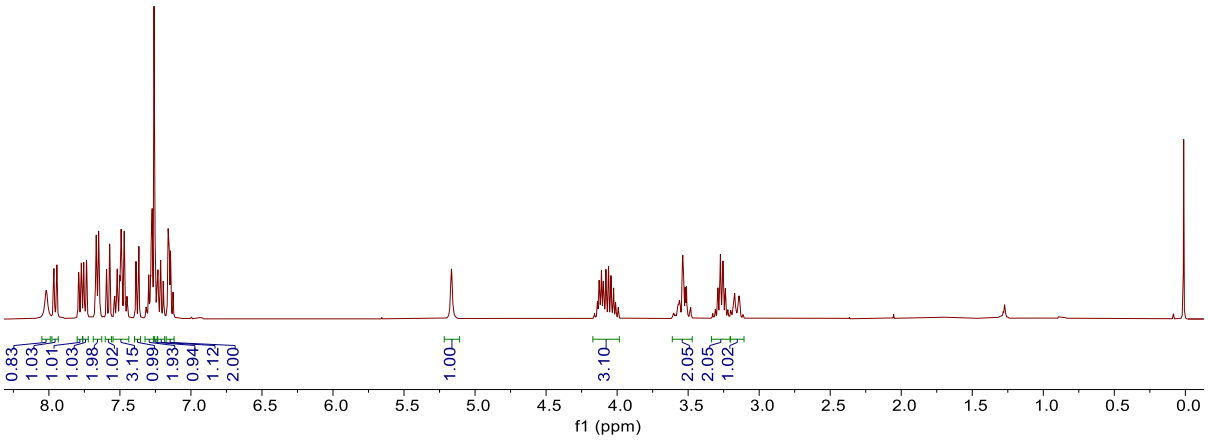
^{13}C NMR (151 MHz, $CDCl_3$)

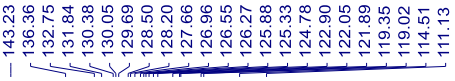


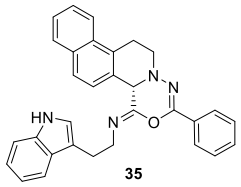


35

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







35

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