Supporting Information for

Design of Polymer Supported Chiral Cobalt Catalyst for Heterogeneous Enantioselective C−H Activations

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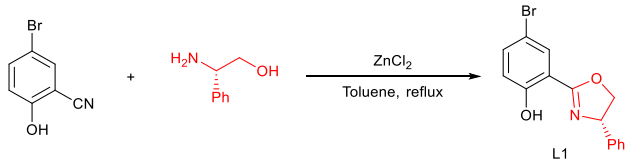
1. General procedures

Commercial reagents were purchased from Adamas-beta, Aladdin, Bidepharm, Energy Chemical and TCI. All air-sensitive manipulations were carried out with standard Schlenk techniques under argon. The progress of the reactions was monitored by TLC with silica gel plates, and the visualization was carried out under UV light (254 nm and 365 nm). HPLC analyses were performed on Agilent 1260 with Daicel chiral columns. NMR spectra were recorded on 400 MHz Bruker spectrometers. Chemical shifts were reported in δ (ppm) referenced to the residual solvent peak of $CDCl_3$ (δ 7.26) for ^1H NMR and $CDCl_3$ (δ 77.1) for ^{13}C NMR. Multiplicity was indicated as follows: s (singlet), d (doublet), t (triplet), q (quartet), m (multiplets), dd (double of doublet). Coupling constants were reported in Hertz (Hz). Nitrogen sorption isotherms at the temperature of liquid nitrogen were performed on a Micromeritics Tristar system, and the samples were degassed for 10 h at 393 K before the measurements. The specific surface areas were calculated from the adsorption data using Brunauer–Emmett–Teller (BET) methods. The total pore volume at P/Po = 0.950. The pore size distribution curves were obtained from the desorption branches using the Barrett-Joyner-Halenda (BJH) method. Scanning electron microscopy (SEM) was performed using a Hitachi SU8020. Transmission electron microscope (TEM) images were performed using a Tecnai G2 F30 S-Twin. Thermogravimetric analysis (TGA) was carried out using a thermal analyzer (METTLER TOLEDO TGA/DSC 3+), the sample was heated at the rate of 10 k·min-1 from room temperature up to 1073 K under a nitrogen atmosphere. FT-IR spectra were recorded on a Thermo fisher Nicolet iS50 FT-IR spectrometer. The content of Co was determined by inductively coupled plasma-Mass Spectrometry (ICP-MS). The X-ray photoelectron spectroscopy (XPS) was conducted using a Thermo Scientific K-Alpha XPS with the Al Kα irradiation.

2. Preparation of polymer-support catalyst

2.1. Synthesis of L1

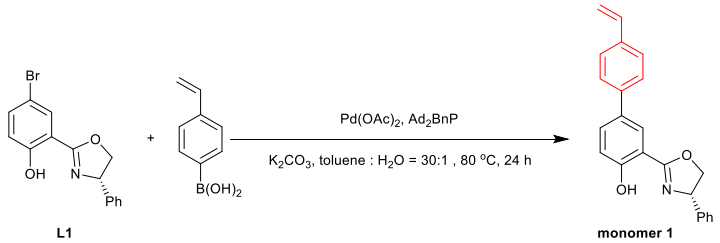


Ligand **L1** was synthesized according reference 1: $ZnCl_2$ (1.14 g, 8.5 mmol, 0.1 eq) was added to a 250 mL round-bottomed flask, toluene (150 mL) was added to the flask under N_2. L-amino

alcohol (126 mmol, 1.5 eq) and 5-bromo-2-hydroxybenzonitrile (84.0 mmol, 1.0 eq) were added sequentially. The mixture was heated at reflux (oil bath 130 °C) under N_2 and maintained at this temperature for 12 h. The reaction progress was monitored by TLC. After the starting material 5-bromo-2-hydroxybenzonitrile was consumed, toluene was removed under reduced pressure. The crude residue was purified by flash column chromatography on silica gel (HE/EtOAc/DCM = 15:1:1 v/v/v) to afford the ligand **L1** as a pink solid (22.63g, 85% yield).

^{1}H NMR (600 MHz, $CDCl_3$) δ 12.14 (s, 1H), 7.85 (d, *J* = 2.4 Hz, 1H), 7.48 (dd, *J* = 9.0, 3.0 Hz, 1H), 7.38 (m, 2H), 7.36 – 7.31 (m, 1H), 7.31 – 7.27 (m, 2H), 6.94 (d, *J* = 9.0 Hz, 1H), 5.48 (dd, *J* = 10.2, 8.4 Hz, 1H), 4.81 (dd, *J* = 10.2, 8.4 Hz, 1H), 4.27 (t, *J* = 8.4 Hz, 1H). **^{13}C NMR (150 MHz, $CDCl_3$)** δ 165.3, 159.1, 141.2, 136.3, 130.6, 128.9, 128.1, 126.5, 118.8, 112.1, 110.3, 77.3, 77.1, 76.9, 74.3, 68.9.

2.2. Synthesis of monomer 1



L1 monomer 1

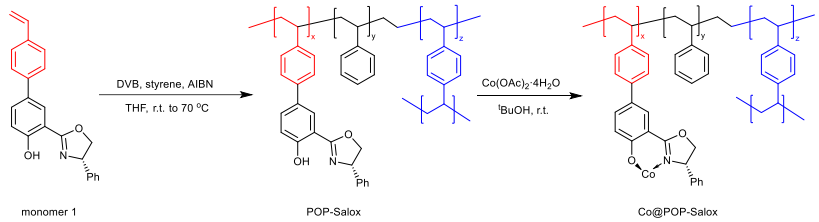
The mixture of (4-vinylphenyl)boronic acid (555 mg, 1.5 equiv.), $Pd(OAc)_2$ (29 mg, 5 mol%), Ad_2BnP (98 mg, 10 mmol%), **L1** (800 mg, 2.5 mmol), K_2CO_3 (759 mg, 2.2 equiv.), toluene (10 mL) and water (0.33 mL) was heated to 80 °C under N_2. After cooling to room temperature, the mixture was extracted with DCM (3 × 40 mL). The combined organic phase was washed with brine, dried over $MgSO_4$, and concentrated. The residue was purified by column chromatography over silica gel to give **monomer 1** (white solid, 563 mg, 66% yield).[2]

（*Several impurity peaks appeared in the NMR spectrum, making it less than perfect due to the presence of adamantyl-based impurities that are difficult to remove.）*

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.89 (d, *J* = 7.2 Hz, 1H), 7.77 (d, *J* = 3.0 Hz, 1H), 7.53 (d, *J* = 8.4 Hz, 1H), 7.33 – 7.29 (m, 3H), 7.17 – 7.14 (m, 2H), 7.08 – 7.06 (m, 2H), 7.00 (dd, *J* = 7.8, 2.4 Hz, 1H), 6.61 – 6.58 (m, 1H), 6.51 (d, *J* = 7.8 Hz, 1H), 6.48 (d, *J* = 9.0 Hz, 1H), 5.61 (dd, *J* = 17.4, 1.2 Hz, 1H), 5.05 (dd, *J* = 10.8, 1.2 Hz, 1H), 4.44 – 4.36 (t, 9.6 Hz, 1H). **^{13}C NMR (150 MHz, $CDCl_3$)** δ 169.2, 142.7,

138.2, 137.6, 136.4, 132.1, 132.0, 128.2, 128.1, 127.4, 126.2, 125.7, 123.4, 111.6, 110.5, 103.1, 77.2, 77.0, 76.8, 73.9, 67.2.

2.3. General procedure for the synthesis of polymer-support catalysis Co@POP-Salox-1-Co@POP-Salox-8



A mixture of **monomer 1** (170 mg, 0.5 mmol), divinylbenzene (80% mixture of isomers, 406 mg, 2.5 mmol), THF (7.5 mL) and AIBN (7 mg, 0.04 mmol) was degassed under vacuum and saturated with argon three times. After that, the mixture was stirred for 30 min at room temperature. The temperature was then raised to 70 °C and the reaction mixture was stirred vigorously for 24 h. The resulting polymers were filtered and washed with MeOH, EtOH and acetone, followed by drying under reduced pressure at 40 °C to give **POP-Salox** as pale-yellow power. $Co(OAc)_2 \cdot 4H_2O$ (0.5 mmol) and **POP-Salox** was added to ^{t}BuOH (2 mL) at room temperature. The reaction mixture was stirred for 2 h. After dried under vacuum, the result solids were washed thoroughly with EtOH for three times. Then dried under vacuum to yield **Co@POP-Salox-1** as brown solid.

Elemental analysis (EA) of **Co@POP-Salox-1**: N 0.73%, C 86.78%, H 7.514%.

ICP-MS: Co 2.84%

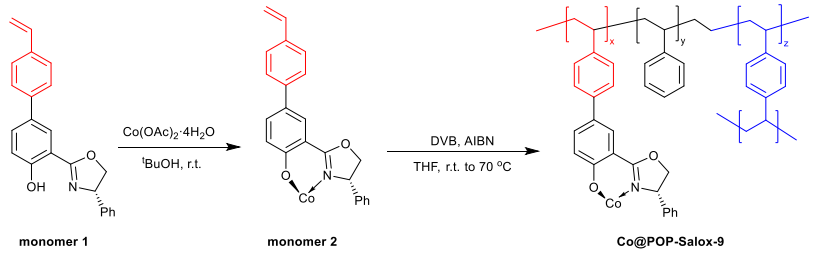
Co@POP-Salox-2-Co@POP-Salox-8 were synthesized under similar conditions but different ratios of starting materials.

Table S1. Ratios of starting materials and monomer incorporation of catalysts

catalysts	ratio (monomer: styrene: DVB)	N%	monomer incorporation (%)
Co@POP-Salox-1	1:0:5	0.73	51.75
Co@POP-Salox-2	1:0:1	1.58	53.23
Co@POP-Salox-3	1:1:2	1.08	54.47
Co@POP-Salox-4	1:0:3	0.88	46.02
Co@POP-Salox-5	1:1:5	0.64	50.13
Co@POP-Salox-6	1:0:7	0.77	68.91

Co@POP-Salox-7	1:0:8	0.67	66.19
Co@POP-Salox-8	1:0:9	0.54	58.37

2.4. General procedure for the synthesis of Polymer-support catalysis Co@POP-Salox-9



To oven dried vial equipped with stirring bars containing $Co(OAc)_2 \cdot 4H_2O$ (0.5 mmol) at room temperature was added the **monomer 1** (170 mg, 0.5 mmol) and then ^{t}BuOH (2 mL). This mixture was stirred for 2 h before the resulting clear solution was filtrated and the solvent was evaporated by a pump to provide dark brown solid **monomer 2**. The mixture of **monomer 2**, divinylbenzene (80% mixture of isomers, 406 mg, 2.5 mmol), THF (7.5 mL) and AIBN (7 mg, 0.04 mmol) was degassed under vacuum and saturated with argon three times. After that, the mixture was stirred for 30 min at room temperature. The temperature was then raised to 70 °C and the reaction mixture was stirred vigorously for 24 h. The resulting polymers were filtered and washed with MeOH, EtOH and acetone, followed by drying under reduced pressure at 40 °C to give **Co@POP-Salox-9** as black power (38.99% of monomer incorporation).

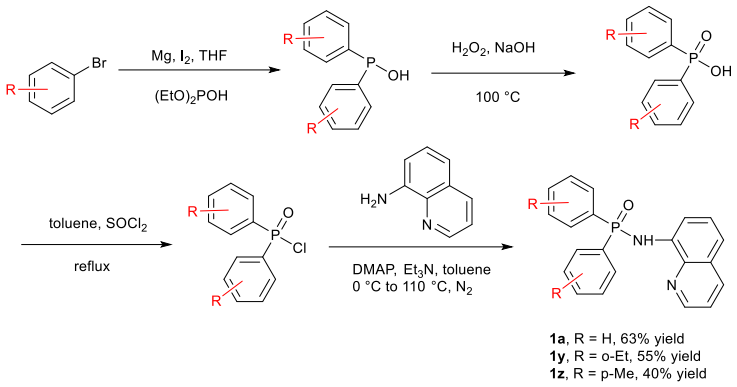
Elemental analysis (EA) of **Co@POP-Salox-9**: N 0.55%, C 89.31%, H 8.137%.

ICP-MS: Co % 0.48%

3. Preparation of substrates

3.1. Synthesis of substituted aryl phosphinamides 1a, 1y and 1z

1a, 1y and **1z** were synthesized according to previously published works.[3-4] The procedure was showed as following:



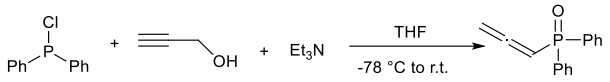
Step 1: I_2 (0.05 g, 0.2 mmol) was added to a stirred extra dry THF (20 mL) solution containing magnesium turnings (0.50 g, 20 mmol) under nitrogen protection. Then, a fraction of aryl bromide (10.0 mmol) in THF (extra dry, 5 mL) was added slowly to the mixture and heated to initiate the reaction. When the color of I_2 faded, the remainder of aryl bromide (10 mmol) was added dropwise over the course of 20 min at room temperature. After 4 h, diethyl phosphate (0.8 ml, 6 mmol) in THF (2 mL) was added slowly into the reaction mixture at 0 °C, then stirred at 80 ℃ for 4 h. After the reaction was completed, the reaction mixture was cooled to 0°C, acidifying the reaction mixture to pH = 1 by diluted HCl (4 N). The solution was evaporated under reduced pressure and the residue was extracted with 20 mL EtOAc three times. The organic layer was dried over anhydrous Na_2SO_4 and concentrated in vacuo to give crude product.

Step 2: Hydrogen peroxide (30%, 5.0 mL) was added dropwise to a suspension of crude product in aqueous NaOH (5 N, 4 mL) at 0 ℃, and the mixture was stirred for 3 h at 100 ℃. After the solution was cooled to room temperature, 20 mL water was added to the mixture and extracted with 20 mL EtOAc. The aqueous phase was separated and hydrochloric acid (4 N) was added dropwise to aqueous phase at 0 ℃ until no white solid was precipitated out. The white solid was filtered out and dry in the oven as crude phosphonic.

Step 3: A suspension of phosphonic acid and thionyl chloride in toluene (10 mL) was stirred at 80 °C for 3 h. After removal of thionyl chloride and toluene under reduced pressure, the residue was re-dissolved in toluene (5 mL), which was added to a mixture of 8-aminoquinoline (5 mmol), N, N dimethyl-4-aminopyridine (0.2 mmol), and triethylamine (6 mmol) in toluene (5 mL) at 0 ℃ under N_2. Then, the solution was stirred at 110 °C for 24 h. After removal of the volatiles under reduced pressure, the residue was dissolved in DCM (20 mL) and washed with saturated ammonium chloride (25 mL × 2). Combined organic phase was dried over anhydrous Na_2SO_4 and concentrated

in vacuo. Then the mixture was subjected to column chromatography on silica gel to give the desired product.

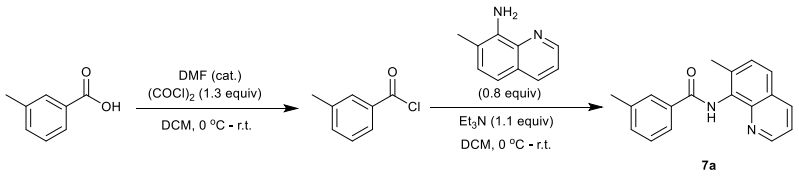
3.2. Synthesis of substituted allene 4a



4a

The substituted allene (**4a**) were synthesized according to literature procedures[7]. To a solution of prop-2-yn-1-ol (600 μL, 10.0 mmol) and triethylamine (2.1 mL,15 mmol, 1.5 equiv.) in dry THF (30 mL) was added chlorodiphenylphosphine (2.7 mL, 15.0 mmol, 1.5 equiv.) dropwise at -78 °C. After the addition, the cooling bath was removed, and the reaction mixture was allowed for warming up to room temperature. After complete conversion the mixture was filtered off. Evaporation of the solvent and flash chromatography on silica gel (eluent: petroleum ether/ether) afforded the product as white solid (1.2 g, 50 % yield).

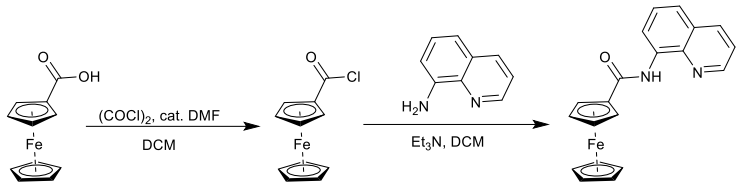
3.3. Synthesis of benzamide substrates 7a



7a

The benzamide substrates (**7a**) were synthesized according to literature procedures[5]. To a solution of carboxylic acid derivative (4 mmol, 1.0 equiv.) and DMF (2-3 drops) in dry DCM was added oxalyl chloride (5.2 mmol, 1.3 equiv.) dropwise at 0 °C. The reaction mixture was stirred at room temperature for 6 h, and then concentrated in vacuo to afford the crude acyl chloride, which was used in next step without further purification. A solution of 8-aminoquinoline derivative (3.2 mmol, 0.8 equiv.) and Et_3N (4.4 mmol, 1.1 equiv.) in dichloromethane was added dropwise to the acyl chloride solution at 0 °C. The resulting mixture was warmed to room temperature and stirred for 12 h. Then the mixture was quenched with saturated $NaHCO_3$ solution and extracted with DCM for three times. The combined organic layer was dried over Na_2SO_4. The concentrated residue was purified by flash column chromatography on silica gel (PE: EA = 5:1) to give the amide.

3.4. Synthesis of ferroceneamide substrates 9a



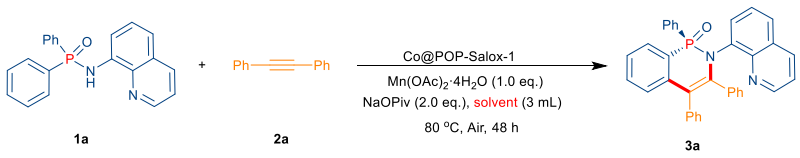
9a

The ferroceneamide substrates (**9a**) were synthesized according to literature procedures[6]. To a solution of ferrocenecarboxylic acid (10 mmol, 1.0 equiv.) in DCM (30 mL) was added oxalyl chloride (1.7 mL, 20 mmol) and a drop of N,N-dimethylformamide. The reaction mixture was stirred at room temperature for 6-12 h. Then the solvent was removed under reduced pressure. The substituted ferrocenecarboxylic chloride was directly used without purification in the next step. A solution of ferrocenecarboxylic chloride in DCM (30 mL) was added dropwise to a solution of 8-aminoquinoline (9.5 mmol, 0.95 equiv.) and Et_3N (3.0 equiv., 30 mmol) in DCM (30 mL) at 0 °C. The mixture was warmed to room temperature and stirred for 2 h. Then the reaction mixture was quenched with ice-cold water and extracted with DCM. The combined organic layers were washed with brine, dried over Na_2SO_4 and filtrated. After the solvent was removed under reduced pressure, the residue was purified by silica gel column chromatography to give **9a** as dark orange solid.

4. Complete reaction data

4.1. Optimization of reaction conditions

Table S2. Optimization of reaction conditions: screening of solvent [a]

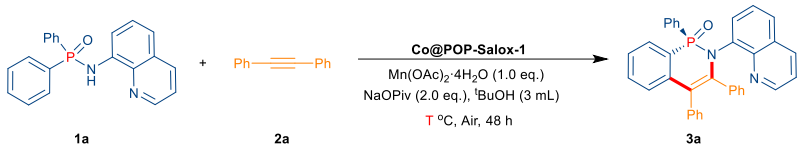


Entry	Solvent	yields	*ee* value
1	***^{t}BuOH***	***95%***	***99%***
2	^{i}PrOH	45%	92%
3	MeOH	71%	80%
4	EtOH	89%	91%
5	1,4-Dioxane	trace	--
6	THF	trace	--

[a] Reactions were run with **1a** (0.1 mmol), **2a** (1.5 eq.), Co catalyst (5.0 mol % Co content),

$Mn(OAc)_2·4H_2O$(1.0 eq.) and NaOPiv (2.0 eq.) in corresponding solvent (3 mL) at 80 °C for 48 h under air. The *ee* value is determined by HPLC analysis.

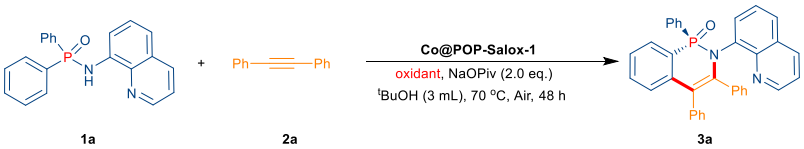
Table S3. Optimization of reaction conditions: screening of temperature [a]



Entry	Temperature	yields	*ee* value
1 (repeated)	80 °C	95%	99%
2	***70 °C***	***95%***	***99%***
3	60 °C	45%	99%
4[b]	60 °C	80%	99%

[a] Reactions were run with **1a** (0.1 mmol), **2a** (1.5 eq.), Co catalyst (5.0 mol % Co content), $Mn(OAc)_2·4H_2O$(1.0 eq.) and NaOPiv (2.0 eq.) in ^{t}BuOH (3 mL) at corresponding temperature for 48 h under air. The *ee* value is determined by HPLC analysis. [b] Reaction for 72 h.

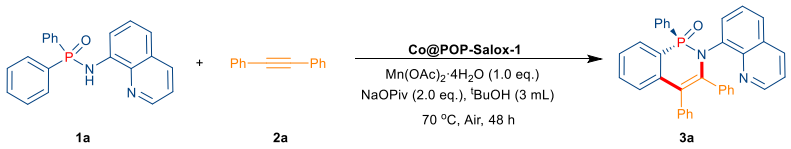
Table S4. Optimization of reaction conditions: screening of oxidants [a]



Entry	Oxidant	yields	*ee* value
1 (repeated)	***$Mn(OAc)_2·4H_2O$ (1.0 eq.)***	***95%***	***99%***
2	$Mn(OAc)_3·4H_2O$ (1.0 eq.)	95%	98%
3	O_2 (1 atm)	N.R.	-
4[b]	O_2 (1 atm)	95%	0%
5[c]	Ag_2CO_3 (1.0 eq.)	96%	99%

[a] Reactions were run with **1a** (0.1 mmol), **2a** (1.5 eq.), Co catalyst (5.0 mol % Co content), oxidant and NaOPiv (2.0 eq.) in ^{t}BuOH (3 mL) at 70 °C for 48 h under air. The *ee* value is determined by HPLC analysis. [b] HFIP as the solvent. [c] The reaction system is turbid, and the catalyst is difficult to recover.

4.2. General procedure for enantioselective C-H annulation of phosphinic amide

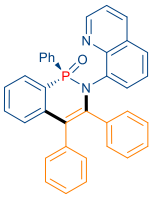


1a 2a 3a

Phosphinic amide **1a** (0.1 mmol), alkyne **2a** (0.15 mmol), **Co@POP-Salox-1** (5.0 mol % Co content), $Mn(OAc)_2{\cdot}4H_2O$ (0.1 mmol), NaOPiv (0.2 mmol) and ^{t}BuOH (3 mL) were added to an oven dried vial equipped with stirring bars. Then, the vial was instantly placed in a heating block set at 70 ℃ under air for 48 h. After the reaction was completed, the reaction mixture was cooled to room temperature, quenched by saturated aqueous Na_2CO_3, and extracted with EtOAc. The organic layer was dried over anhydrous Na_2SO_4 and concentrated in vacuo. Then the mixture was subjected to column chromatography on silica gel to give the desired product.

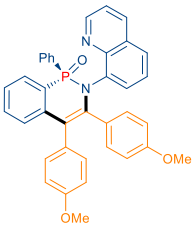
Data of compounds

(*S*)-1,3,4-triphenyl-2-(quinolin-8-yl)-2*H*-benzo[*c*][1,2]azaphosphinine 1-oxide (3a):



The 99% *ee* was determined by Daicel Chiralcel IC, Hexanes/IPA = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 20.899 min, t (minor) = 28.134 min; **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.82 (dd, *J* = 4.4, 1.6 Hz, 1H), 8.08 (d, *J* = 7.6 Hz, 1H), 7.81 – 7.76 (m, 2H), 7.67 – 7.65 (m, 1H),7.49 (dd, *J* = 14.0, 7.6 Hz, 1H), 7.38 (t, *J* = 7.6 Hz, 1H), 7.31 – 7.11 (m, 9H), 7.09 – 7.04 (m, 2H), 7.00 – 6.93 (m, 4H), 6.56 – 6.52 (m, 3H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 149.3, 144.5 (d, J_{CP} = 3.6 Hz), 142.6, 139.3 (d, J_{CP} = 3.6 Hz), 138.7, 137.6 (d, J_{CP} = 2.3 Hz), 136.6 (d, J_{CP} = 4.0 Hz), 135.5, 133.4 (d, J_{CP} = 10.5 Hz), 132.4, 131.5 (d, J_{CP} = 2.9 Hz), 131.4 (d, J_{CP} = 2.9 Hz), 131.4 (d, J_{CP} = 1.6 Hz), 131.0, 130.9, 130.2 (d, J_{CP} = 124.8 Hz), 128.2, 127.8, 127.4, 127.0 (d, J_{CP} = 13.5 Hz), 126.5, 126.4, 126.3, 125.8, 125.7 (d, J_{CP} = 14.6 Hz), 125.4, 124.4 (d, J_{CP} = 129.3 Hz), 121.0, 117.8 (d, J_{CP} = 7.3 Hz). NMR is in accordance with previously reports[3]. The absolute configuration was determined from the literature[3].

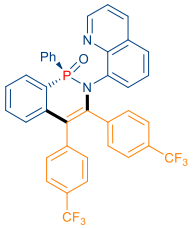
(*S*)-3,4-Bis(4-methoxyphenyl)-1-phenyl-2-(quinolin-8-yl)-2*H*-benzo[*c*][1,2]azaphos-phinine 1 oxide (3b):



The 98% *ee* was determined by Daicel Chiralcel IA, Hexanes/IPA = 70/30, 1.0 mL/min, λ = 254 nm, t (minor) = 7.693 min, t (major) = 9.475 min. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.80 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.03 (d, *J* = 7.6 Hz, 1H), 7.83 – 7.69 (m, 3H), 7.52 – 7.36 (m, 2H), 7.25 (s, 1H), 7.22 – 7.13 (m, 6H), 7.11

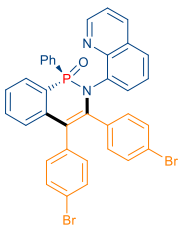
– 7.04 (m, 1H), 6.99 – 6.93 (m, 2H), 6.88 (d, J = 8.8 Hz, 2H), 6.73 (d, J = 8.0 Hz, 2H), 6.09 (d, J = 8.4 Hz,2H), 3.70 (s, 3H), 3.37 (s, 3H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 157.8, 157.5, 149.2, 144.5 (d, J_{CP} = 3.5 Hz), 142.6, 139.8 (d, J_{CP} = 4.5 Hz), 137.9 (d, J_{CP} = 2.4 Hz), 135.5, 133.4, 133.3, 132.2, 131.9 (d, J_{CP} = 140.2 Hz), 131.4 (d, J_{CP} = 3.0 Hz), 131.3 (d, J_{CP} = 2.9 Hz), 131.3, 131.2, 130.8 (d, J_{CP} = 12.7 Hz), 129.5 (d, J_{CP} = 4.0 Hz), 128.2, 127.3, 127.0 (d, J_{CP} = 14.6 Hz), 126.5 (d, J_{CP} = 13.2 Hz), 125.5, 125.4, 124.4 (d, J_{CP} = 129.4 Hz), 120.9, 117.4 (d, J_{CP} = 7.3 Hz), 113.2, 111.3, 55.1, 54.6. NMR is in accordance with previously reports[3]. The absolute configuration was determined from the literature[3].

_(S)_-1-phenyl-2-(quinolin-8-yl)-3,4-bis(4-(trifluoromethyl)phenyl)-2H-benzo[c][1,2]azaphosphinine 1-oxide (3c):



The >99% *ee* was determined by Daicel Chiralcel IC, Hexanes/IPA = 90/10, 1.0 mL/min, λ = 254 nm, t (major) = 9.434 min, t (minor) = 11.558 min. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.82 (d, J = 4.0 Hz, 1H), 8.08 (d, J = 7.2 Hz, 1H), 7.74 (td, J = 13.0, 11.4, 4.6 Hz, 3H), 7.56 – 7.37 (m, 6H), 7.36 – 7.28 (m, 2H), 7.24 – 7.15 (m, 2H), 7.10 (p, J = 7.4 Hz, 4H), 6.99 (dd, J = 7.8, 3.4 Hz, 2H), 6.85 (d, J = 8.0 Hz, 2H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 149.5, 144.2 (d, J_{CP} = 2.4 Hz), 142.2, 141.5, 139.9, 138.2, 137.0, 135.7, 133.4 (d, J_{CP} = 10.0 Hz), 132.7, 131.7 (d, J_{CP} = 2.4 Hz), 131.4, 131.2-131.1(m), 130.3, 129.1-128.5(m), 128.3, 127.9, 127.2, 127.0, 126.4-126.1(m), 125.5, 125.4, 123.0 (d, J_{CP} = 4.0 Hz), 121.3. NMR is in accordance with previously reports[3]. The absolute configuration was determined from the literature[3].

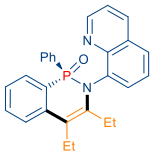
(_S_)-3,4-Bis(4-bromophenyl)-1-phenyl-2-(quinolin-8-yl)-2_H_-benzo[_c_][1,2]azaphos-phinine 1-oxide (3d):



The 98% *ee* was determined by Daicel Chiralcel IC, Hexanes/IPA = 80/20, 1.0 mL/min, λ = 254 nm, t (minor) = 12.198 min, t (major) = 15.849 min; **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.80 (d, J = 4.0 Hz, 1H), 8.04 (d, J = 7.2 Hz, 1H), 7.78 – 7.68 (m, 3H), 7.53 – 7.39 (m, 2H), 7.36 – 7.30 (m, 3H), 7.28 – 7.22 (m, 1H), 7.20 – 7.07 (m, 6H), 6.95 (td, J = 7.6, 3.6 Hz, 2H), 6.85 (d, J = 8.0 Hz, 2H), 6.73 (d, J = 8.4 Hz, 2H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 149.4, 144.2 (d, J_{CP} = 3.4 Hz), 141.5, 138.7 (d, J_{CP} = 4.4 Hz), 137.4,

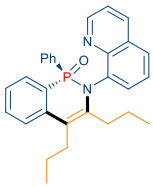
137.2 (d, J_{CP} = 2.4 Hz), 135.7, 135.4 (d, J_{CP} = 3.8 Hz), 134.0, 133.5 (d, J_{CP} = 10.6 Hz), 132.4, 131.6 (d, J_{CP} = 6.7 Hz), 131.3 (d, J_{CP} = 2.6 Hz), 131.1 (d, J_{CP} = 12.0 Hz), 129.4, 128.3, 127.8, 127.1 (d, J_{CP} = 13.6 Hz), 126.3 (d, J_{CP} = 26.4 Hz), 126.2 (d, J_{CP} = 3.2 Hz), 126.0, 125.5, 121.2, 121.0, 120.8, 116.9 (d, J_{CP} = 7.4 Hz). NMR is in accordance with previously reports[3]. The absolute configuration was determined from the literature[3].

(*S*)-3,4-Diethyl-1-phenyl-2-(quinolin-8-yl)-2*H*-benzo[*c*][1,2]azaphosphinine 1-oxide (3e):



The >99% *ee* was determined by Daicel Chiralcel IC, Hexanes/IPA = 80/20, 1.0 mL/min, λ = 254 nm, t (minor) = 13.888 min, t (major) = 17.064 min; **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.78 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.07 (d, *J* = 7.6 Hz, 1H), 7.96 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.68 (dd, *J* = 8.0, 4.8 Hz, 1H), 7.63 – 7.50 (m, 4H), 7.35 – 7.27 (m, 3H), 7.17 (td, *J* = 7.6, 2.8 Hz, 1H), 7.09 – 7.05 (m, 1H), 6.92 (td, *J* = 7.6, 3.2 Hz, 2H), 2.78 (q, *J* = 7.6 Hz, 2H), 2.53– 2.43 (m, 1H), 1.85 – 1.76 (m, 1H), 1.33 (t, *J* = 7.6 Hz, 3H), 0.97 (t, *J* = 7.6 Hz, 5H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 150.1, 145.3 (d, J_{CP} = 3.7 Hz), 142.2, 139.0 (d, J_{CP} = 4.3 Hz), 137.4, 135.8, 133.3 (d, J_{CP} =10.4 Hz), 131.4, 131.2, 130.8 (d, J_{CP} = 12.7 Hz), 130.6, 128.5, 127.4, 126.9, 126.8 (d, J_{CP} = 13.4 Hz), 125.8, 124.9, 124.8, 123.6, 123.5, 121.2, 114.1 (d, J_{CP} = 8.4 Hz), 24.8, 22.4, 15.0, 13.3. NMR is in accordance with previously reports[3]. The absolute configuration was determined from the literature[3].

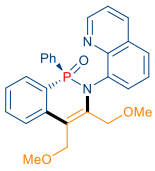
(S)-1-phenyl-3,4-dipropyl-2-(quinolin-8-yl)-2H-benzo[c][1,2]azaphosphinine 1-oxide (3f):



The 99% *ee* was determined by Daicel Chiralcel IA, Hexanes/IPA = 80/20, 1.0 mL/min, λ = 254 nm, t (minor) = 6.192 min, t (major) = 11.085 min; **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.77 (d, *J* = 4.0 Hz, 1H), 8.03 (dt, *J* = 7.6, 1.6 Hz, 1H), 7.96 (dd, *J* = 8.4, 2.0 Hz, 1H), 7.68 (dd, *J* = 8.4, 5.2 Hz, 1H), 7.66 7.51 (m, 4H), 7.36-7.26 (m, 3H), 7.17 (tdd, *J* = 7.6, 2.8, 0.8 Hz, 1H), 7.09-7.05 (m, 1H), 6.91 (td, *J* = 8.0, 3.2 Hz, 2H), 2.71-2.67 (m, 2H), 2.47-2.39 (m, 1H), 2.53-2.44 (m, 1H), 1.85-1.66 (m, 3H), 1.59-1.40 (m, 2H), 1.09 (t, *J* = 7.6 Hz, 3H), 0.61 (t, *J* = 7.6 Hz, 3H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 150.1, 145.3 (d, J_{CP} = 3.7 Hz), 141.3 (d, J_{CP} = 1.6 Hz), 139.2 (d, J_{CP} = 4.3 Hz), 137.6 (d, J_{CP} = 2.7 Hz), 135.8, 133.3 (d, J_{CP} = 10.1 Hz), 131.3 (d, J_{CP} = 2.5 Hz), 131.2 (d, J_{CP} = 2.7 Hz), 130.8, 130.6, 130.4 (d, J_{CP} = 3.3 Hz), 128.5,

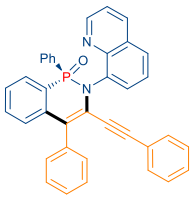
127.3, 126.9 (d, J_{CP} = 13.5 Hz), 125.7, 124.9, 124.7, 123.6 (d, J_{CP} = 9.5 Hz), 121.2, 113.5 (d, J_{CP} = 8.4 Hz), 33.8 (d, J_{CP} = 2.5 Hz), 31.8, 23.6, 22.2, 14.4, 14.0. NMR is in accordance with previously reports[3]. The absolute configuration was determined from the literature[3].

(*S*)-3,4-Dibutyl-1-phenyl-2-(quinolin-8-yl)-2*H*-*L*-benzo[*c*][1,2]azaphosphinine 1-oxide (3g):



The >99% *ee* was determined by Daicel Chiralcel AD, Hexanes/IPA = 90/10, 1.0 mL/min, λ = 254 nm, t (minor) = 21.295 min, t (major) = 30.420 min; **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.76 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.17 (d, *J* = 7.2 Hz, 1H), 7.97 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.89 (dd, *J* = 8.4, 4.8 Hz, 1H) 7.64 – 7.51 (m, 4H), 7.39 – 7.22 (m, 4H), 7.09 (td, *J* = 7.6, 1.6 Hz, 1H), 6.90 (td, *J* = 7.6, 3.2 Hz, 1H), 4.78 (AB, J = 12.0 Hz, 1H), 4.66 (AB, *J* = 11.6 Hz, 1H), 4.43 (dd, *J* = 12.8, 2.4 Hz, 1H), 3.67 (d, *J* = 12.8 Hz, 1H), 3.52 (s, 3H), 3.07 (m, 3H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 150.3, 144.8 (d, J_{CP} = 3.9 Hz), 141.3, 138.4 (d, J_{CP} = 4.1 Hz), 136.3 (d, J_{CP} = 2.2 Hz), 135.8, 133.3 (d, J_{CP} = 10.4 Hz), 131.7 (d, J_{CP} = 3.4 Hz), 131.5 (d, J_{CP} = 3.2 Hz), 131.4 (d, J_{CP} = 2.4 Hz), 130.4 (d, J_{CP} = 12.4 Hz), 129.7 (d, J_{CP} = 137.7 Hz), 128.3, 127.8, 126.9 (d, J_{CP} = 13.6 Hz), 126.1, 125.9, 125.8, 124.8 (d, J_{CP} = 129.8 Hz), 124.6 (d, J_{CP} = 9.1 Hz), 121.2, 112.5 (d, J_{CP} = 8.5 Hz), 69.6, 68.6 (d, J_{CP} = 2.4 Hz), 57.4, 57.3. NMR is in accordance with previously reports[1]. The absolute configuration was determined from the literature[1].

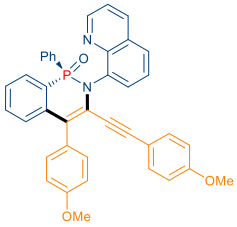
(*S*)-1,4-Diphenyl-3-(phenylethynyl)-2-(quinolin-8-yl)-2*H*-benzo[*c*][1,2]azaphosphinine 1-oxide (3h):



The 99% *ee* was determined by Daicel Chiralcel AD, Hexanes/IPA = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 6.042 min, t (minor) = 13.693 min; **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.84 (dd, *J* = 4.4, 2.0 Hz, 1H), 8.30 (d, *J* = 7.6 Hz, 1H), 8.00 (d, *J* = 8.4, 1H), 7.89 – 7.84 (m, 2H), 7.66 (d, *J* = 8.4, 2H), 7.59 – 7.41 (m, 7H), 7.28 – 7.21 (m, 2H), 7.21 – 7.14 (m, 2H), 7.07 – 6.98 (m, 3H), 6.90 (t, *J* = 8.0 Hz, 2H), 6.15 – 6.12 (m, 2H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 150.0, 145.4, 138.9, 138.4 (d, J_{CP} = 4.4 Hz), 137.9, 135.7, 133.8 (d, J_{CP} = 10.5 Hz) 132.0, 131.8 (d, J_{CP} = 3.0 Hz), 131.4 (d, J_{CP} = 2.5 Hz), 131.1, 131.0, 130.8 (d, J_{CP} = 139.0 Hz), 130.7, 128.6, 128.2, 128.0 (d, J_{CP} = 12.8 Hz), 127.8, 127.4, 127.2 (d, J_{CP} = 13.7 Hz), 126.8, 126.7 (d, J_{CP} = 8.8 Hz), 126.3, 126.0, 125.6 (d, J_{CP} = 128.0 Hz), 123.7 (d, J_{CP} =

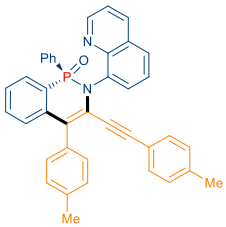
6.8 Hz), 122.2, 121.3, 97.4, 87.1, 87.0. NMR is in accordance with previously reports[3]. The absolute configuration was determined from the literature[3].

(*S*)-4-(4-Methoxyphenyl)-3-((4-methoxyphenyl)ethynyl)-1-phenyl-2-(quinolin-8-yl)-*2H*-benzo[*c*][1,2]azaphosphinine 1-oxide (3i):



The 99% *ee* was determined by Daicel Chiralcel IC, Hexanes/IPA = 80/20, 1. 0 mL/min, λ = 254 nm, t (major) = 10.423 min, t (minor) = 23.827 min. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.82 (s, 1H), 8.30 (d, J = 6.4 Hz, 1H), 7.95 (d, J = 8.0 Hz, 1H), 7.85 (t, J = 10.0 Hz, 2H), 7.62 (d, J = 8.0 Hz, 1H), 7.55 – 7.33 (m, 5H), 7.29 – 7.08 (m, 4H), 7.0 8-6.94 (m, 4H), 6.43 (d, J = 8.4 Hz, 2H), 6.12 (d, J = 8.0 Hz, 2H), 3.83 (s, 3H), 3.58 (s, 3 H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 159.4, 158.9, 149.9, 145.3, 138.7, 138.0, 135.6, 133.7 (d, J_{CP} = 11.8 Hz), 133.0, 132.2, 131.7, 131.3 (d, J_{CP} = 7.4 Hz), 131.0, 130.9, 129.5, 128.5, 127.7, 127.3 (d, J_{CP} = 13.5 Hz), 127.0, 126.6 (d, J_{CP} = 11.0 Hz), 126.2, 126.0, 125.9, 125.4, 122.5 (d, J_{CP} = 6.7 Hz), 121.2, 114.3, 113.6 (d, J_{CP} = 3.6 Hz), 97.4, 86.1 (d, J_{CP} = 5.9 Hz), 55.4, 55.1. NMR is in accordance with previously reports[3]. The absolute configuration was determined from the literature[3].

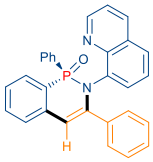
(*S*)-1-Phenyl-2-(quinolin-8-yl)-4-(p-tolyl)-3-(p-tolylethynyl)-*2H*-benzo[*c*][1,2]azaphosphinine 1-oxide (3j):



The 99% *ee* was determined by Daicel Chiralcel AD, Hexanes/IPA = 80/20, 1.0 mL/min, λ = 254 nm, t (minor) = 9.245 min, t (major) = 14.896 min. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.83 (dd, J = 4.0, 1.6 Hz, 1H), 8.29 (d, J = 7.6 Hz, 1H), 7.98 (dd, J = 8.0, 1.6 Hz, 1H), 7.87 – 7.80 (m, 2H), 7.64 (dd, J = 8.0, 1.6 Hz, 1H), 7.51 – 7.36 (m, 5H), 7.29 – 7.17 (m, 5H), 7.15 (td, J = 7.6, 1.6 Hz, 1H), 7.04 (td, J = 8.0, 3.6 Hz, 2H), 6.72 (d, J = 7.6 Hz, 2H), 6.06 (d, J = 8.0 Hz, 2H), 2.43 (s, 3H), 2.13 (s, 3H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 149.9, 145.3, 138.6 (d, J_{CP} = 4.5 Hz), 138.1, 137.9, 136.8, 135.7, 135.5, 133.7 (d, J_{CP} = 10.5 Hz), 131.9, 131.6 (d, J_{CP} = 2.9 Hz), 131.3 (d, J_{CP} = 2.6 Hz), 131.1, 131.0, 130.9, 130.6, 129.5 (d, J_{CP} = 56.4 Hz), 128.8, 128.5, 127.7 (d, J_{CP} = 182.7 Hz) 127.3 (d, J_{CP} = 13.4 Hz), 126.7, (d, J_{CP} = 9.1 Hz) 126.2 (d, J_{CP} = 14.6 Hz), 125.5 (d, J_{CP} = 128.0 Hz), 123.3 (d, J_{CP} = 7.0 Hz),

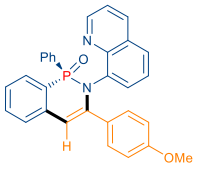
121.1, 119.2, 97.4, 86.6 (d, J_{CP} = 6.5 Hz), 21.4, 21.3. NMR is in accordance with previously reports[3]. The absolute configuration was determined from the literature[3].

(*S*)-1,3-Diphenyl-2-(quinolin-8-yl)-2*H*-benzo[*c*][1,2]azaphosphinine 1-oxide (3k):



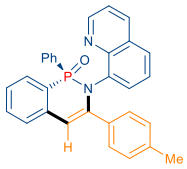
The >99% *ee* was determined by Daicel Chiralcel IC, Hexanes/IPA = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 19.326 min, t (minor) = 22.321 min; **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.71 (dd, *J* = 4.4, 1.6 Hz, 1H), 8.12 (dt, *J* = 7.2, 1.6 Hz, 1H), 7.76 – 7.64 (m, 3H), 7.59 – 7.49 (m, 1H), 7.50 – 7.40 (m, 2H), 7.38 – 7.32 (m, 3H), 7.29 – 7.19 (m, 2H), 7.16 – 7.05 (m, 2H), 6.97 (td, *J* = 7.6, 3.2 Hz, 2H), 6.89 (dd, *J* = 4.8, 2.0 Hz, 3H), 6.33 (d, *J* = 2.0 Hz, 1H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 149.3, 145.2, 144.1 (d, J_{CP} = 3.3 Hz), 138.4 (d, J_{CP} = 4.3 Hz), 138.1 (d, J_{CP} = 5.0 Hz), 137.8 (d, J_{CP} = 2.4 Hz), 135.5, 133.1, 133.0, 131.8 (d, J_{CP} = 2.5 Hz), 131.5 (d, J_{CP} = 2.9 Hz), 130.9 (d, J_{CP} = 12.3 Hz), 130.4 (d, J_{CP} = 2.9 Hz), 129.0, 128.4, 127.4, 127.3, 127.2, 127.1, 127.0, 126.8 (d, J_{CP} = 9.2 Hz), 126.0 (d, J_{CP} = 12.4 Hz), 125.5, 124.1 (d, J_{CP} = 129.7 Hz), 121.0, 107.7 (d, J_{CP} = 7.8 Hz). NMR is in accordance with previously reports[3]. The absolute configuration was determined from the literature[3].

(*S*)-3-(4-Methoxyphenyl)-1-phenyl-2-(quinolin-8-yl)-2*H*-benzo[*c*][1,2]azaphosphini-ne 1-oxide (3l):



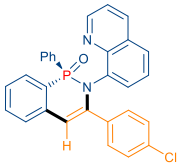
The 98% *ee* was determined by Daicel Chiralcel IC, Hexanes/IPA = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 26.305 min, t (minor) = 32.955 min; **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.70 – 8.69 (m, 1H), 8.07 (d, *J* = 6.4, 1H), 7.71 –7.65 (m, 3H), 7.49 –7.38 (m, 4H), 7.31 – 7.27 (m, 3H), 7.22 – 7.17 (m, 2H), 7.10 – 7.06 (m, 2H), 6.96 – 6.92 (m, 2H), 6.41 (d, *J* = 8.8 Hz, 2H), 6.27 (d, *J* = 2.0 Hz, 1H), 3.49 (s, 3H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 158.8, 149.3, 144.9, 144.1, 138.2 (d, J_{CP} = 5.0 Hz), 137.8 (d, J_{CP} = 2.3 Hz), 135.5, 132.9 (d, J_{CP} = 10.6 Hz), 131.8 (d, J_{CP} = 2.3 Hz), 131.5 (d, J_{CP} = 2.8 Hz), 131.0, 130.8 (d, J_{CP} = 4.4 Hz), 130.7 (d, J_{CP} = 12.2 Hz), 130.2 (d, J_{CP} = 2.8 Hz), 130.1, 129.3, 128.4, 127.2 (d, J_{CP} = 9.5 Hz) , 127.0, 126.6 (d, J_{CP} = 9.3 Hz) 125.8 (d, J_{CP} = 14.3 Hz), 125.4, 123.7 (d, J_{CP} = 126.7 Hz), 121.0, 112.5, 107.3 (d, J_{CP} = 7.6 Hz), 55.0. NMR is in accordance with previously reports[3]. The absolute configuration was determined from the literature[3].

(*S*)-1-phenyl-2-(quinolin-8-yl)-3-(*p*-tolyl)-2*H*-benzo[*c*][1,2]azaphosphinine 1-oxide (3m):



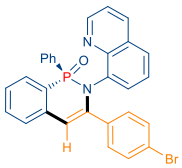
The >99% *ee* was determined by Daicel Chiralcel IA, Hexanes/IPA = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 20.933 min, t (minor) = 26.387 min; **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.71 (d, *J* = 3.6 Hz, 1H), 8.09 (d, *J* = 7.2 Hz, 1H), 7.73 – 7.63 (m, 3H), 7.53 – 7.39 (m, 4H), 7.31 (d, *J* = 8.0 Hz, 1H), 7.25 – 7.19 (m, 3H), 7.12 – 7.05 (m, 2H), 6.95 (td, *J* = 7.6, 3.2 Hz, 2H), 6.70 (d, *J* = 7.6 Hz, 2H), 6.30 (s, 1H), 2.01 (s, 3H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 149.3, 145.2, 137.2, 135.4, 133.0 (d, J_{CP} = 10.6 Hz), 131.7 (d, J_{CP} = 2.5 Hz), 131.4 (d, J_{CP} = 2.9 Hz), 130.8, 130.7, 130.3 (d, J_{CP} = 2.9 Hz), 128.8, 128.3, 127.7 (d, J_{CP} = 5.6 Hz), 127.1, 127.0, 126.6, 126.5, 125.9, 125.7, 125.4, 121.0, 107.5 (d, J_{CP} = 7.7 Hz), 21.0. **^{31}P NMR (162 MHz, $CDCl_3$)** δ 18.94; HRMS (ESI) calculated for $C_{30}H_{23}N_2OP$ $[M + H]^+$: 459.1621, found: 459.1623.

(*S*)-3-(4-Chlorophenyl)-1-phenyl-2-(quinolin-8-yl)-2*H*-benzo[*c*][1,2]azaphosphinine 1-oxide (3n):



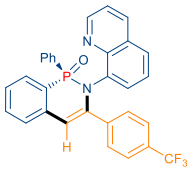
The >99% *ee* was determined by Daicel Chiralcel IA, Hexanes/IPA = 70/30, 1.0 mL/min, λ = 254 nm, t (minor) = 13.360 min, t (major) = 33.579 min; **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.71 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.11 (d, *J* = 7.2 Hz, 1H), 7.77 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.72 – 7.62 (m, 2H), 7.58 – 7.51 (m, 1H), 7.49 – 7.35 (m, 4H), 7.30 (d, *J* = 8.4 Hz, 2H), 7.23 (s, 1H), 7.15 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.09 (d, *J* = 7.6 Hz, 1H), 6.96 (td, *J* = 8.0, 3.6 Hz, 2H), 6.88 (d, *J* = 8.4 Hz, 2H), 6.29 (d, *J* = 2.0 Hz, 1H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 149.3, 144.0, 143.9, 137.8 (d, J_{CP} = 2.0 Hz), 137.5 (d, J_{CP} = 2.5 Hz), 137.0 (d, J_{CP} = 4.4 Hz), 135.6, 133.2, 133.0, 132.9, 131.8 (d, J_{CP} = 2.4 Hz), 131.5 (d, J_{CP} = 2.9 Hz), 131.0 (d, J_{CP} = 120.6 Hz), 130.2, 128.4, 127.5, 127.3, 127.2 (d, J_{CP} = 3.6 Hz), 126.7 (d, J_{CP} = 9.3 Hz), 126.2 (d, J_{CP} = 14.4 Hz), 125.5, 123.6 (d, J_{CP} = 127.8 Hz), 121.1, 107.8 (d, J_{CP} = 7.8 Hz). NMR is in accordance with previously reports[3]. The absolute configuration was determined from the literature[3].

(*S*)-3-(4-Methoxyphenyl)-1-phenyl-2-(quinolin-8-yl)-2*H*-benzo[*c*][1,2]azaphosphini-ne 1-oxide (3o):



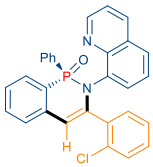
The >99% *ee* was determined by Daicel Chiralcel IC, Hexanes/IPA = 70/30, 1.0 mL/min, λ = 254 nm, t (major) = 24.770 min, t (minor) = 33.176 min; **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.70 (d, *J* = 4.0 Hz, 1H), 8.12 (d, *J* = 7.6 Hz, 1H), 7.80 (d, *J* = 8.4 Hz, 1H), 7.68 – 7.63 (m, 2H), 7.55 (t, *J* = 7.6 Hz, 1H), 7.49 – 7.44 (m, 2H), 7.36 (d, *J* = 8.4 Hz, 1H), 7.28 – 7.24 (m, 4H), 7.19 – 7.16 (m, 1H), 7.11 (d, *J* = 7.6 Hz, 1H), 7.03 (d, *J* = 8.0 Hz, 2H), 6.99-6.91 (m, 2H), 6.29 (s, 1H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 149.3, 144.0, 143.8 (d, J_{CP} = 3.0 Hz), 137.8 (d, J_{CP} = 5.0 Hz), 137.5 (d, J_{CP} = 4.0 Hz), 135.6, 133.0 (d, J_{CP} = 11.0 Hz), 131.8 (d, J_{CP} = 2.9 Hz), 131.5 (d, J_{CP} = 3.0 Hz), 130.9, 130.8 (d, J_{CP} = 117.5 Hz), 130.4, 130.2, 130.1 (d, J_{CP} = 2.0 Hz), 128.4, 127.5, 127.1 (d, J_{CP} = 13.0 Hz), 126.8 (d, J_{CP} = 11.0 Hz), 126.1 (d, J_{CP} = 14.0 Hz), 125.5, 124.2 (d, J_{CP} = 126.0 Hz), 121.6, 121.2, 107.8 (d, J_{CP} = 8.0 Hz). NMR is in accordance with previously reports[3]. The absolute configuration was determined from the literature[3].

(*S*)-1-Phenyl-2-(quinolin-8-yl)-3-(4-(trifluoromethyl)phenyl)-2*H*-benzo[*c*][1,2]aza-phosphinine 1-oxide (3p):



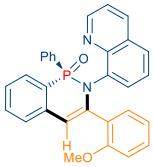
The >99% *ee* was determined by Daicel Chiralcel IA, Hexanes/IPA = 80/20, 1.0 mL/min, λ = 254 nm, t (minor) = 17.295 min, t (major) = 24.567 min; **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.72 (dd, *J* = 4.4, 1.6 Hz, 1H), 8.14 (d, *J* = 7.6 Hz), 7.77 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.68 – 7.63 (m, 3H), 7.57 (t, *J* = 7.6 Hz, 2H), 7.52 – 7.43 (m, 4H), 7.38 (d, *J* = 8.0 Hz, 1H), 7.29 – 7.24 (m, 3H), 7.17 (m, 3H), 7.13 – 7.08 (m, 1H), 6.97 (td, *J* = 7.6, 3.6 Hz, 2H), 6.34 (s, 1H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 149.4, 143.8, 143.7 (d, J_{CP} = 3.3 Hz), 142.0, 137.6 (d, J_{CP} = 4.9 Hz), 137.3 (d, J_{CP} = 2.6 Hz), 135.6, 133.0 (d, J_{CP} = 10.6 Hz), 131.9 (d, J_{CP} = 2.5 Hz), 131.6 (d, J_{CP} = 2.9 Hz), 131.0 (d, J_{CP} = 12.0 Hz), 130.2 (d, J_{CP} = 2.9 Hz), 129.1, 128.4, 127.6, 127.2, 127.1, 126.9 (d, J_{CP} = 9.3 Hz), 126.5 (d, J_{CP} = 14.4 Hz), 125.5, 124.0 (q, J_{CF} = 270.5 Hz) 121.2, 108.5 (d, J_{CP} = 8.0 Hz). NMR is in accordance with previously reports[3]. The absolute configuration was determined from the literature[3].

(*S*)-3-(2-Chlorophenyl)-1-phenyl-2-(quinolin-8-yl)-*2H*-benzo[*c*][1,2]azaphosphini-ne 1-oxide (3q):



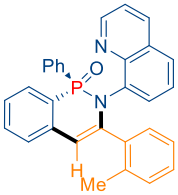
The 99% *ee* was determined by Daicel Chiralcel IA, Hexanes/IPA = 80/20, 1.0 mL/min, λ = 254 nm, t (minor) = 10.603 min, t (mjaor) =18.437 min; **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.79 (dd, *J* = 4.4, 1.6 Hz, 1H), 8.36 (d, *J* = 7.2 Hz, 1H), 7.74 – 7.63 (m, 3H), 7.52 (t, *J* = 7.2 Hz, 1H), 7.45-7.40 (m, 2H), 7.37 – 7.31 (m, 2H), 7.25 – 7.19 (m, 2H), 7.16 (dd, *J* = 8.2, 4.4 Hz, 1H), 7.09 – 7.02 (m, 1H), 6.97 (d, *J* = 7.6 Hz, 1H), 6.92 (td, *J* = 8.0, 3.2 Hz, 2H), 6.83 (td, *J* = 7.6, 1.6 Hz, 1H), 6.70 (t, *J* = 7.6 Hz, 1H), 6.25 (d, *J* = 2.4 Hz, 1H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 149.3, 144.3, 142.5, 137.7 (d, J_{CP} = 4.7 Hz), 136.7, 136.5 (d, J_{CP} = 2.6 Hz), 135.4, 133.8, 133.3 (d, J_{CP} = 10.6 Hz), 132.1, 131.7 (d, J_{CP} = 2.4 Hz), 131.4 (d, J_{CP} = 2.8 Hz), 131.0 (d, J_{CP} = 12.6 Hz), 130.7 (d, J_{CP} = 2.6 Hz), 129.1, 128.7, 128.0, 127.7, 127.0, 126.8 (d, J_{CP} = 9.3 Hz), 126.1 (d, J_{CP} = 14.4 Hz), 125.4, 125.0, 124.5 (d, J_{CP} = 127.9 Hz), 121.0, 107.4. NMR is in accordance with previously reports[3]. The absolute configuration was determined from the literature[3].

(*S*)-3-(2-Methoxyphenyl)-1-phenyl-2-(quinolin-8-yl)-*2H*-benzo[*c*][1,2]azaphosphini-ne 1-oxide (3r):



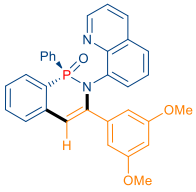
The 99% *ee* was determined by Daicel Chiralcel IA, Hexanes/IPA = 80/20, 1.0 mL/min, λ = 254 nm, t (minor) = 14.498 min, t (mjaor) = 29.448 min; **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.76 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.23 (dd, *J* = 7.2, 1.6 Hz, 1H), 7.75 – 7.65 (m, 3H), 7.56 – 7.36 (m, 4H), 7.33 (dd, *J* = 8.2, 1.6 Hz, 1H), 7.26 (dd, *J* = 7.6, 1.6 Hz, 1H), 7.25 – 7.14 (m, 2H), 7.12 (dd, *J* = 8.4, 4.4 Hz, 1H), 7.11 – 7.02 (m, 1H), 6.93 (td, *J* = 7.6, 3.6 Hz, 2H), 6.86 (td, *J* = 7.6, 2.0 Hz, 1H), 6.48 – 6.33 (m, 2H), 6.24 (d, *J* = 2.0 Hz, 1H), 3.71 (s, 3H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 156.2, 149.2, 144.4 (d, J_{CP} = 3.7 Hz), 143.3, 138.2 (d, J_{CP} = 4.7 Hz), 137.2 (d, J_{CP} = 2.4 Hz), 135.3, 133.3 (d, J_{CP} = 10.5 Hz), 131.7, 131.5 (d, J_{CP} = 2.5 Hz), 131.3 (d, J_{CP} = 3.0 Hz), 130.9 (d, J_{CP} = 11.0 Hz), 130.7, 129.5, 127.9, 127.5, 127.1 (d, J_{CP} = 4.1 Hz), 127.0 (d, J_{CP} = 13.6 Hz), 126.5, 125.6 (d, J_{CP} = 14.4 Hz), 124.9, 124.2 (d, J_{CP} = 128.3 Hz), 121.1 (d, J_{CP} = 180.5 Hz), 120.7, 119.0, 109.2, 106.6 (d, J_{CP} = 7.3 Hz), 54.9. NMR is in accordance with previously reports[3]. The absolute configuration was determined from the literature[3].

(*S*)-1-phenyl-2-(quinolin-8-yl)-3-(*o*-tolyl)-2*H*-benzo[*c*][1,2]azaphosphinine 1-oxide (3s)



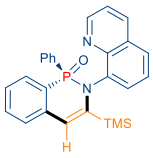
The >99% *ee* was determined by Daicel Chiralcel IA, Hexanes/IPA = 80/20, 1.0 mL/min, λ = 254 nm, t (minor) = 25.165 min, t (major) = 32.105 min; **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.79 (d, *J* = 4.8 Hz, 1H), 8.18 (s, 1H), 7.78 – 7.62 (m, 3H), 7.54 (t, *J* = 7.6 Hz, 1H), 7.46 (d, *J* = 8.0 Hz, 2H), 7.32 (d, *J* = 8.0 Hz, 1H), 7.26 – 7.20 (m, 2H), 7.17 (dd, *J* = 8.0, 4.2 Hz, 2H), 7.06 (d, *J* = 7.2 Hz, 1H), 6.95 (d, *J* = 7.2 Hz, 2H), 6.81 (d, *J* = 6.4 Hz, 2H), 6.64 (d, *J* = 7.6 Hz, 1H), 6.19 (s, 1H), 2.50 (s, 3H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 149.3, 136.9, 135.4, 131.7, 131.4, 130.8, 130.7, 130.5, 128.1, 127.7, 127.6, 127.0, 126.9, 126.6, 126.5, 125.8, 125.6, 125.3, 123.9, 121.0, 107.0, 77.4, 77.1, 76.7, 19.9; **^{31}P NMR (162 MHz, $CDCl_3$)** δ 18.11; HRMS (ESI) calculated for $C_{30}H_{23}N_2OP$ $[M + H]^+$: 459.1621, found: 459.1622.

(*S*)-3-(3,5-dimethoxyphenyl)-1-phenyl-2-(quinolin-8-yl)-2*H*-benzo[*c*][1,2]azaphosphinine 1-oxide (3t)



The 99% *ee* was determined by Daicel Chiralcel OD, Hexanes/IPA = 90/10, 1.0 mL/min, λ = 254 nm, t (major) = 21.880 min, t (minor) = 30.212 min; **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.73 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.03 (d, *J* = 7.2 Hz, 1H), 7.78 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.76 – 7.68 (m, 2H), 7.54 (t, *J* = 7.6 Hz, 2H), 7.51 – 7.43 (m, 2H), 7.38 (d, *J* = 8.0 Hz, 1H), 7.25 – 7.22 (m, 1H), 7.18 – 7.10 (m, 2H), 7.00 (td, *J* = 7.6, 3.2 Hz, 2H), 6.54 (d, *J* = 2.4 Hz, 2H), 6.40 (d, *J* = 2.0 Hz, 1H), 6.03 (t, *J* = 2.4 Hz, 1H), 3.49 (s, 6H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 159.4, 149.3, 144.9, 140.2, 140.2, 137.9, 137.8, 135.6, 132.9, 131.8 (d, J_{CP} = 2.3 Hz), 131.5 (d, J_{CP} = 2.9 Hz), 130.8, 130.7, 130.2 (d, J_{CP} = 2.8 Hz), 128.5, 127.2, 127.1, 126.8, 126.7, 126.3, 126.1, 125.5, 121.1, 108.1, 108.0, 107.0, 100.7, 77.4, 77.1, 76.8, 55.2; **^{31}P NMR (162 MHz, $CDCl_3$)** δ 19.22; HRMS (ESI) calculated for $C_{31}H_{26}N_2O_3P$ $[M + H]^+$: 505.1676, found: 505.1679.

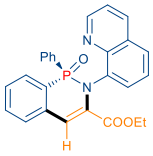
(*S*)-1-Phenyl-2-(quinolin-8-yl)-3-(trimethylsilyl)-2*H*-benzo[*c*][1,2]azaphosphinine 1-oxide (3u):



The >99% *ee* was determined by Daicel Chiralcel OD, Hexanes/IPA = 95/5, 1.0 mL/min, λ = 254 nm, t (major) = 5.062 min, t (minor) = 5.861 min; **^{1}H NMR (400**

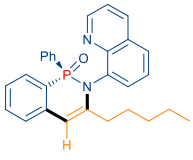
MHz, $CDCl_3$) δ 8.76 (dd, *J* = 4.2, 1.6 Hz, 1H), 8.22 (d, *J* = 7.2 Hz, 1H), 7.95 (dd, *J* = 8.2, 1.6 Hz, 1H), 7.66 – 7.48 (m, 4H), 7.48 – 7.35 (m, 3H), 7.28 – 7.20 (m, 2H), 7.04 (td, *J* = 7.2, 1.2 Hz, 1H), 6.90 (td, *J* = 7.6, 3.2 Hz, 2H), -0.34 (s, 9H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 150.1, 148.5 (d, J_{CP} = 4.6 Hz), 146.2, 138.1, 137.3 (d, J_{CP} = 3.5 Hz), 135.8, 133.5, 133.4, 132.7 (d, J_{CP} = 2.6 Hz), 131.6 (d, J_{CP} = 2.0 Hz), 131.2 (d, J_{CP} = 2.3 Hz), 130.6 (d, J_{CP} = 12.0 Hz), 128.8, 128.4, 126.8, 126.7, 126.7, 126.4, 126.2, 125.7, 124.7 (d, J_{CP} = 128.5 Hz), 121.4, 115.2 (d, J_{CP} = 11.3 Hz), 0.1. NMR is in accordance with previously reports[3]. The absolute configuration was determined from the literature[3].

Ethyl (*S*)-1-phenyl-2-(quinolin-8-yl)-2*H*-benzo[*c*][1,2]azaphosphinine-3-carboxylate 1-oxide (3v):



The 91% *ee* was determined by Daicel Chiralcel IA, Hexanes/IPA = 80/20, 1.0 mL/min, λ = 254 nm, t (minor) = 22.745 min, t (major) = 38.077 min; **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.76 (dd, *J* = 4.4, 2.0 Hz, 1H), 8.15 (s, 1H), 7.96 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.62 – 7.54 (m, 4H), 7.53 – 7.42 (m, 2H), 7.38 – 7.29 (m, 2H), 7.28 – 7.25 (m, 1H),7.22 (s, 1H), 7.14 – 7.10 (m, 1H), 6.98 (s, 2H), 3.77 (q, *J* = 7.2 Hz, 2H), 0.68 (t, *J* = 7.2 Hz, 3H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 164.1 (d, J_{CP} = 6.5 Hz), 149.5, 144.1, 138.3, 135.8, 135.7 (d, J_{CP} = 4.5 Hz), 135.0, 132.9 (d, J_{CP} = 10.6 Hz), 131.9 (d, J_{CP} = 2.3 Hz), 131.6, 131.1, 128.3, 128.1, 128.0, 127.3, 127.2, 126.4, 125.9 (d, J_{CP} = 125.7 Hz), 60.9, 13.4. NMR is in accordance with previously reports[3]. The absolute configuration was determined from the literature[3].

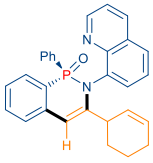
(*S*)-3-Pentyl-1-phenyl-2-(quinolin-8-yl)-2*H*-benzo[*c*][1,2]azaphosphinine 1-oxide (3w)



The 99% *ee* was determined by Daicel Chiralcel IC, Hexanes/IPA = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 26.183 min, t (minor) = 34.845 min; **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.77 (dd, *J* = 4.4, 2.0 Hz, 1H), 8.22 (dt, *J* = 7.2, 1.6 Hz, 1H), 7.96 (dd, *J* = 8.4, 2.0 Hz, 1H), 7.60 (d, *J* = 8.4, 1H), 7.55 – 7.47 (m, 3H), 7.44 – 7.34 (m, 3H), 7.27 – 7.24 (m, 1H), 7.17 – 7.12 (m, 1H), 7.02 (td, *J* = 8.4, 1.6 Hz, 1H), 6.90 – 6.85 (m, 2H), 6.12 (d, *J* = 2.0, 1H), 2.12 – 2.04 (m, 1H), 1.99 – 1.91 (m, 1H), 1.50 – 1.46 (m, 2H), 1.11 – 0.97 (m, 4H), 0.72 (t, *J* = 6.8 Hz, 3H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 150.2, 145.3, 138.5 (d, J_{CP} = 4.6 Hz), 135.9, 133.2 (d, J_{CP} = 10.5 Hz), 132.1 (d, J_{CP} = 2.9Hz), 131.6 (d, J_{CP} = 2.4 Hz), 131.2 (d, J_{CP} = 2.9 Hz),

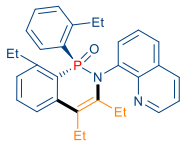
130.7 (d, J_{CP} = 12.5 Hz), 128.5, 128.2, 126.8, 126.6, 126.1 (d, J_{CP} = 9.2 Hz), 125.8, 125.0 (d, J_{CP} = 14.5 Hz), 122.9 (d, J_{CP} = 128.3 Hz), 121.2, 102.7 (d, J_{CP} = 8.4Hz), 34.9 (d, J_{CP} = 2.8 Hz), 31.2, 28.2, 22.2, 13.8. NMR is in accordance with previously reports[3]. The absolute configuration was determined from the literature[3].

(*S*)-3-(Cyclohex-1-en-1-yl)-1-phenyl-2-(quinolin-8-yl)-*2H*-benzo[*c*][1,2]azaphosphi-nine 1-oxide (3x):



The 99% *ee* was determined by Daicel Chiralcel IA, Hexanes/IPA = 80/20, 1.0 mL/min, λ = 254 nm, t (minor) = 10.660 min, t (major) = 13.961 min; **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.76 (d, *J* = 4.0 Hz, 1H), 8.02 (d, *J* = 7.2 Hz, 1H), 7.93 (d, *J* = 8.4 Hz, 1H), 7.68 (dd, *J* = 13.2, 7.6 Hz, 2H), 7.54 – 7.44 (m, 2H), 7.43-7.36 (m, 2H), 7.31 (t, *J* = 7.6 Hz, 1H), 7.24 (dd, *J* = 8.4, 4.4 Hz, 1H), 7.21-7.14 (m, 1H), 7.10 (t, *J* = 7.6 Hz, 1H), 6.98 (td, *J* = 7.6, 3.2 Hz, 2H), 6.18 (d, *J* = 2.0 Hz, 1H), 5.72 (t, *J* = 4.0 Hz, 1H), 2.07-1.96 (m, 2H), 1.67-1.38 (m, 2H), 1.17-0.96(m, 4H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 149.3, 147.4, 144.8 (d, J_{CP} = 3.4 Hz), 138.3 (d, J_{CP} = 5.0 Hz), 138.0 (d, J_{CP} = 2.4 Hz), 135.5, 135.3 (d, J_{CP} = 4.0 Hz), 133.1 (d, J_{CP} = 10.5 Hz), 131.8 (d, J_{CP} = 121.8 Hz), 131.5 (d, J_{CP} = 2.4 Hz), 131.3 (d, J_{CP} = 2.7 Hz), 130.7 (d, J_{CP} = 12.2 Hz), 130.4, 130.3 (d, J_{CP} = 2.9 Hz), 128.5, 127.1, 126.9, 126.4 (d, J_{CP} = 9.4 Hz), 125.5, 125.3, 124.0 (d, J_{CP} = 127.6 Hz), 121.0, 104.8 (d, J_{CP} = 7.7 Hz), 28.1, 25.1, 22.4, 21.6. NMR is in accordance with previously reports[3]. The absolute configuration was determined from the literature[3].

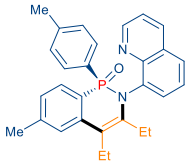
(*S*)-3,4,5-triethyl-1-(2-ethylphenyl)-2-(quinolin-8-yl)-2*H*-benzo[*c*][1,2]azaphosphinine 1-oxide (3y):



The >99% *ee* was determined by Daicel Chiralcel IA, Hexanes/IPA = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 5.112 min, t (minor) = 9.420 min; **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.68 (s, 1H), 8.20 (s, 1H), 7.94 – 7.82 (m, 2H), 7.55 – 7.47 (m, 3H), 7.29 (d, J = 10.0 Hz, 1H), 7.23 – 7.18 (m, 1H), 7.09 – 7.04 (m, 1H), 6.94 (d, *J* = 7.2 Hz, 1H), 6.83 (s, 1H), 6.66 (s, 1H), 2.77 (ddt, J = 20.4, 14.8, 7.6 Hz, 4H), 2.52 (dt, *J* = 15.2, 7.2 Hz, 2H), 2.14 (dd, *J* = 15.6, 7.6 Hz, 1H), 1.80 – 1.69 (m, 1H), 1.33 (d, J = 7.6 Hz, 3H), 0.97 (t, *J* = 7.2 Hz, 3H), 0.92 – 0.86 (m, 3H), 0.49 (t, *J* = 6.4 Hz, 3H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 149.5, 136.9,

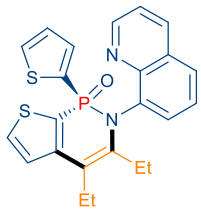
135.6, 131.4, 131.3, 131.0, 128.3, 127.8, 127.1, 125.6, 124.1, 122.0, 120.9, 77.4, 77.0, 76.7, 29.7, 27.1 (d, J_{CP} = 6.3 Hz), 26.2, 25.0, 15.1, 14.5, 13.6, 13.4; **^{31}P NMR (162 MHz, $CDCl_3$)** δ 12.33; HRMS (ESI) calculated for $C_{31}H_{34}N_2OP$ $[M + H]^+$: 481.2403, found: 481.2409.

(*S*)-3,4-Diethyl-6-methyl-2-(quinolin-8-yl)-1-(*p*-tolyl)-2*H*-benzo[*c*][1,2]azaphosphinine 1-oxide (3z):



The 99% *ee* was determined by Daicel Chiralcel ID, Hexanes/IPA = 70/30, 1.0 mL/min, λ = 254 nm, t (major) = 8.842 min, t (minor) = 12.210 min; **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.76 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.06 (d, *J* = 7.2 Hz, 1H), 7.95 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.52 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.48 – 7.42 (m, 3H), 7.33 – 7.25 (m, 2H), 7.19 (dd, *J* = 14.4, 8.0 Hz, 1H), 6.98 (d, *J* = 8.0 Hz, 1H), 6.72 (d, *J* = 8.0, 3.2 Hz, 2H), 2.75 (q, *J* = 7.6 Hz, 2H), 2.49 – 2.43 (m, 4H), 2.07 (s, 3H), 1.76 (dq, *J* = 14.8, 7.2 Hz, 1H), 1.32 (t, *J* = 7.2 Hz, 3H), 0.95 (t, *J* = 7.6 Hz, 3H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 150.0, 145.3 (d, J_{CP} = 3.5 Hz), 142.2, 141.4 (d, J_{CP} = 2.9 Hz), 141.3 (d, J_{CP} = 2.5 Hz), 139.0 (d, J_{CP} = 4.5 Hz), 137.6 (d, J_{CP} = 2.5 Hz), 135.8, 133.3 (d, J_{CP} = 10.5 Hz), 130.8 (d, J_{CP} = 13.0 Hz), 130.5 (d, J_{CP} = 3.3 Hz), 128.5, 128.1 (d, J_{CP} = 137.9 Hz), 127.7 (d, J_{CP} = 13.6 Hz), 127.2, 126.0 (d, J_{CP} = 15.0 Hz), 125.8, 123.8 (d, J_{CP} = 9.8 Hz), 123.0 (d, J_{CP} = 132.0 Hz), 121.2, 113.9 (d, J_{CP} = 8.4 Hz), 24.8 (d, J_{CP} = 2.5 Hz), 22.4, 22.2, 21.4, 15.1, 13.3. NMR is in accordance with previously reports[3]. The absolute configuration was determined from the literature[3].

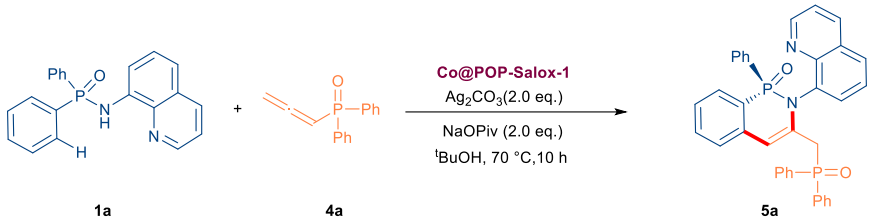
(*S*)-3,4-diethyl-2-(quinolin-8-yl)-1-(thiophen-2-yl)-2H-thieno[2,3-c][1,2]azaphosphinine 1-oxide: (3aa)



The 99% *ee* was determined by Daicel Chiralcel IA, Hexanes/IPA = 80/20, 1.0 mL/min, λ = 254 nm, t (minor) = 16.982 min, t (major) = 23.010 min; **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.80 – 8.72 (m, 1H), 8.25 (d, *J* = 7.2 Hz, 1H), 8.01 (d, *J* = 8.0 Hz, 1H), 7.69 – 7.65 (m, 2H), 7.48 (t, *J* = 7.8 Hz, 1H), 7.30 – 7.26 (m, 2H), 7.22 (t, *J* = 4.8 Hz, 1H), 7.16 (dd, *J* = 8.2, 3.6 Hz, 1H), 6.61 – 6.55 (m, 1H), 2.71 (qd, *J* = 7.4, 2.2 Hz, 2H), 2.45 (ddd, *J* = 14.8, 7.6, 2.6 Hz, 1H), 1.77 (dd, *J* = 14.8, 7.4 Hz, 1H), 1.27 (t, *J* = 7.4 Hz, 3H), 0.90 (t, *J* = 7.4 Hz, 3H).. **^{13}C NMR (100 MHz, $CDCl_3$)** δ 150.2, 148.4 (d, J_{CP} = 6.7 Hz),

145.3, 142.4, 137.5 (d, J_{CP} = 12.0 Hz), 136.3, 135.9, 133.9 (d, J_{CP} = 6.5 Hz), 132.2 (d, J_{CP} = 12.0 Hz), 128.5, 128.3, 126.8 (d, J_{CP} = 16.5 Hz), 125.9, 124.7 (d, J_{CP} = 12.5 Hz), 121.3, 118.7 (d, J_{CP} = 148.9 Hz), 111.6 (d, J_{CP} = 6.4 Hz), 24.0 (d, J_{CP} = 3.3 Hz), 23.8, 15.2, 13.9. NMR is in accordance with previously reports[3]. The absolute configuration was determined from the literature[3].

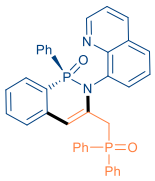
4.3. General procedure for enantioselective C–H annulation with allene



Phosphinic amide **1a** (0.1 mmol), **Co@POP-Salox-1** (5.0 mol % Co content), Ag_2CO_3 (0.2 mmol), NaOPiv (0.2 mmol), and ^{t}BuOH (2.0 mL) were added to an oven dried vial equipped with stirring bars. Then allene **4a** (0.20 mmol) was added in one batch. The vial was stirred in a heating block set at 70 °C for 10 h. After the reaction was completed, the reaction mixture was cooled to room temperature, quenched by saturated aqueous Na_2CO_3, and extracted with EtOAc. The organic layer was dried over anhydrous Na_2SO_4 and concentrated in vacuo. Then the mixture was subjected to column chromatography on silica gel to give the desired product **5a**[1].

Data of the compound

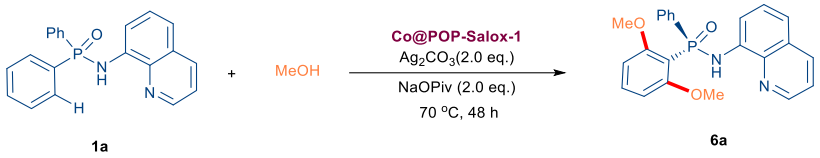
(*S*)-3-((diphenylphosphoryl)methyl)-1-phenyl-2-(quinolin-8-yl)-2*H*-benzo[*c*][1,2]azaphosphinine 1-oxide (5a)



The 99% *ee* was determined by Daicel Chiralcel IA, Hexanes/IPA = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 31.964 min, t (minor) = 52.951 min. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.76 (d, *J* = 2.0 Hz, 1H), 7.95 (dq, *J* = 6.8, 2.4 Hz, 1H), 7.59 (dt, *J* = 9.6, 5.2 Hz, 4H), 7.56 – 7.35 (m, 12H), 7.28 (s, 2H), 7.16 (d, *J* = 7.6 Hz, 2H), 7.01 (s, 1H), 6.85 (s, 2H), 6.39 (t, *J* = 2.8 Hz, 1H), 3.39 (t, *J* = 16.4 Hz, 1H), 2.91 (dd, *J* = 15.6, 12.4 Hz, 1H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 150.3, 144.7 (d, J_{CP} = 3.1 Hz), 137.6 (dd, J_{CP} = 4.7,2.9 Hz), 136.0, 135.1 (d, J_{CP} = 2.4 Hz), 135.0 (d, J_{CP} = 6.6 Hz), 132.8 (d, J_{CP} = 10.8 Hz), 132.1 (d, J_{CP} = 2.8 Hz), 132.0, 132.0 (d, J_{CP} = 2.8 Hz), 131.8 (d, J_{CP} = 101.0 Hz), 131.7 (d, J_{CP} = 2.5 Hz), 131.7 (d, J_{CP} = 2.7 Hz), 131.4, 131.3 (d, J_{CP} = 1.5 Hz), 131.2 (d, J_{CP} = 2.9 Hz),

130.8 (d, J_{CP} = 12.4 Hz), 128.8 (d, J_{CP} = 6.6 Hz), 128.7 (d, J_{CP} = 6.4 Hz), 128.4, 128.3, 126.8 (d, J_{CP} = 13.7 Hz), 126.5 (d, J_{CP} = 8.9 Hz), 126.0, 125.6 (d, J_{CP} = 14.6 Hz), 122.4 (dd, J_{CP} = 127.5, 1.5 Hz), 121.5, 106.7 (t, J_{CP} = 7.7 Hz), 36.2 (dd, J_{CP} = 65.6, 2.8 Hz). NMR is in accordance with previously reports[10]. The absolute configuration was determined from the literature[10].

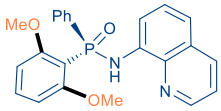
4.4. General procedure for enantioselective C–H alkoxylation of diarylphosphinamides



To a 10 mL Schlenk tube was added **1a** (0.10 mmol), methanol (1.5 mL), **Co@POP-Salox-1** (5.0 mol % Co content, $Co(ClO_4)_2 \cdot 6H_2O$ as Co source), Ag_2CO_3 (55.2 mg, 0.20 mmol, 2.0 equiv.) and NaOPiv (24.8 mg, 0.20 mmol, 2.0 equiv). Then, the vial was instantly placed in a heating aluminum block set at 70 ℃ and stirred under air for noted time. After cooling to room temperature, the reaction system was quenched with water (20 mL) and extracted with DCM (3×15 mL). The combined organic layer was dried over anhydrous Na_2SO_4, filtered, and concentrated in vacuo. After concentration, the resulting residue was purified by flash chromatography using petroleum ether/dichloromethane/acetone as the eluent to afford the desired product **6a**[8].

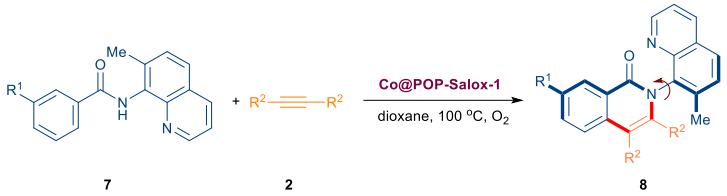
Data of the compound

(*S*)-*P*-(2,6-dimethoxyphenyl)-*P*-phenyl-*N*-(quinolin-8-yl)phosphinic amide (6a)



The 99% *ee* was determined by Daicel Chiralcel ID, Hexanes/IPA = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 28.081 min, t (minor) = 43.347 min. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 10.24 (d, *J* = 9.6 Hz, 1H), 8.84 (dd, *J* = 4.2, 1.6 Hz, 1H), 8.12 (dd, *J* = 8.2, 1.6 Hz, 1H), 8.02 – 7.94 (m, 2H), 7.45 – 7.33 (m, 6H), 7.23 (d, *J* = 3.4 Hz, 2H), 6.60 (dd, *J* = 8.4, 4.6 Hz, 2H), 3.81 (s, 6H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 162.2, 147.2, 138.4, 136.9, 134.2, 132.1 (d, J_{CP} = 10.9 Hz), 130.7 (d, J_{CP} = 2.8 Hz), 128.6, 127.8 (d, J_{CP} = 13.8 Hz), 127.5, 121.2, 118.4, 105.0 (d, J_{CP} = 6.9 Hz), 56.0. NMR is in accordance with previously reports[8]. The absolute configuration was determined from the literature[8].

4.5. General procedure for enantioselective C-H annulation of benzamide derivatives

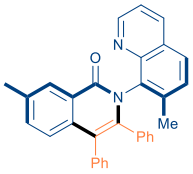


7 2 8

Benzamide derivatives **7** (0.20 mmol), alkynes **2** (0.30 mmol), **Co@POP-Salox-1** (5.0 mol % Co content) and anhydrous solvent dioxane (2.0 mL) was added successively to a 10 mL oven-dried Schlenk tube containing a magnetic stir bar under the oxygen atmosphere. Then the reaction system was closed with a ground glass stopper and stirred at 100°C for 12 h. The mixture was cooled to room temperature and diluted with 25 mL of DCM and filtered over a celite. The reaction solution was concentrated in vacuum and purified by flash column chromatography to give the product **8**[5].

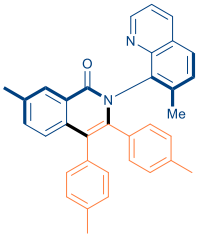
Data of the compounds

(*R*)-7-Methyl-2-(7-methylquinolin-8-yl)-3,4-diphenylisoquinolin-1(2H)-one (8a)



The 95% *ee* was determined by Daicel Chiralcel AD, Hexanes/IPA = 90/10, 1.0 mL/min, λ = 254 nm, t (major) = 15.840 min, t (minor) =27.442 min. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.90 (dd, *J* = 4.2, 1.6 Hz, 1H), 8.41 (s, 1H), 7.99 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.56 (d, *J* = 8.4 Hz, 1H), 7.44 (dd, *J* = 8.3, 2.0 Hz, 1H), 7.30 (dd, *J* = 8.2, 4.4 Hz, 1H), 7.26 – 7.23 (m, 3H), 7.18 – 7.12 (m, 3H), 6.95 (d, *J* = 7.6 Hz, 1H), 6.81 – 6.68 (m, 3H), 6.46 (td, *J* = 7.6, 1.6 Hz, 1H), 2.52 (s, 3H), 2.38 (s, 3H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 162.0, 150.6, 145.1, 141.0, 137.5, 136.8, 136.6, 136.0, 135.9, 135.6, 134.6, 133.8, 131.9, 131.7, 130.0, 129.2, 128.9, 128.1, 128.0, 127.9, 127.7, 127.3, 127.1, 126.6, 126.4, 126.1, 125.7, 125.6, 120.6, 118.8, 21.4, 19.0. NMR is in accordance with previously reports[5]. The absolute configuration was determined from the literature[5].

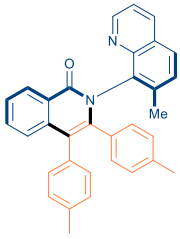
(*R*)-7-Methyl-2-(7-methylquinolin-8-yl)-3,4-di-p-tolylisoquinolin-1(2H)-one (8b)



The 95% *ee* was determined by Daicel Chiralcel IA, Hexanes/IPA = 90/10, 1.0 mL/min, λ = 254 nm, t (major) = 35.457 min, t (minor) =48.875 min. **^{1}H NMR (400 MHz, DMSO-d_6)** δ 8.87 (dd, *J* = 4.3, 1.6 Hz, 1H), 8.25 (dd, *J* = 8.4, 1.6 Hz, 1H), 8.14 (d, *J* = 2.0 Hz, 1H), 7.74 (d, *J* = 8.4 Hz, 1H), 7.53 (dd, *J* = 8.4, 2.0 Hz, 1H), 7.46 (dd, *J* = 8.2, 4.2 Hz, 1H), 7.35 (d, *J* = 8.4 Hz, 1H), 7.16 (dd, *J* = 7.6, 2.0 Hz, 1H), 7.06 (dd, *J* = 7.8, 4.2 Hz, 2H), 7.02 – 6.93 (m, 3H), 6.65 (dd, *J* = 8.0, 1.8 Hz, 1H), 6.51 (dd, *J* = 8.0,

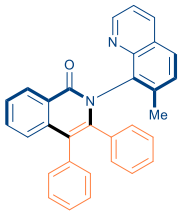
2.0 Hz, 1H), 6.26 (dd, *J* = 8.0, 1.8 Hz, 1H), 2.46 (s, 3H), 2.28 (s, 3H), 2.20 (s, 3H), 1.86 (s, 3H). **^{13}C NMR (100 MHz, DMSO-d_6)** δ 161.1, 150.9, 144.9, 141.4, 137.6, 137.0, 136.8, 136.4, 136.2, 136.2, 135.9, 134.5, 133.8, 131.9, 131.9, 131.5, 129.4, 129.2, 129.1, 128.4, 127.7, 127.4, 127.1, 127.1, 125.7, 125.3, 121.5, 118.0, 21.4, 21.2, 20.9, 18.9. The absolute configuration was determined from the literature[5].

(*R*)-2-(7-methylquinolin-8-yl)-3,4-di-p-tolylisoquinolin-1(2H)-one (8c)



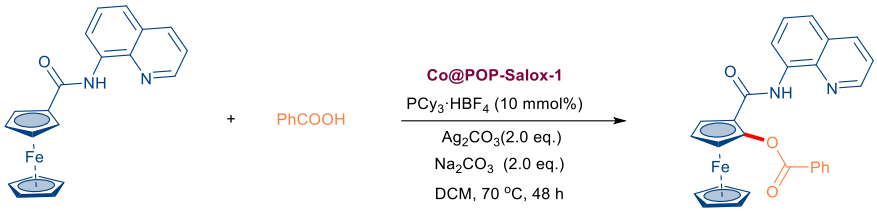
The 96% *ee* was determined by Daicel Chiralcel IA, Hexanes/IPA = 90/10, 1.0 mL/min, λ = 254 nm, t (major) = 13.844 min, t (minor) =18.101 min. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.87 (dd, *J* = 4.3, 1.6 Hz, 1H), 8.25 (dd, *J* = 8.4, 1.6 Hz, 1H), 8.14 (d, *J* = 2.0 Hz, 1H), 7.74 (d, *J* = 8.4 Hz, 1H), 7.53 (dd, *J* = 8.4, 2.0 Hz, 1H), 7.46 (dd, *J* = 8.2, 4.2 Hz, 1H), 7.35 (d, *J* = 8.4 Hz, 1H), 7.16 (dd, *J* = 7.6, 2.0 Hz, 1H), 7.06 (dd, *J* = 7.8, 4.2 Hz, 2H), 7.02 – 6.93 (m, 3H), 6.65 (dd, *J* = 8.0, 1.8 Hz, 1H), 6.51 (dd, *J* = 8.0, 2.0 Hz, 1H), 6.26 (dd, *J* = 8.0, 1.8 Hz, 1H), 2.46 (s, 3H), 2.28 (s, 3H), 2.20 (s, 3H), 1.86 (s, 3H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 161.1, 150.9, 144.9, 141.4, 137.6, 137.0, 136.8, 136.4, 136.2, 136.2, 135.9, 134.5, 133.8, 131.9, 131.9, 131.5, 129.4, 129.2, 129.1, 128.4, 127.7, 127.4, 127.1, 127.1, 125.7, 125.3, 121.5, 118.0, 21.4, 21.2, 20.9, 18.9. The absolute configuration was determined from the literature[5].

(*R*)-2-(7-methylquinolin-8-yl)-3,4-diphenylisoquinolin-1(2H)-one (8d)



The 91% *ee* was determined by Daicel Chiralcel IA, Hexanes/IPA = 90/10, 1.0 mL/min, λ = 254 nm, t (minor) = 18.912 min, t (major) =20.945 min. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.90 (dd, *J* = 4.4, 1.6 Hz, 1H), 8.61 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.99 (dd, *J* = 8.2, 1.8 Hz, 1H), 7.63 – 7.50 (m, 3H), 7.35 – 7.29 (m, 2H), 7.24 (d, *J* = 3.3 Hz, 3H), 7.16 (s, 3H), 6.96 (d, *J* = 7.8 Hz, 1H), 6.79 (t, *J* = 7.6 Hz, 2H), 6.75 – 6.69 (m, 1H), 6.49 – 6.43 (m, 1H), 2.39 (s, 3H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 162.0, 150.6, 145.1, 141.9, 138.3, 137.6, 136.6, 135.7, 135.7, 134.5, 132.4, 131.9, 131.8, 129.9, 129.1, 128.9, 128.5, 128.1, 128.0, 127.8, 127.5, 127.1, 126.8, 126.6, 126.5, 126.2, 125.7, 125.7, 120.7, 118.9, 19.0. The absolute configuration was determined from the literature[5].

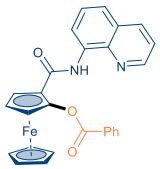
4.6. General procedure for enantioselective C-H acyloxylation with benzoic acid



To an oven dried vail equipped with stirring bar, ferrocenecarboxamide **9a** (0.1 mmol), benzoic acid **10a** (0.15 mmol), **Co@POP-Salox-1** (5.0 mol % Co content), Ag_2CO_3 (0.2 mmol), Na_2CO_3 (0.2 mmol), PCy_3•HBF_4 (10 mmol%), and DCM (2.0 mL) were added. The vial was instantly placed in a heating block set at 70 °C for 24 hours. The reaction mixture was then cooled to room temperature. The resulting mixture was filtered through a celite pad and concentrated in vacuo. The residue was purified by preparative TLC using PE/DCM/EtOAc as the eluent to afford the product **11a**[9].

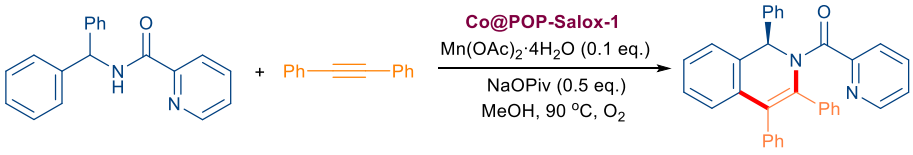
Data of the compound

(*S*)-[1-(benzoyloxy)-2-(8-quinolinylamino)carbonyl]ferrocene 11a:



The 98% *ee* was determined by Daicel Chiralcel IC, Hexanes/IPA = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 14.263 min, t (minor) = 40.106 min. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 10.81 (s, 1H), 8.87 (d, J = 7.6 Hz, 1H), 8.33 (d, J = 7.6 Hz, 2H), 8.10 (d, J = 8.0 Hz, 1H), 8.01 (s, 1H), 7.70 – 7.60 (m, 1H), 7.60 – 7.36 (m, 4H), 7.33 – 7.23 (m, 1H), 4.93 (s, 2H), 4.39 (s, 5H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 167.9, 165.2, 147.9, 138.6, 136.2, 133.7, 130.8, 129.3, 128.6, 128.0, 127.6, 121.5, 121.3, 116.9, 114.6, 68.0, 65.6, 65.4, 65.0. NMR is in accordance with previously reports[3].

4.7. General procedure for enantioselective C-H annulation of benzylamide derivative

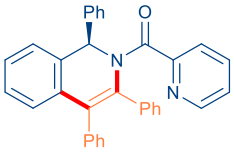


To an oven-dried 10 mL Schlenk tube containing a stirring bar was added benzylamide **12a** (0.10 mmol), alkyne **2a** (0.20 mmol), **Co@POP-Salox-1** (5.0 mol % Co content), $Mn(OAc)_2$·$4H_2O$

(0.01 mmol), NaOPiv (0.05 mmol) and MeOH (1.0 mL). The reaction flask was degassed three times with O_2. The mixture was then stirred for 24 h at 90 °C followed by cooling. The resulting mixture was filtered through a celite pad and concentrated in vacuo. The residue was purified by preparative TLC using hexane/EtOAc as the eluent to afford the desired product **13a**.[11]

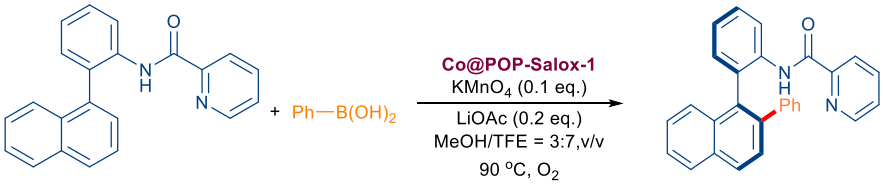
Data of the compound

(*R*)-pyridin-2-yl(1,3,4-triphenylisoquinolin-2(1H)-yl)methanone 13a



The 93% *ee* was determined by Daicel Chiralcel OD-H, Hexanes/IPA = 80/20, 1.0 mL/min, λ = 254 nm, t (minor) = 9.685 min, t (major) = 12.093 min. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.35 (s, 1H), 7.49 (d, *J* = 7.5 Hz, 2H), 7.41 (t, *J* = 7.5 Hz, 2H), 7.35 (d, *J* = 6.7 Hz, 2H), 7.31 (m, 5H), 7.23 – 6.95 (m, 7H), 6.69 – 6.53 (m, 3H), 6.25 (d, *J* = 7.7 Hz, 2H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 169.1, 154.8, 148.0, 140.3, 137.8, 136.8, 136.2, 133.8, 133.7, 133.0, 131.0, 129.1, 129.0, 128.6, 128.1, 128.0, 127.9, 127.0, 126.9, 126.4, 125.7, 124.0, 123.8, 57.3. NMR is in accordance with previously reports[11].

4.8. General procedure for atroposelective C–H arylation of biaryl compound

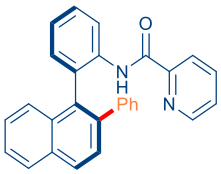


14a **15a** **16a**

To an oven-dried 10 mL Schlenk tube containing a stirring bar was added amide derivative (0.10 mmol), phenylboronic acid (0.15 mmol, 1.5 eq), **Co@POP-Salox-1** (5.0 mol % Co content), $KMnO_4$ (10 mol%), LiOAc (20 mol%) and MeOH/TFE (3/7, v/v, 1.2 mL). The reaction flask was degassed three times with O_2. The mixture was then stirred for 12 h at 80 °C followed by cooling. The resulting mixture was filtered through a celite pad and concentrated in vacuo. The residue was purified by preparative TLC using Hexane/EtOAc as the eluent to afford the desired product **16a**.[12]

Data of the compound

(*R*)-pyridin-2-yl(1,3,4-triphenylisoquinolin-2(1H)-yl)methanone 16a



The 94% *ee* was determined by Daicel Chiralcel AD-H, Hexanes/IPA = 70/30, 1.0 mL/min, λ = 254 nm, t (major) = 6.662 min, t (minor) = 9.032 min. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 9.74 (s, 1H), 8.45 (d, *J* = 8.3 Hz, 1H), 8.03 – 7.92

(m, 3H), 7.85 (d, J = 8.1 Hz, 1H), 7.57 (d, J = 8.7 Hz, 2H), 7.50 (d, J = 8.5 Hz, 1H), 7.38 (t, J = 7.5 Hz, 1H), 7.34 – 7.27 (m, 2H), 7.20 (d, J = 7.5 Hz, 1H), 7.12 – 6.99 (m, 7H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 161.6, 149.7, 147.6, 141.0, 139.7, 137.3, 136.2, 133.1, 132.7, 132.3, 132.2, 129.6, 129.0, 128.7, 128.5, 128.3, 128.0, 127.6, 126.8, 126.4, 126.1, 126.0, 123.6, 121.9, 120.2. NMR is in accordance with previously reports[12].

5. General procedure for recycle and continuous flow

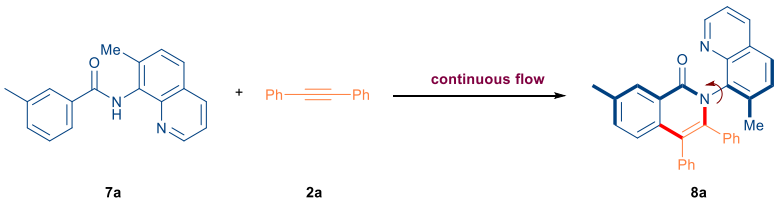
5.1. General procedure for recycle

Phosphinic amide **1a** (0.1 mmol), alkyne **2a** (0.15 mmol), **Co@POP-Salox-1** (5.0 mol % Co content), $Mn(OAc)_2{\cdot}4H_2O$ (0.1 mmol), NaOPiv (0.2 mmol) and ^{t}BuOH (3 mL) were added to an oven dried vial equipped with stirring bars. Then, the vial was instantly placed in a heating block set at 70 ℃ under air for 48 h. After reaction, the catalyst was separated through centrifugation, and the catalyst was washed with EtOH, dried and reused in a next run.

Table S5. Recycle of catalyst Co@POP-Salox-1

run times	1	2	3	4	5	6
yield(%)	95	93	90	88	85	79
e.e.	99	98	95	95	95	94

5.2. Optimization of continuous flow conditions



7a 2a 8a

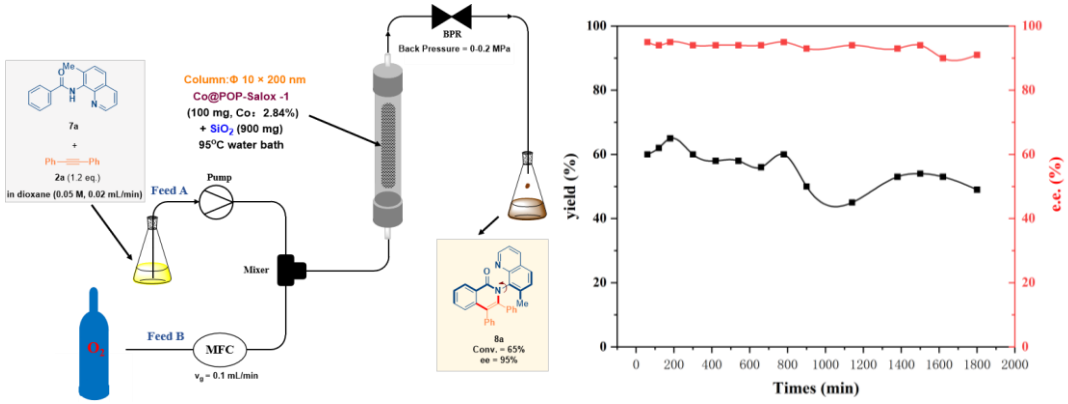
Table S6. Optimization of continuous flow conditions[a]

Entry	V_{column} (mL)	V_g (mL/min)	V_l (mL/min)	R_t (min)	Temp. (℃)	Yield	*Ee*
1	1.67	0.4	0.02	3.98	80	< 5%	--
2	1.67	0.1	0.02	13	80	33%	91%
3	3.32	0.1	0.02	26	80	55%	94%
4	***3.32***	***0.1***	***0.02***	***26***	***95***	***65%***	***95%***

[a] The *ee* value is determined by HPLC analysis.

5.3. General procedure for continuous flow

Feed A consisted of **7a** (0.05 M) and **2a** (1.2 eq.) dissolved in dioxane, whereas feed B was oxygen. The liquid stream (0.02 mL/min) and the gaseous stream (0.1 mL/ min) were mixed together in a mixer. The resulting segmented flow stream was passed through a column (Φ 10 × 200 nm, reactor volume = 3.32 mL, residence time = 26 min) filled with Co-POP-Salox (100 mg) and SiO_2 (900 mg) at 95 °C. After passing a back pressure regulator the solution was collected.



Scheme S1. Heterogeneous Catalytic System under Continuous Flow

6. Characterization

6.1. Sheldon test and measure of content of Co in system

Phosphinic amide **1a** (0.3 mmol), alkyne **2a** (0.45 mmol), **Co@POP-Salox-1** (31mg, 5.0 mol % Co content), $Mn(OAc)_2{\cdot}4H_2O$ (0.3 mmol), NaOPiv (0.6 mmol) and ^{t}BuOH (5 mL) were added to an oven dried vial equipped with stirring bars. Then, the vial was instantly placed in a heating block set at 70 °C under air for 12 h. 1.0 mL reaction solution was withdrawn with a syringe. After removing the solvent, ^{1}H NMR and HPLC was determined. At the same time, the catalyst was separated through centrifugation, and $Mn(OAc)_2{\cdot}4H_2O$ (0.3 mmol), NaOPiv (0.6 mmol), L1 (5.0 mmol%) were added to the supernatant. The mixtures were further stirred for an additional 6 h at 70 °C without **Co@POP-Salox-1**. After removing the solvent, ^{1}H NMR and HPLC was determined. The two quenched mixtures were mixed together and dry with vacuum pump, 124 mg of dark brown solid obtained, which was taken for ICP-MS detection of cobalt.

Condition	Catalyzed by **Co@POP-Salox-1** for 12 h	Removed **Co@POP-Salox-1** for next 6 h
Yield (%)	35	36
e.e. (%)	98	98
W (Co in the system)	6.36 ppm	

Leaching amounts $= \frac{\text{M (Co in system)}}{\text{M(Co in POPs)}} = \frac{\text{W (Co in system)}\times \text{M (system)}}{\text{W (Co in POPs)} \times \text{M (POPs)}} = \frac{6.36\times10^{-6}\times124}{2.84\times10^{-2}\times31} \approx 0.09\%$

6.2. Characterization of the catalyst

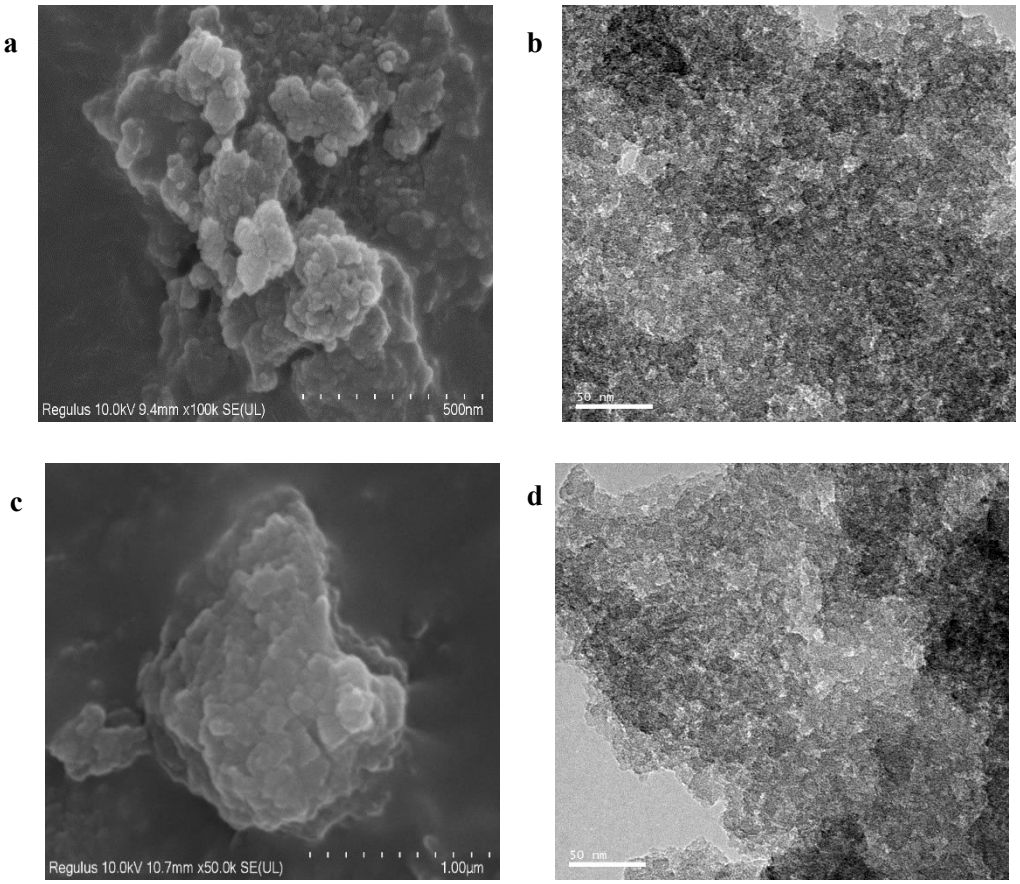


Figure S1. (a) SEM images of **Co@POP-Salox-9**. (b)TEM images of **Co@POP-Salox-9**. (c) SEM images of the reused catalyst. (d)TEM images of the reused catalyst.

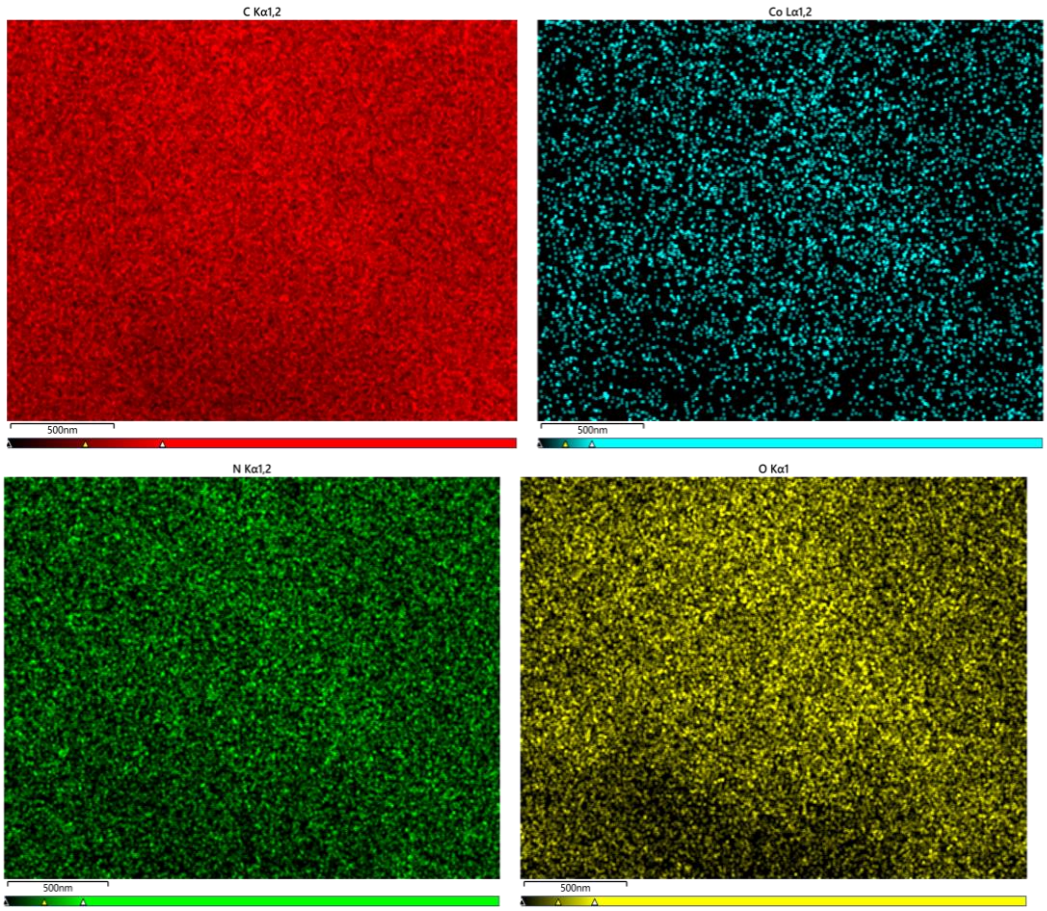


Figure S2. Energy-dispersive X-ray spectroscopy (EDS) of reused catalyst

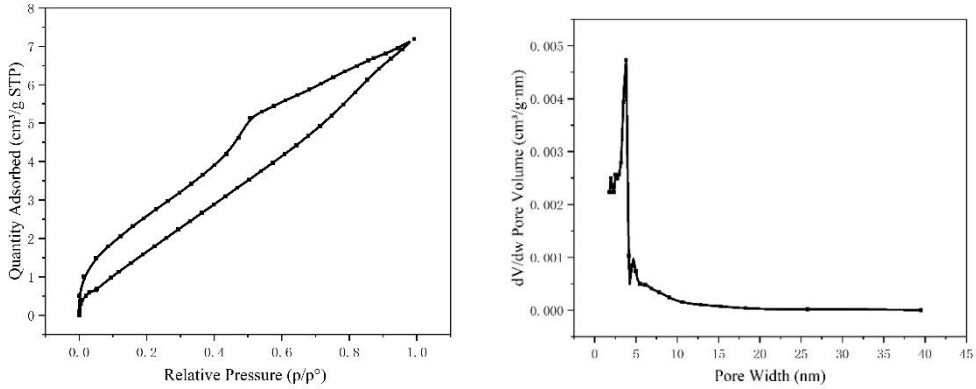


Figure S3. N_2 sorption isotherms and pore size distribution of the reused catalyst

6.3. XPS spectra of Co@POP-Salox-1

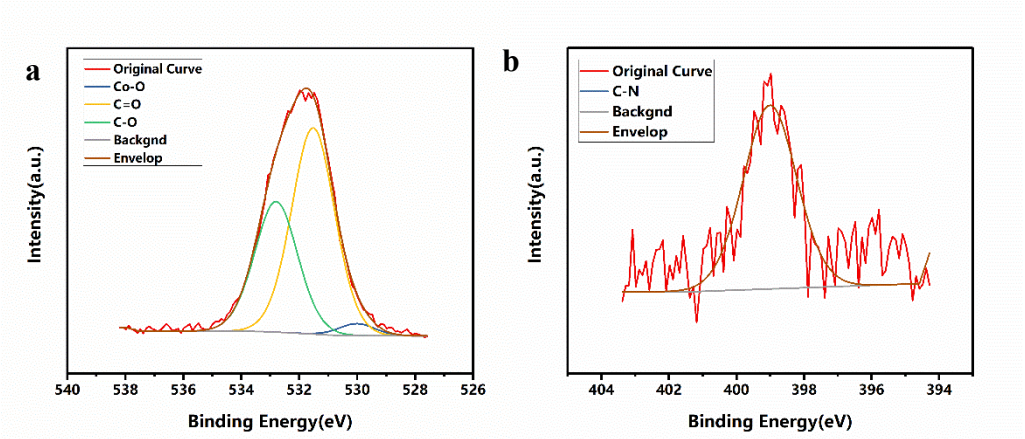


Figure S4. X-ray photoelectron spectroscopy (XPS) of **Co@POP-Salox-1**. (a) O 1s. (b) N 1s.

7. Reference

(1) Q.-J. Yao, J.-H. Chen, H. Song, F.-R. Huang and B.-F. Shi, Cobalt/Salox-Catalyzed Enantioselective C−H Functionalization of Arylphosphinamides. *Angew. Chem., Int. Ed.,* 2022, **134**, e202202892.

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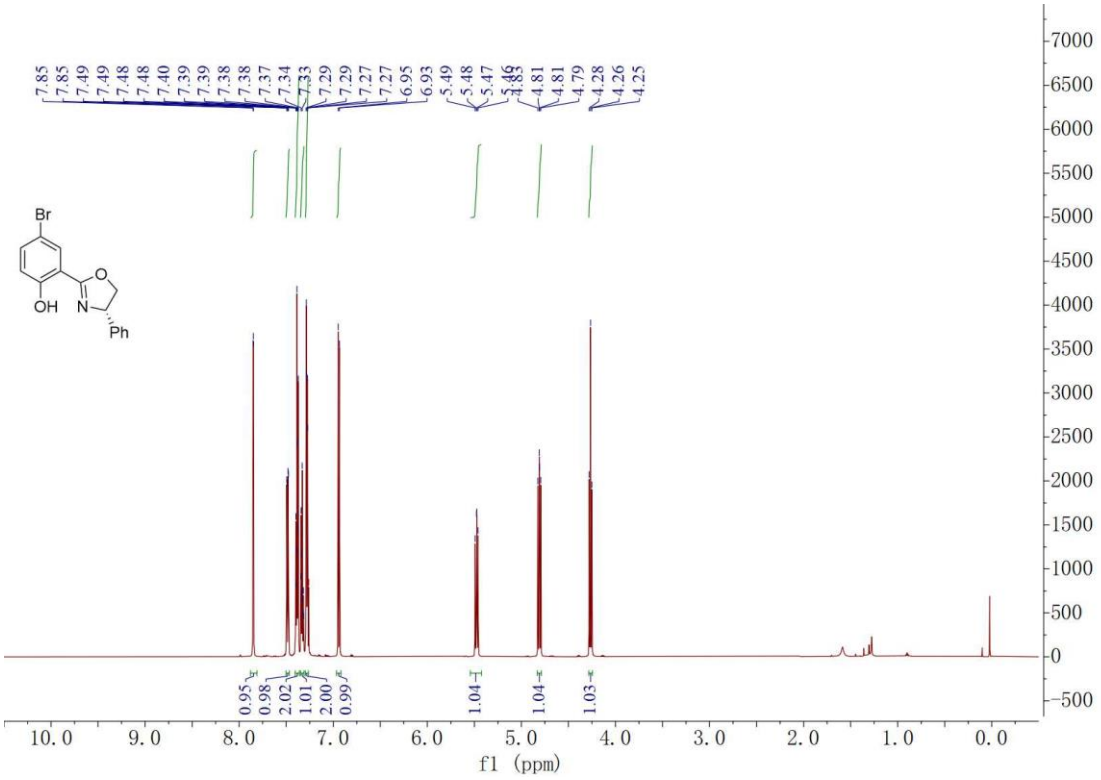
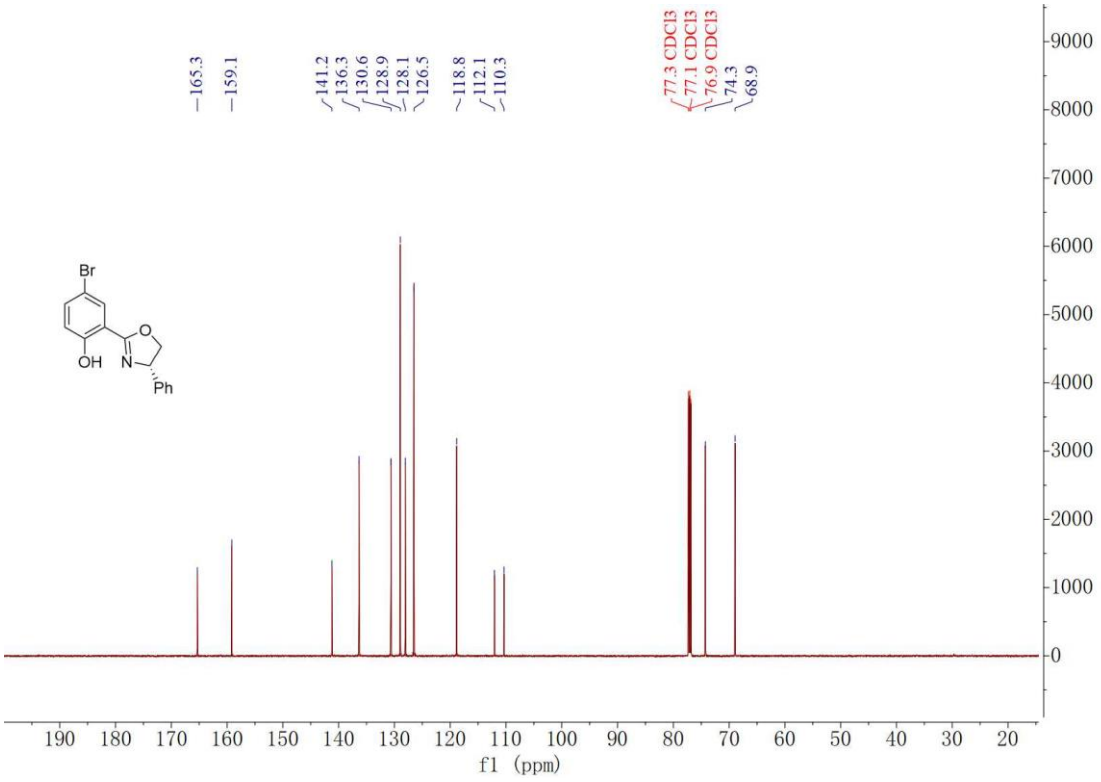
(12) Y.-J. Wu, Z.-K. Wang, Z.-S. Jia, J.-H. Chen, F.-R. Huang, B.-B. Zhan, Q.-J. Yao and B.-F. Shi, *Angew. Chem., Int. Ed.*, 2023, **62**, e202310004.

8. NMR spectra

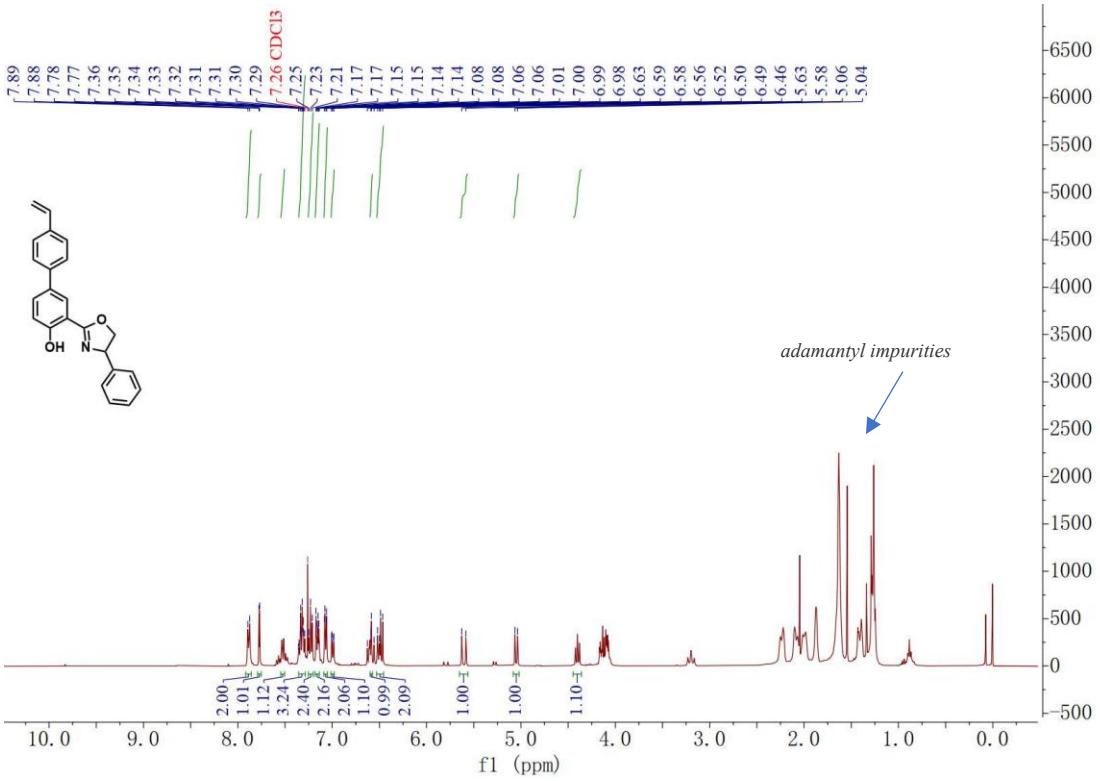
^{1}H NMR of L1



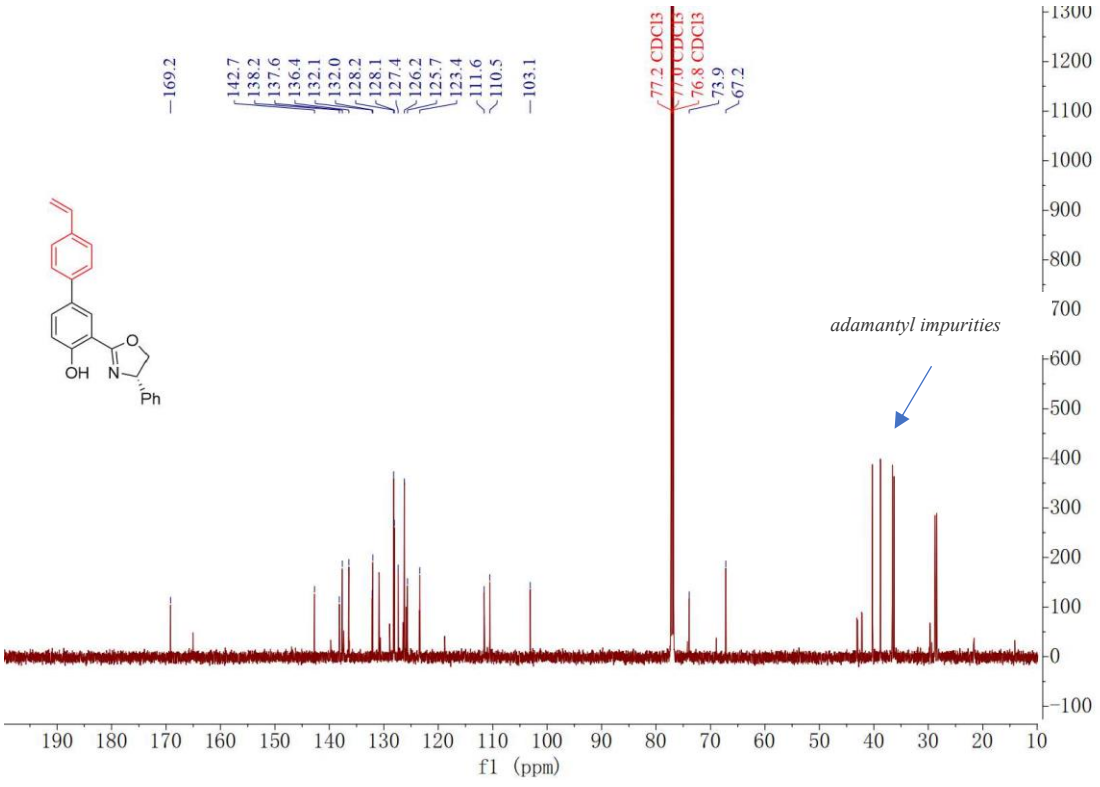
^{13}C NMR of L1



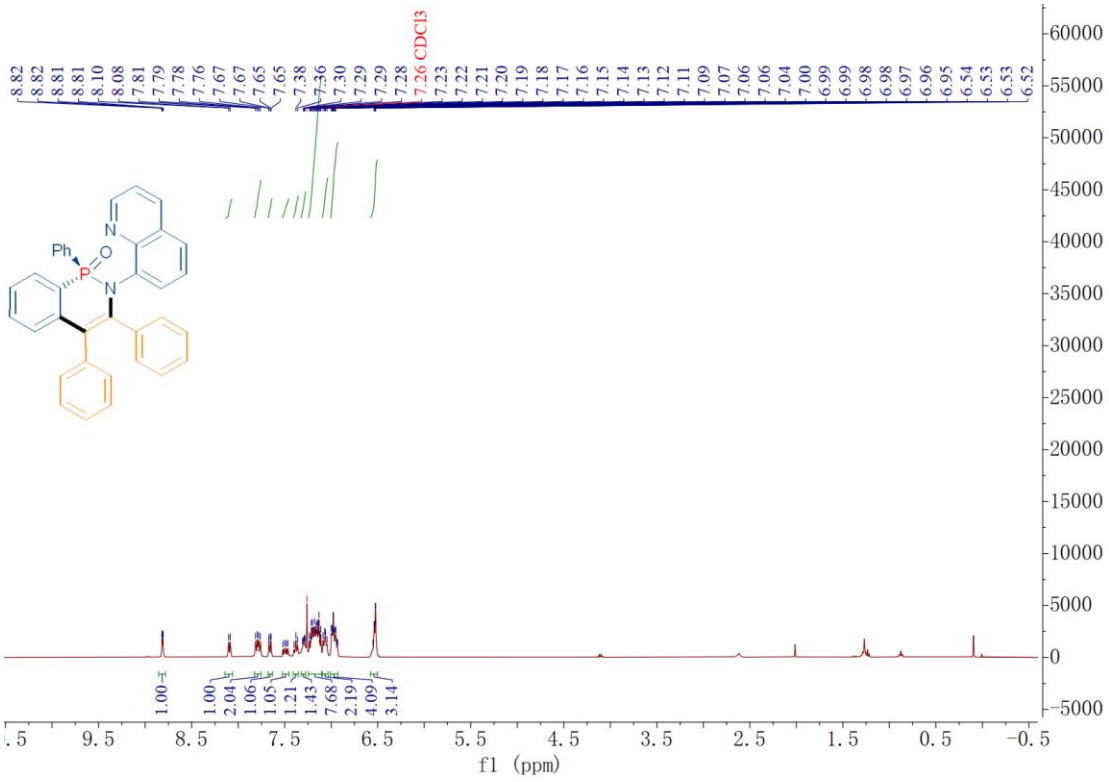
^{1}H NMR of monomer 1



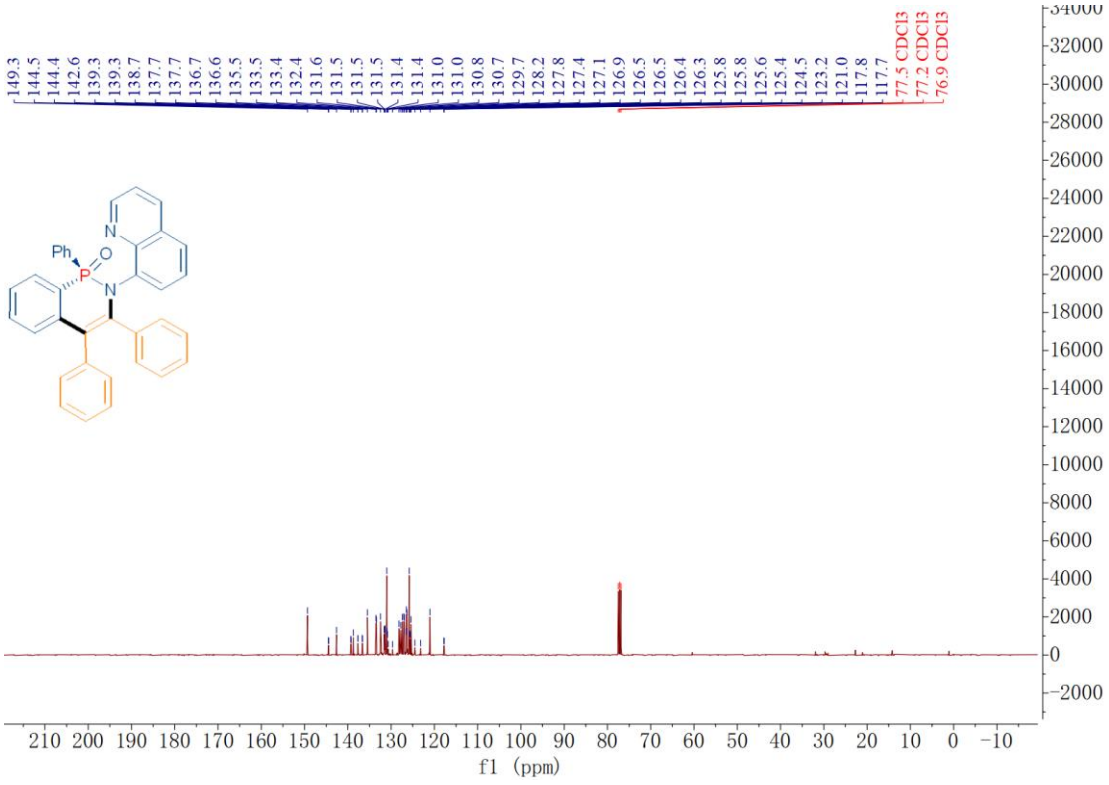
^{13}C NMR of monomer 1



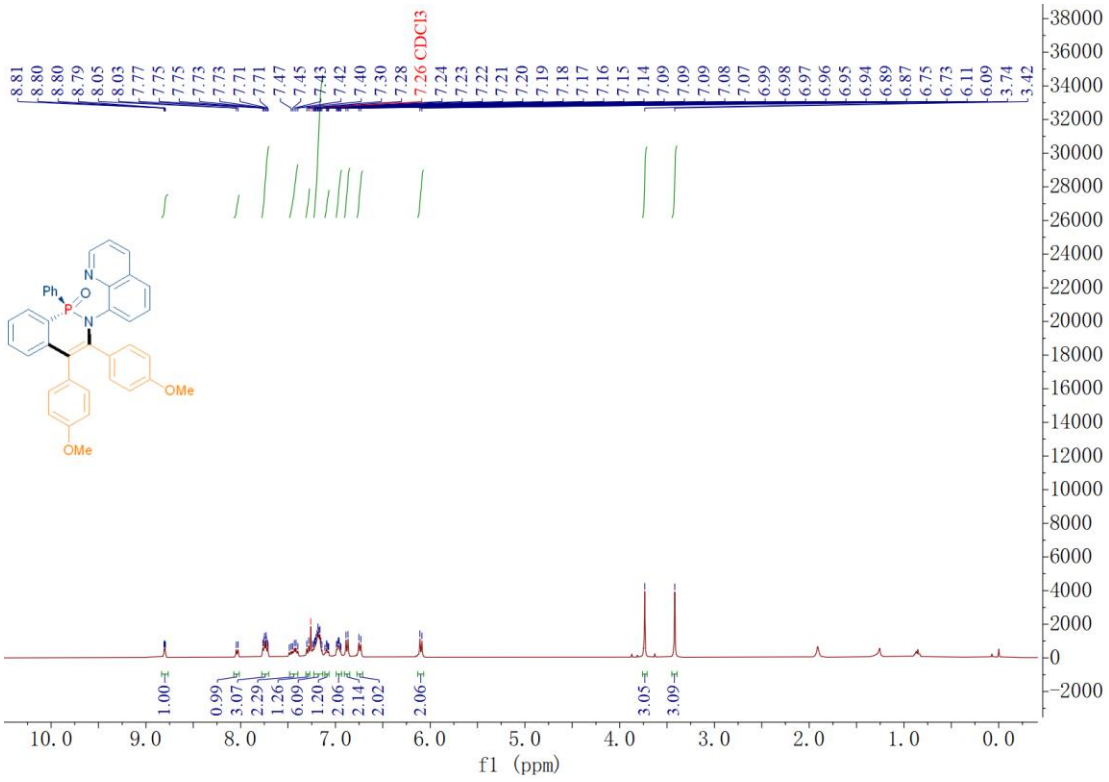
^{1}H NMR of 3a



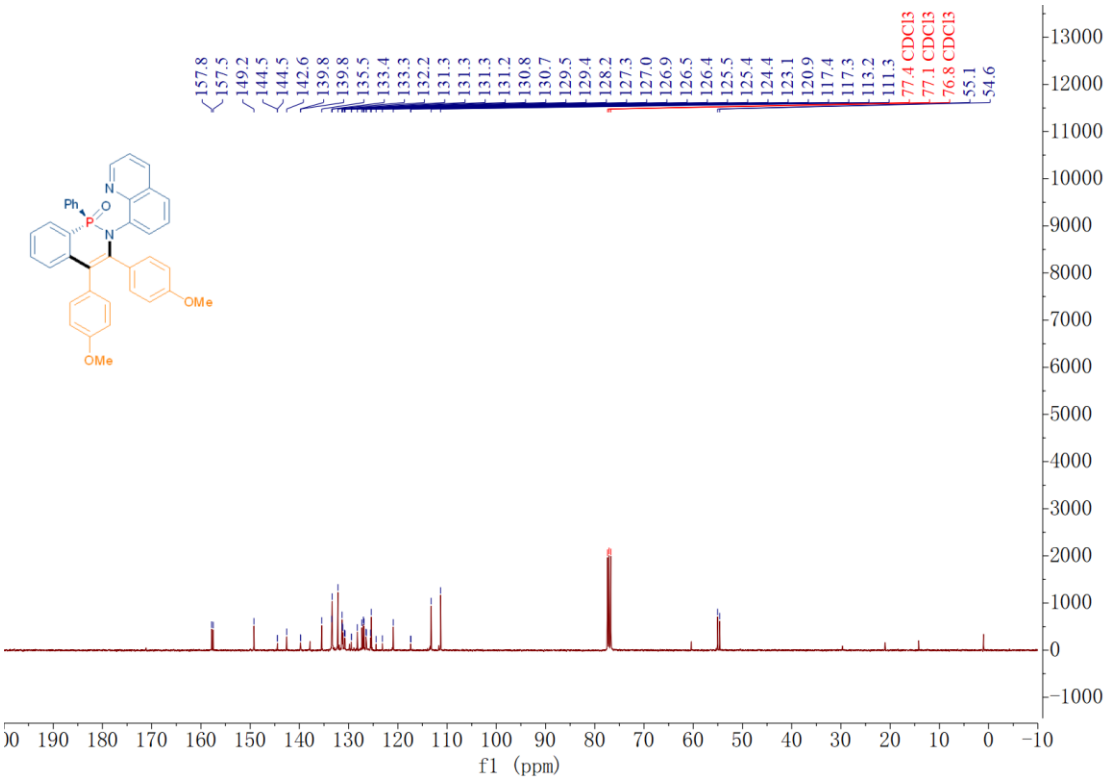
^{13}C NMR of 3a



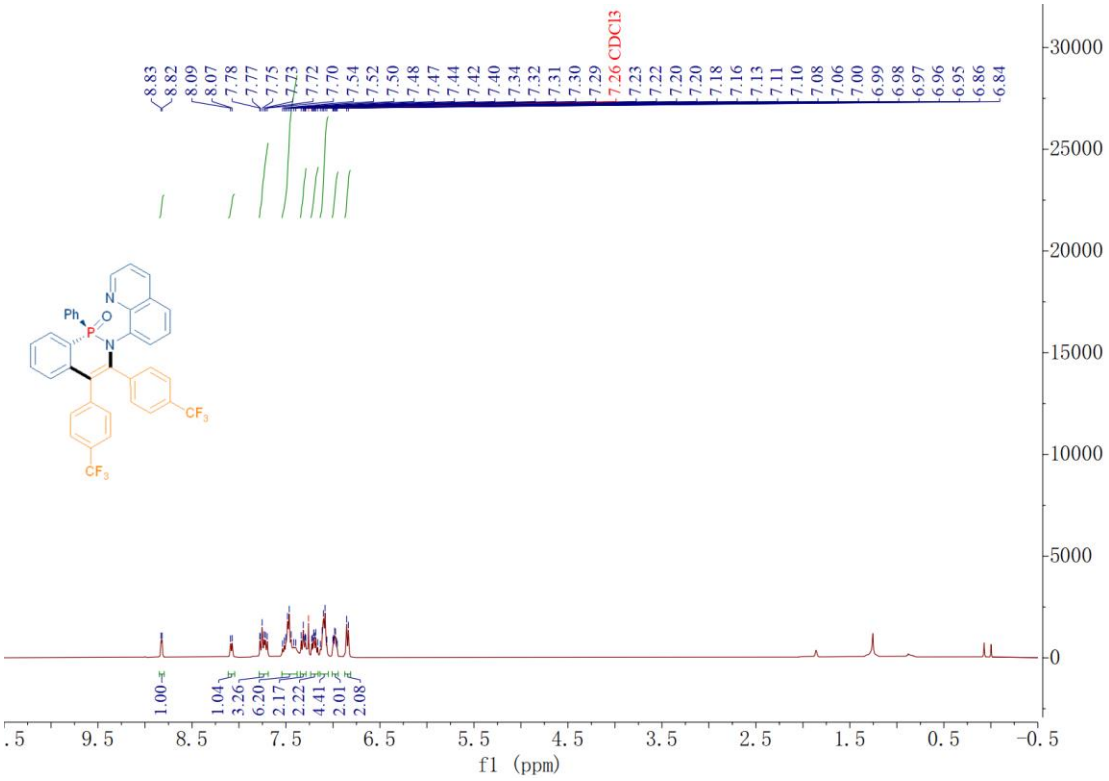
^{1}H NMR of 3b



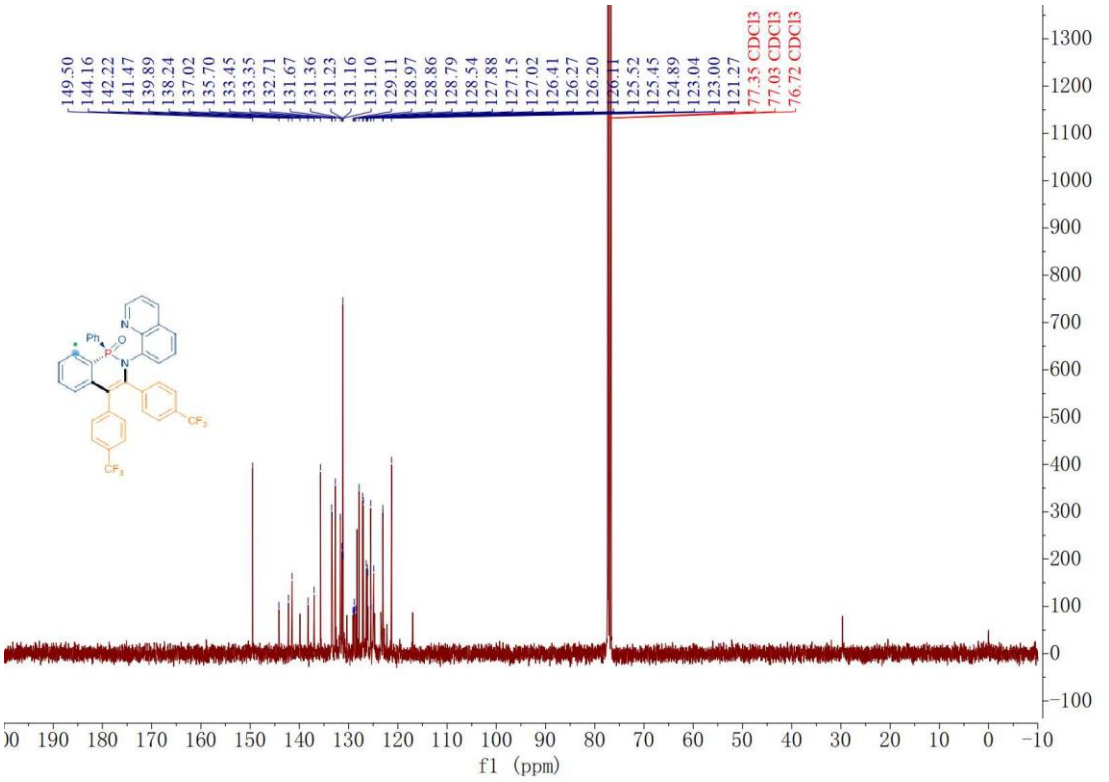
^{13}C NMR of 3b



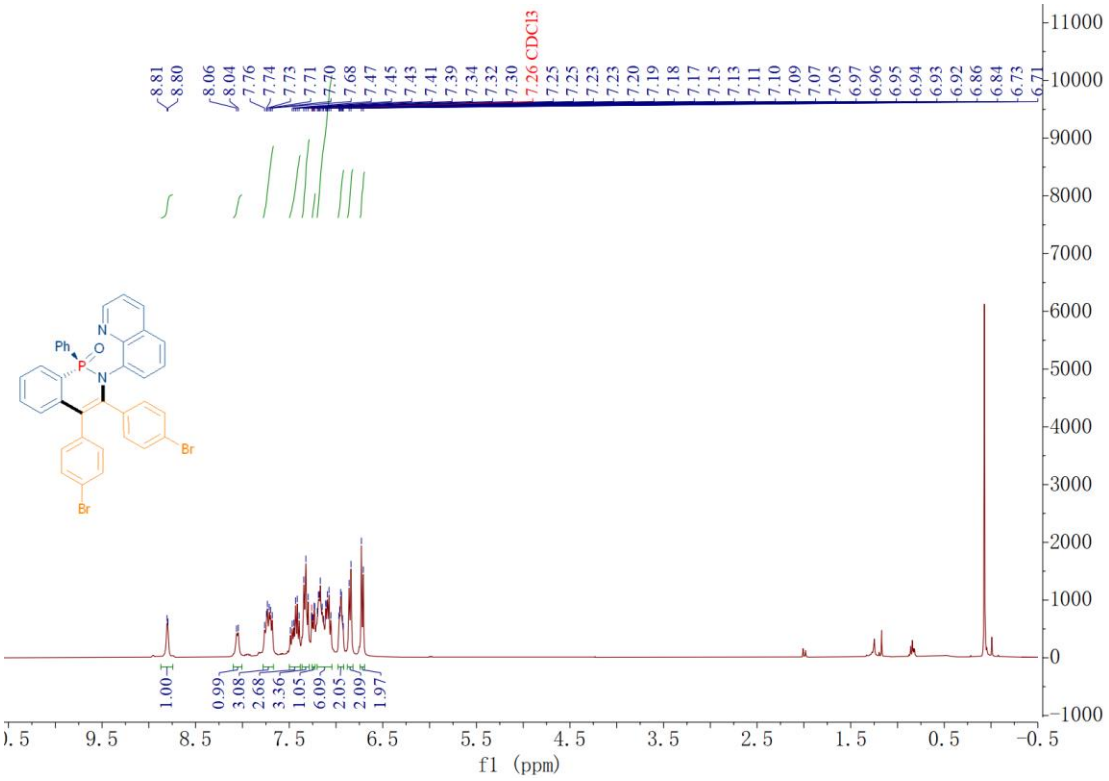
^{1}H NMR of 3c



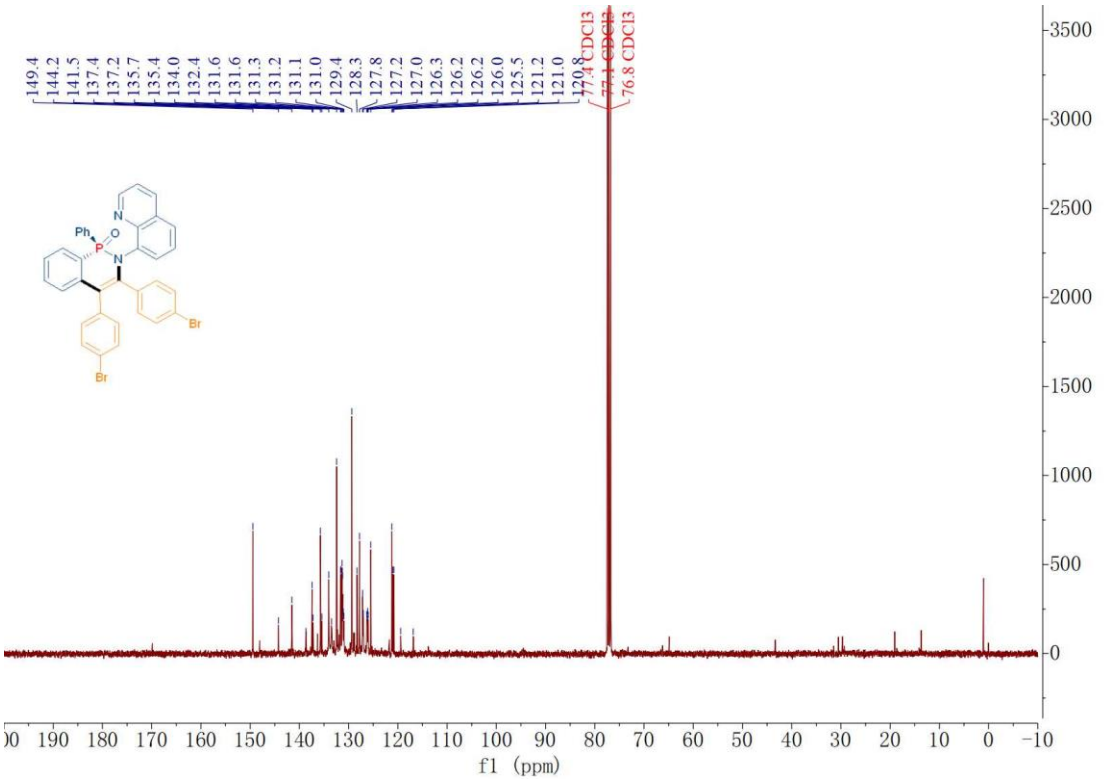
^{13}C NMR of 3c



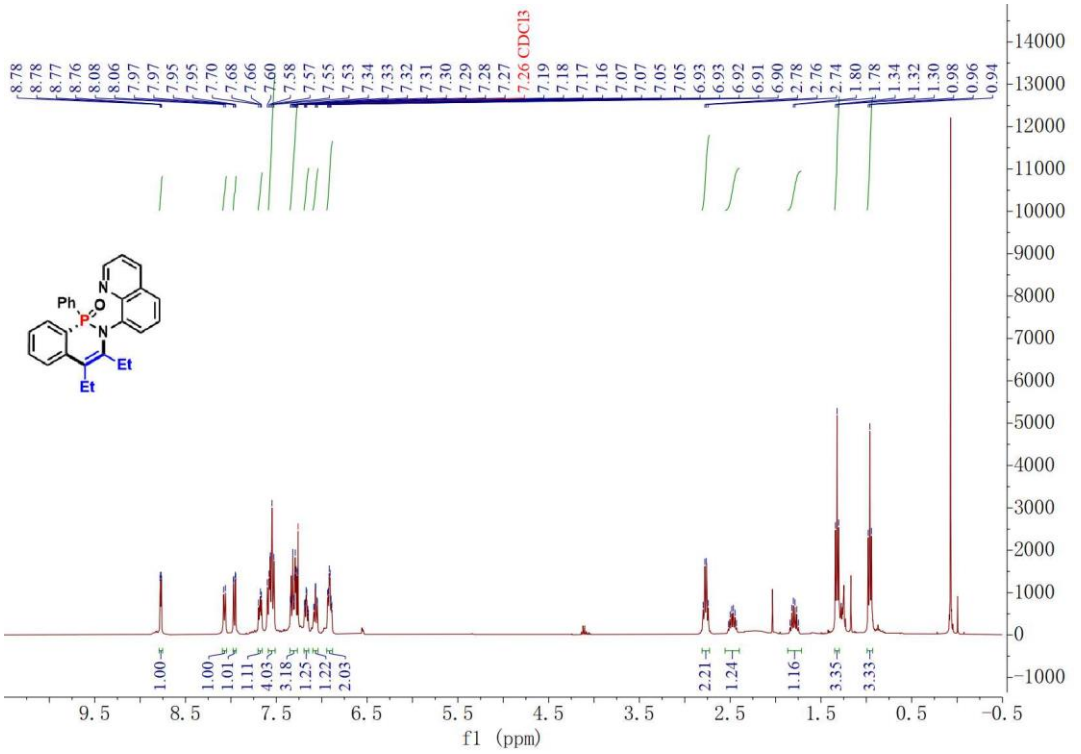
^{1}H NMR of 3d



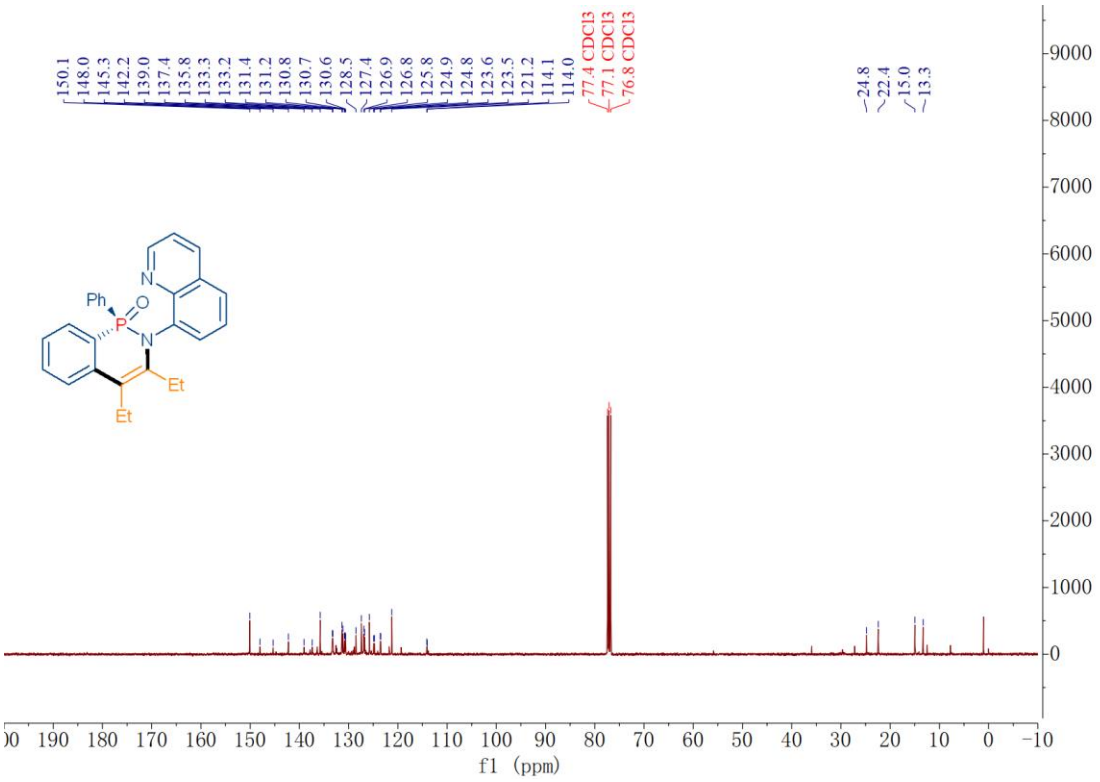
^{13}C NMR of 3d



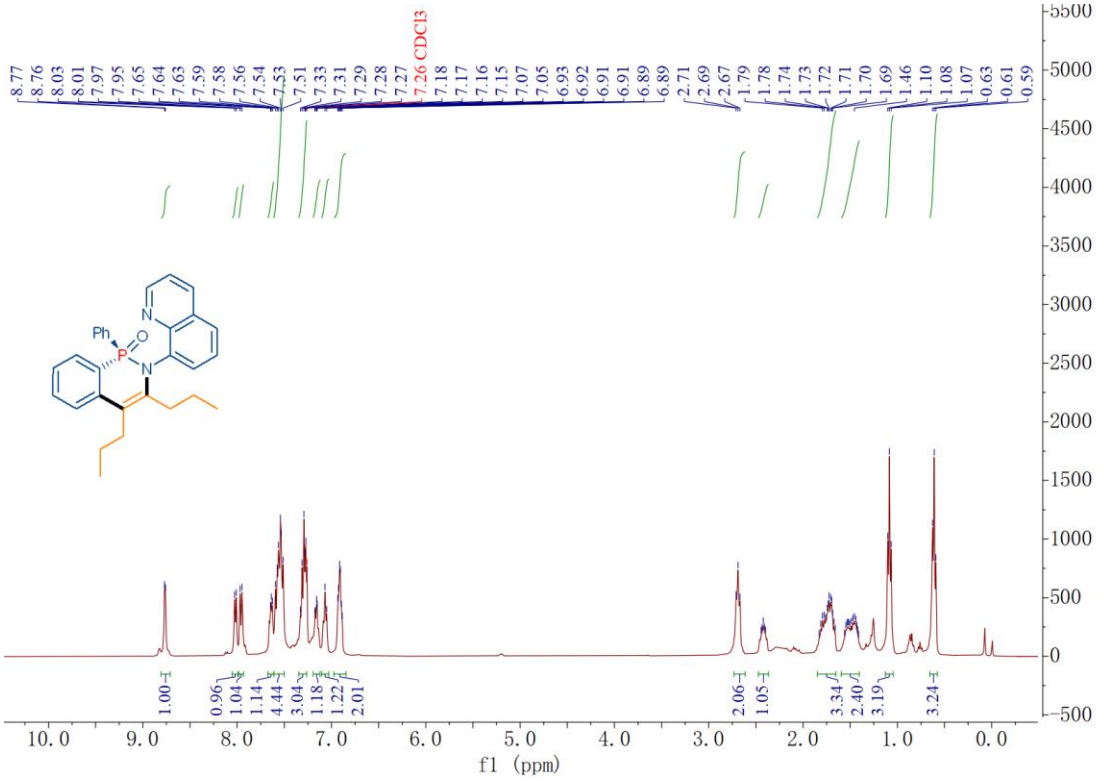
^{1}H NMR of 3e



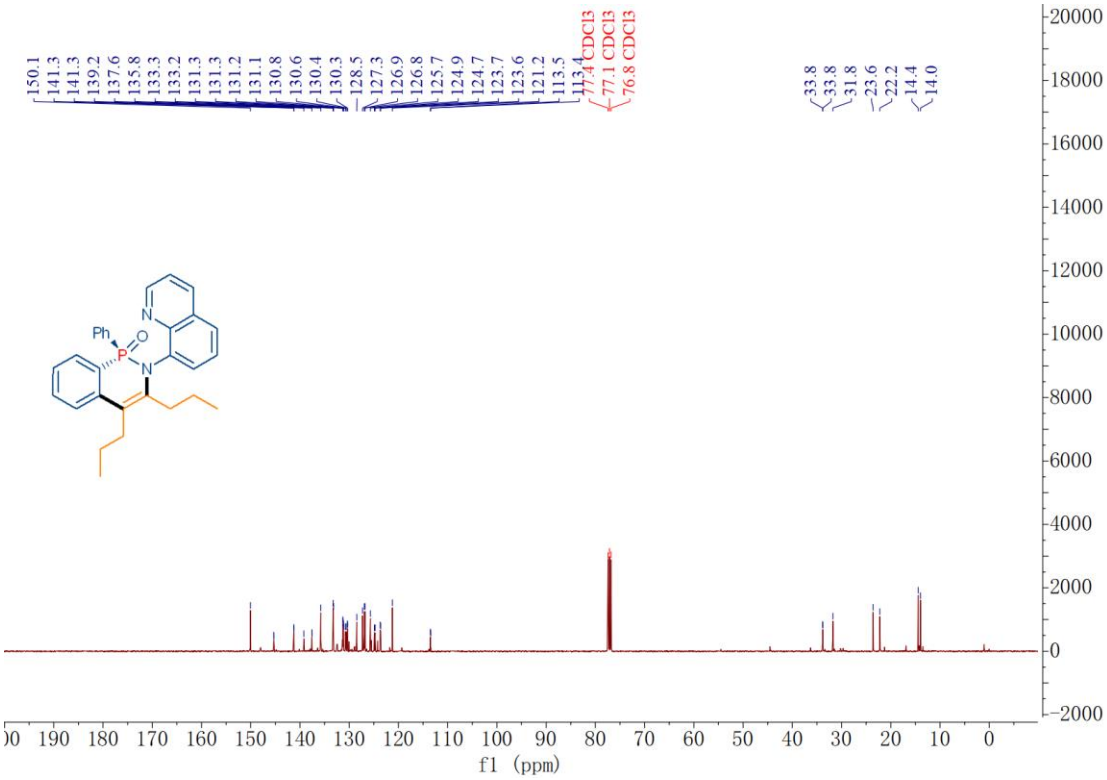
^{13}C NMR of 3e



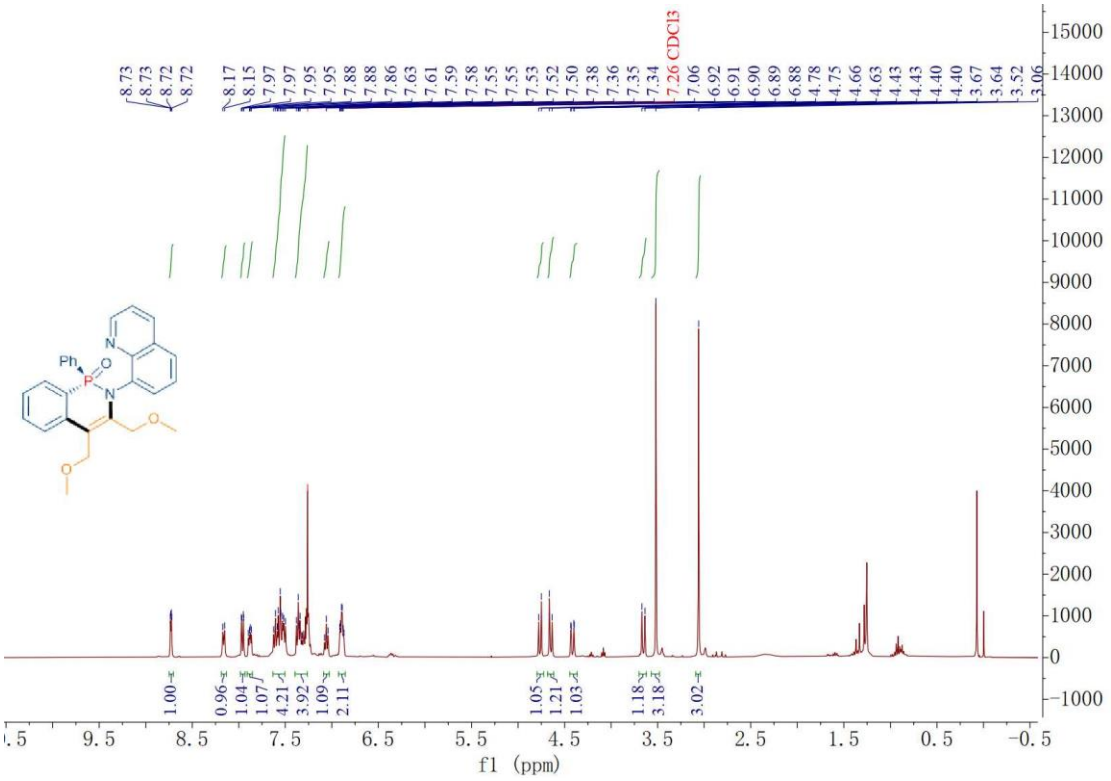
^{1}H NMR of 3f



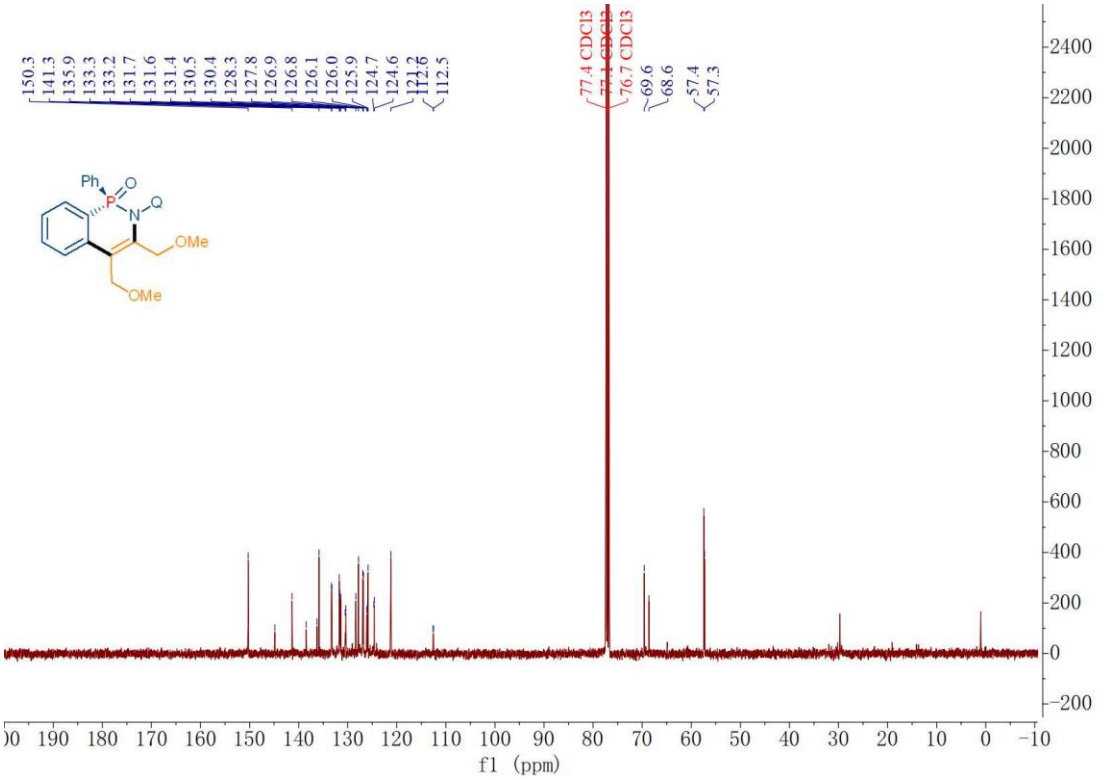
^{13}C NMR of 3f



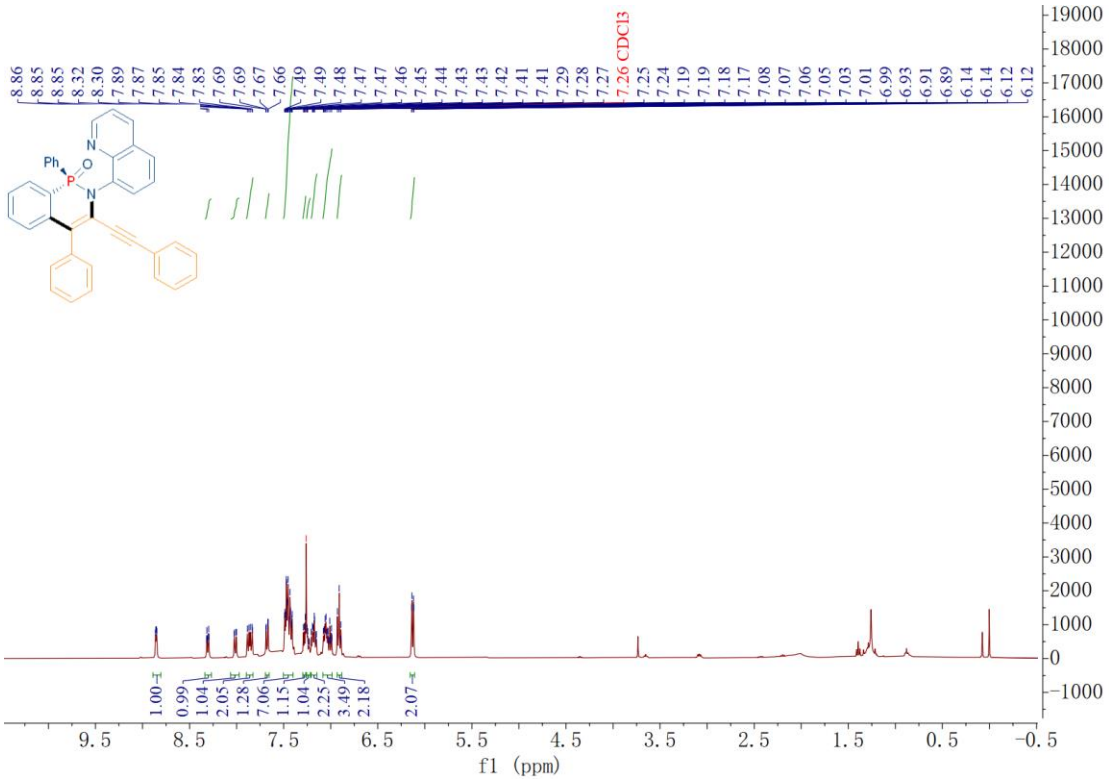
^{1}H NMR of 3g



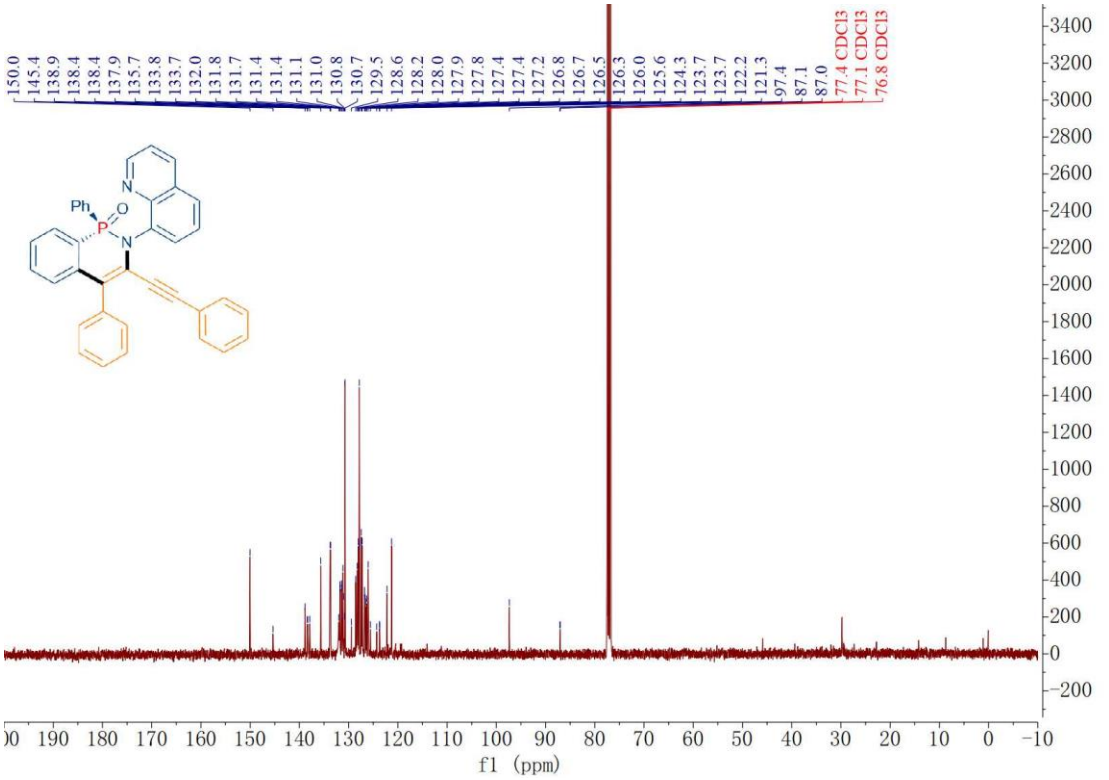
^{13}C NMR of 3g



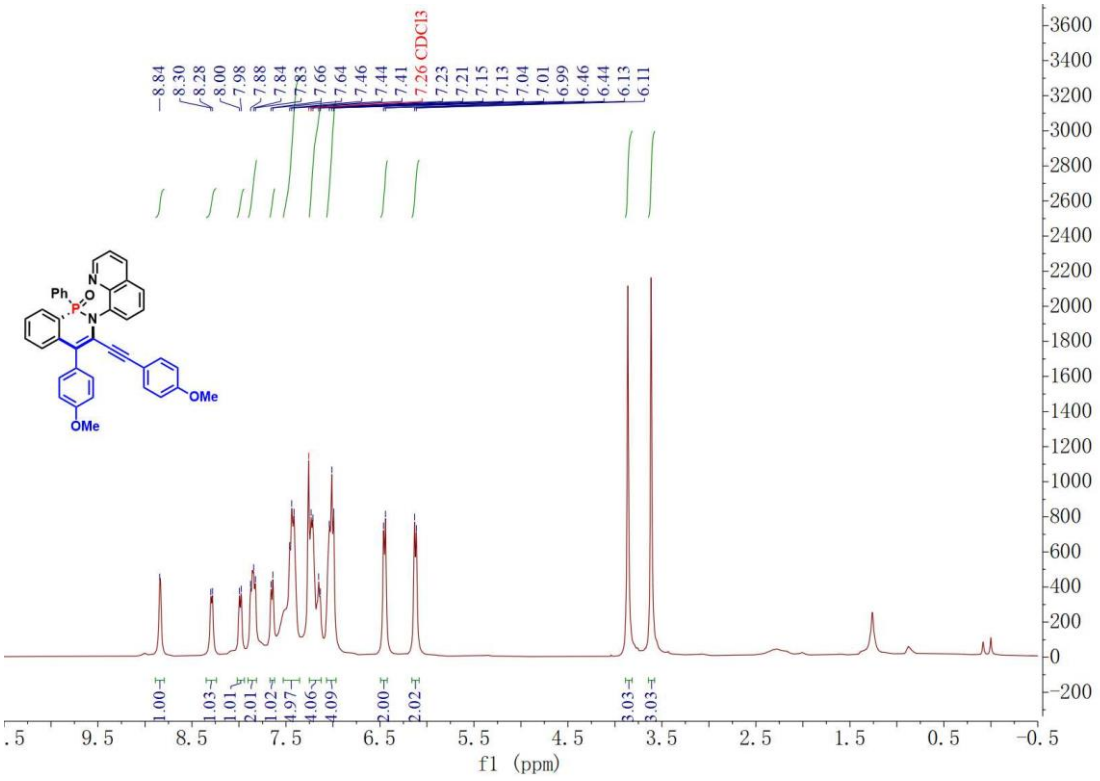
^{1}H NMR of 3h



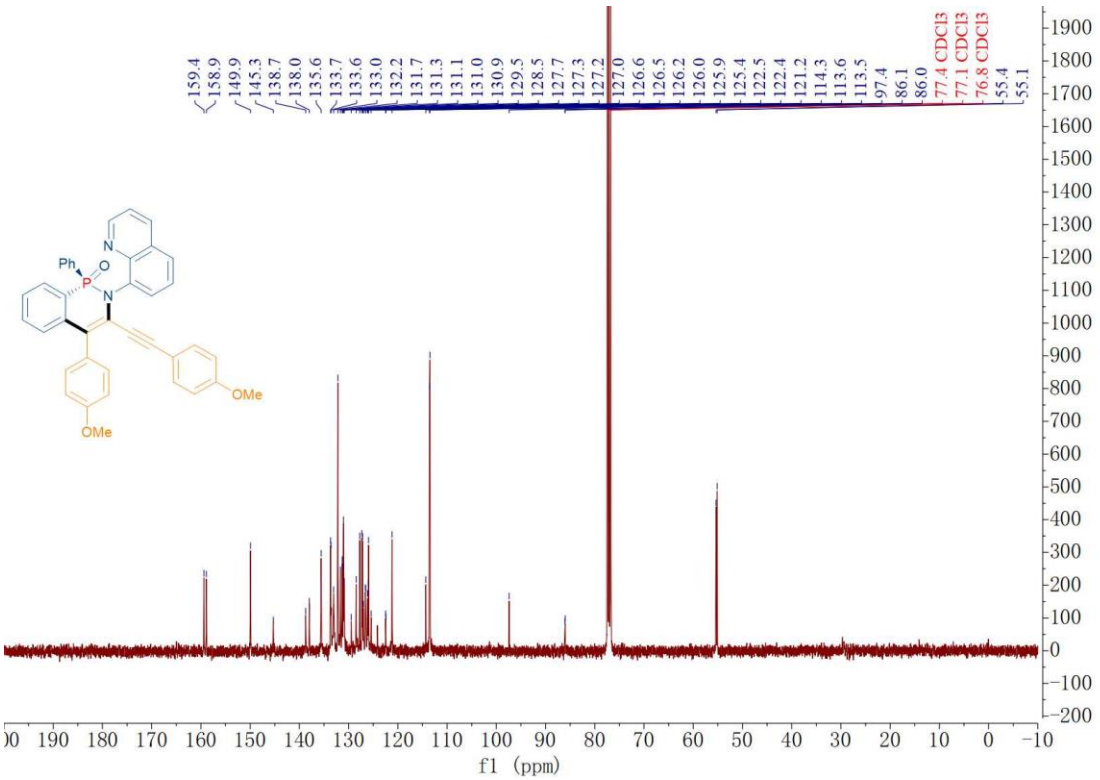
^{13}C NMR of 3h



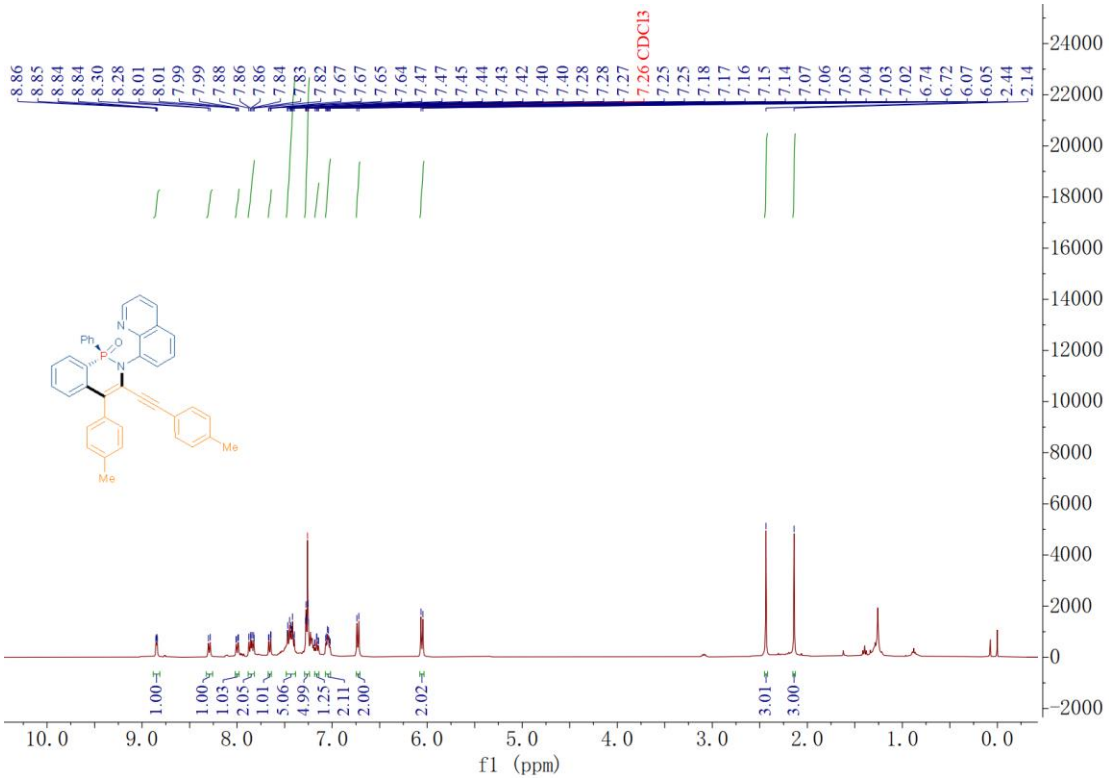
^{1}H NMR of 3i



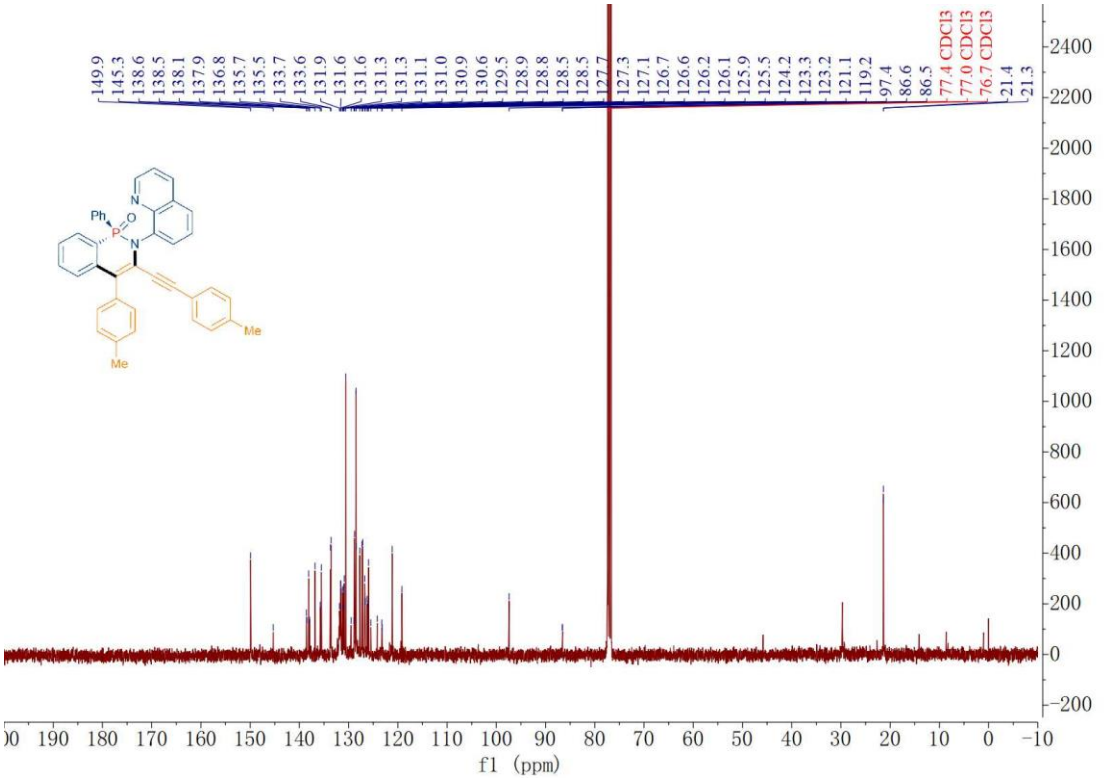
^{13}C NMR of 3i



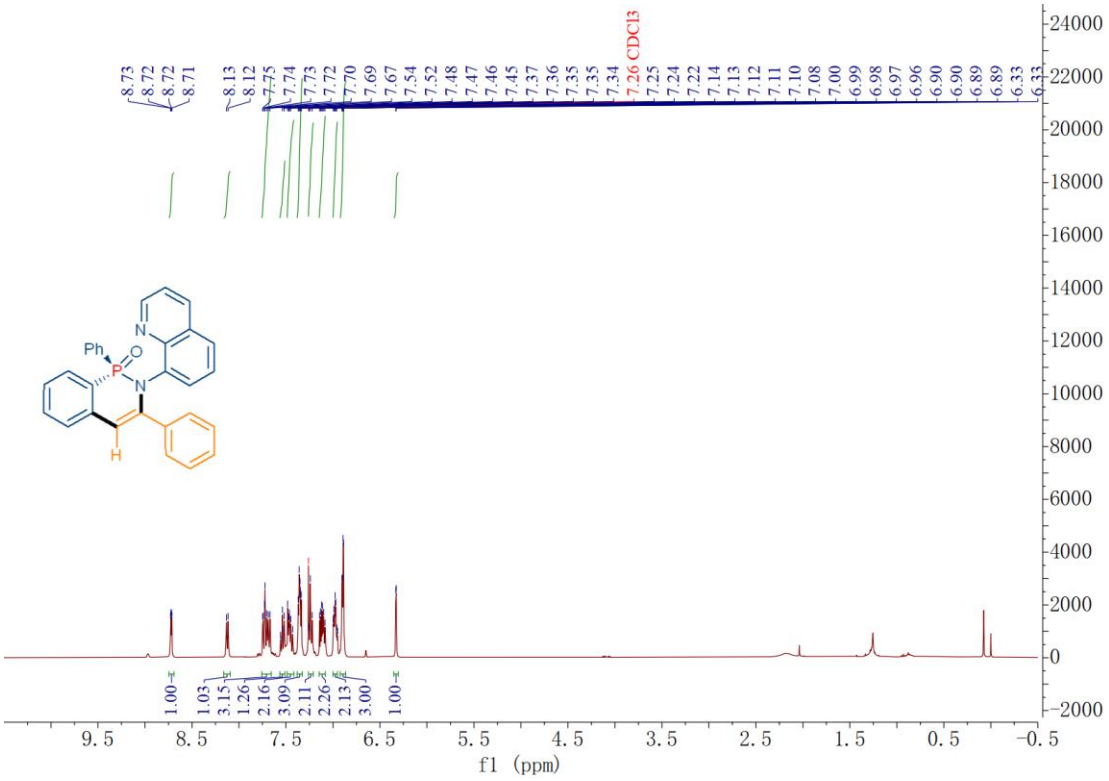
^{1}H NMR of 3j



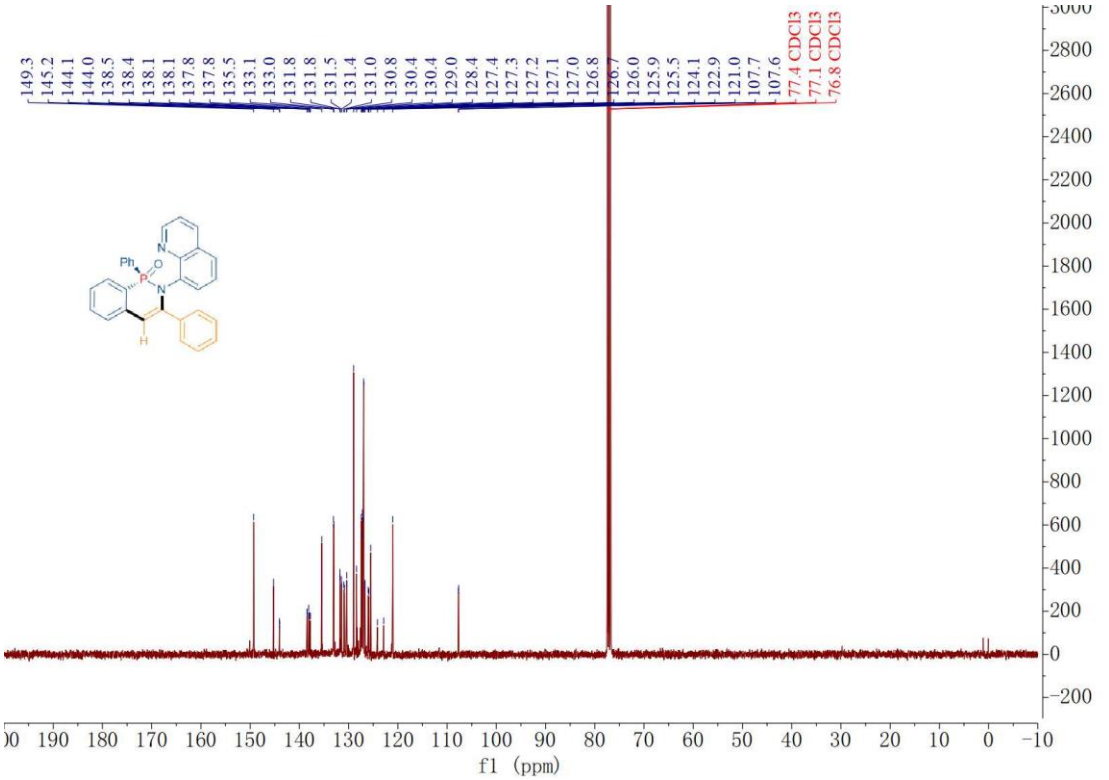
^{13}C NMR of 3j



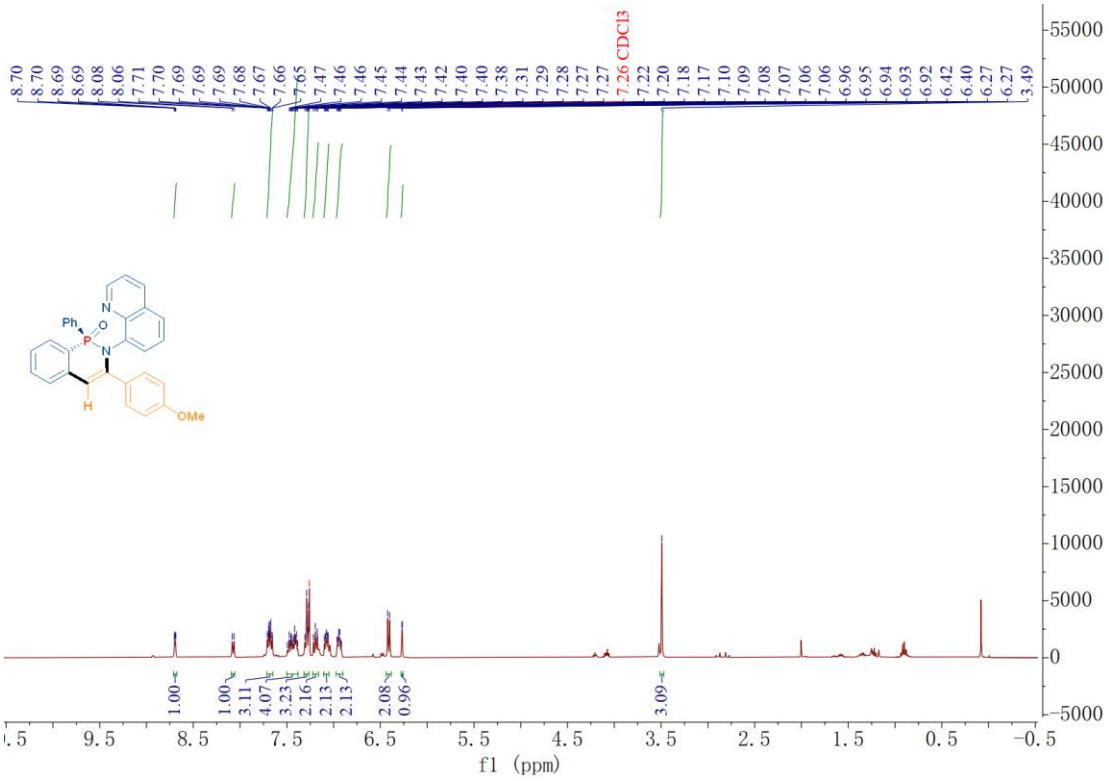
^{1}H NMR of 3k



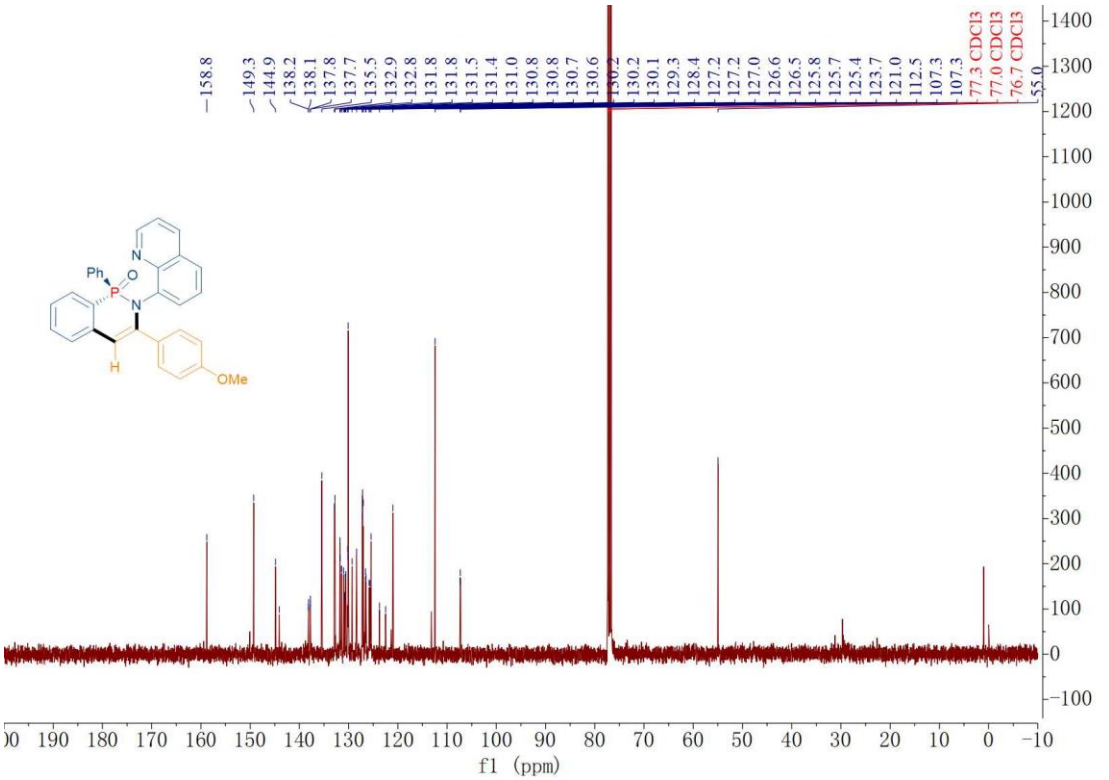
^{13}C NMR of 3k



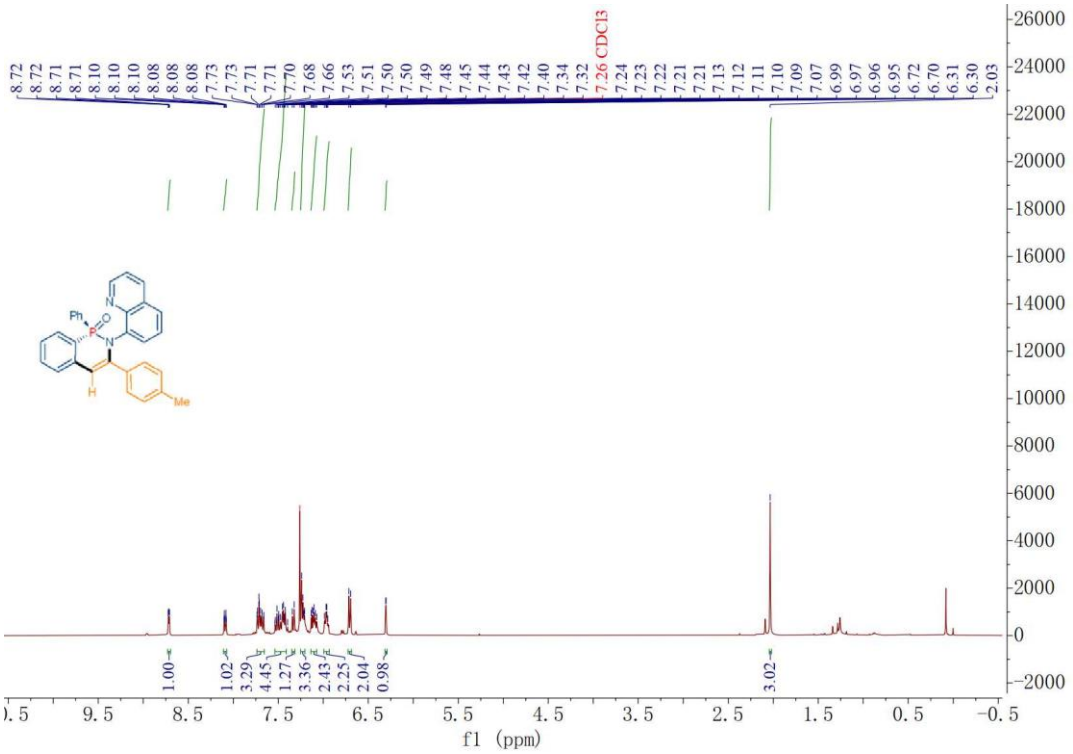
^{1}H NMR of 3l



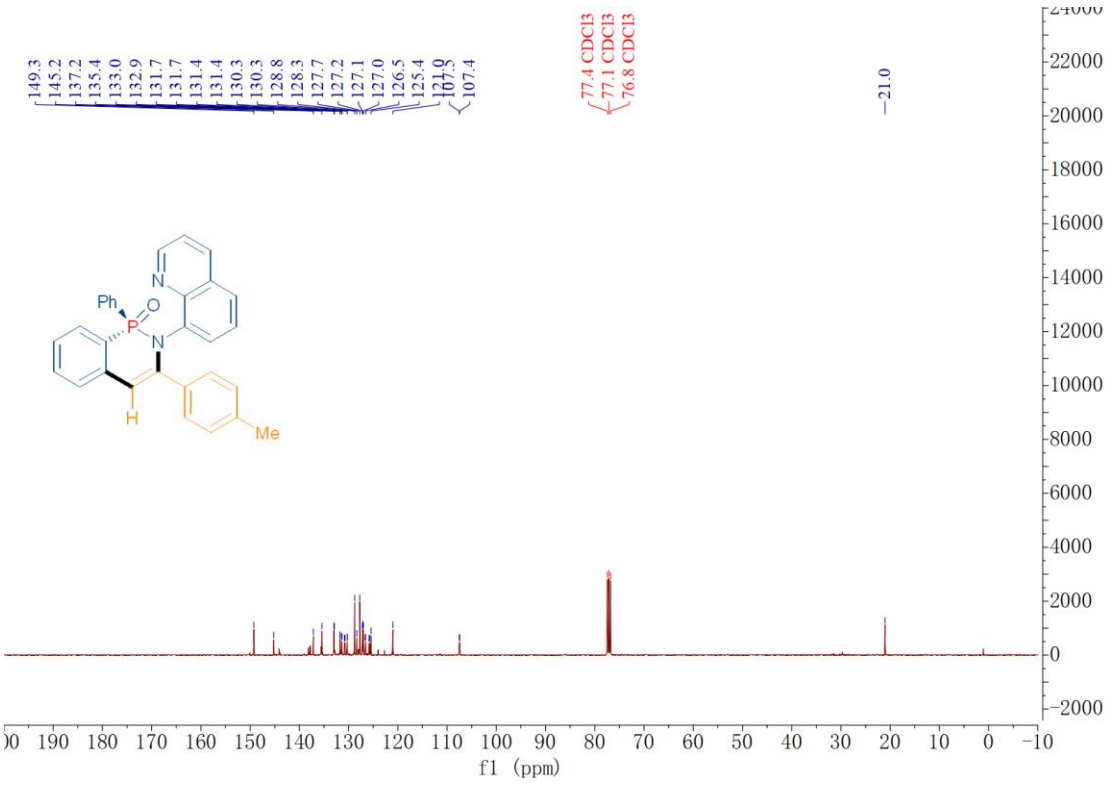
^{13}C NMR of 3l



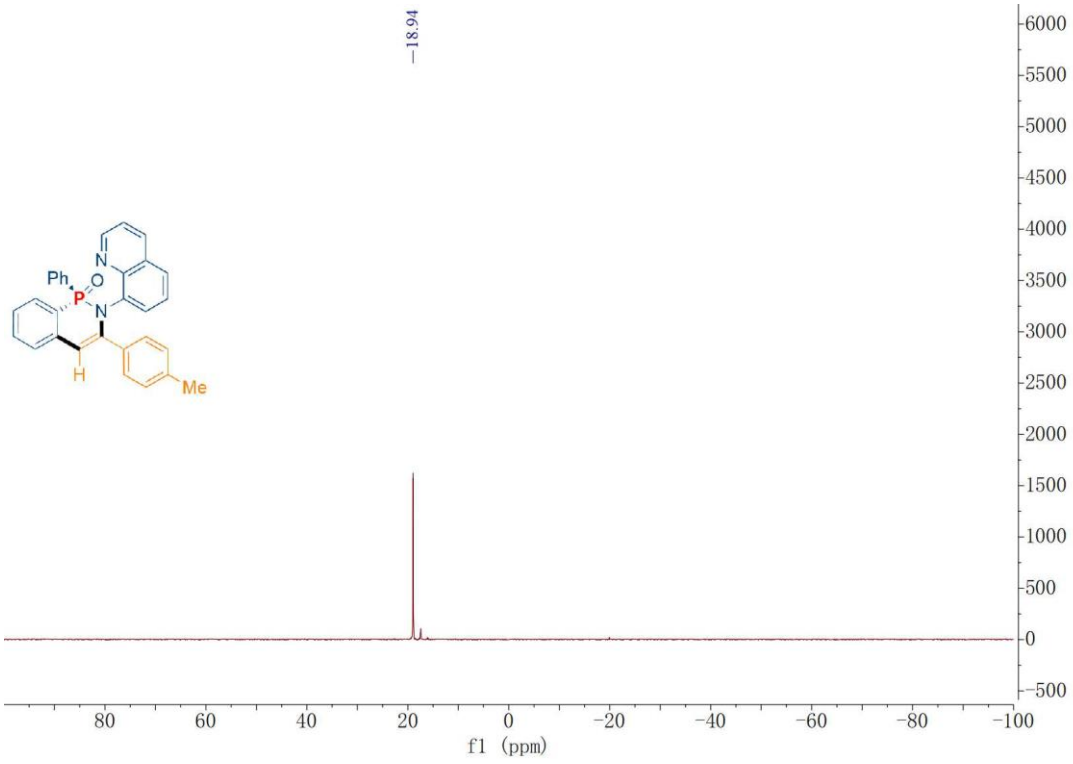
^{1}H NMR of 3m



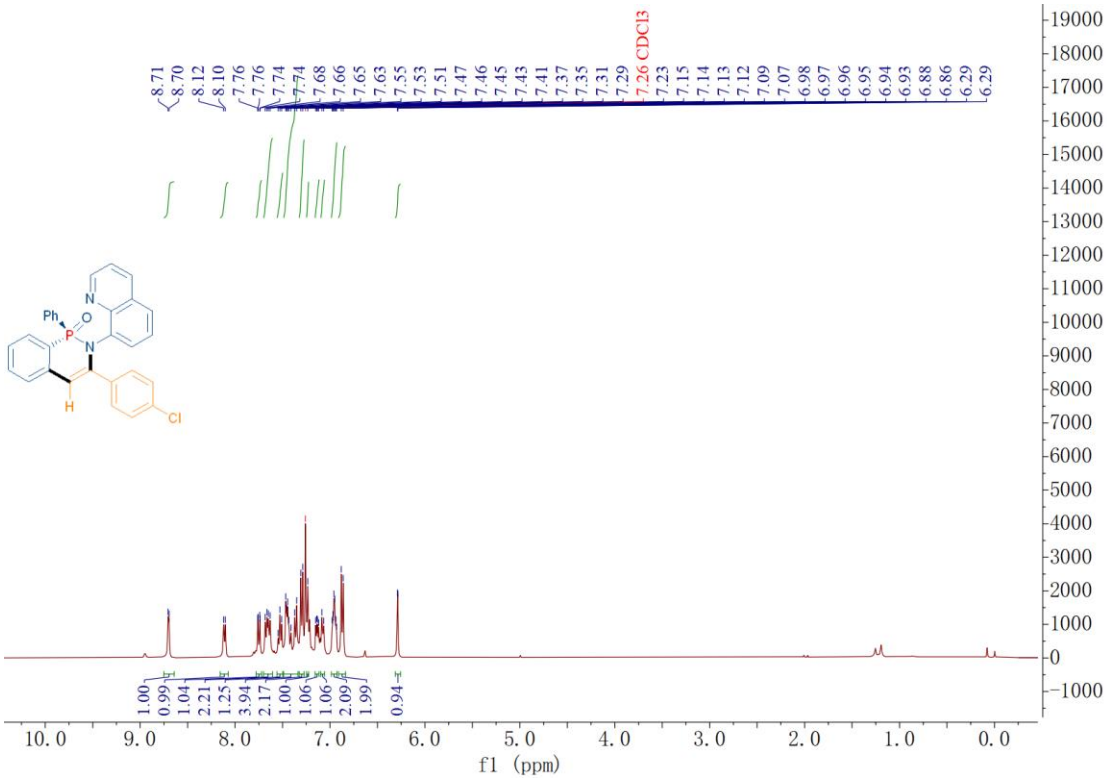
^{13}C NMR of 3m



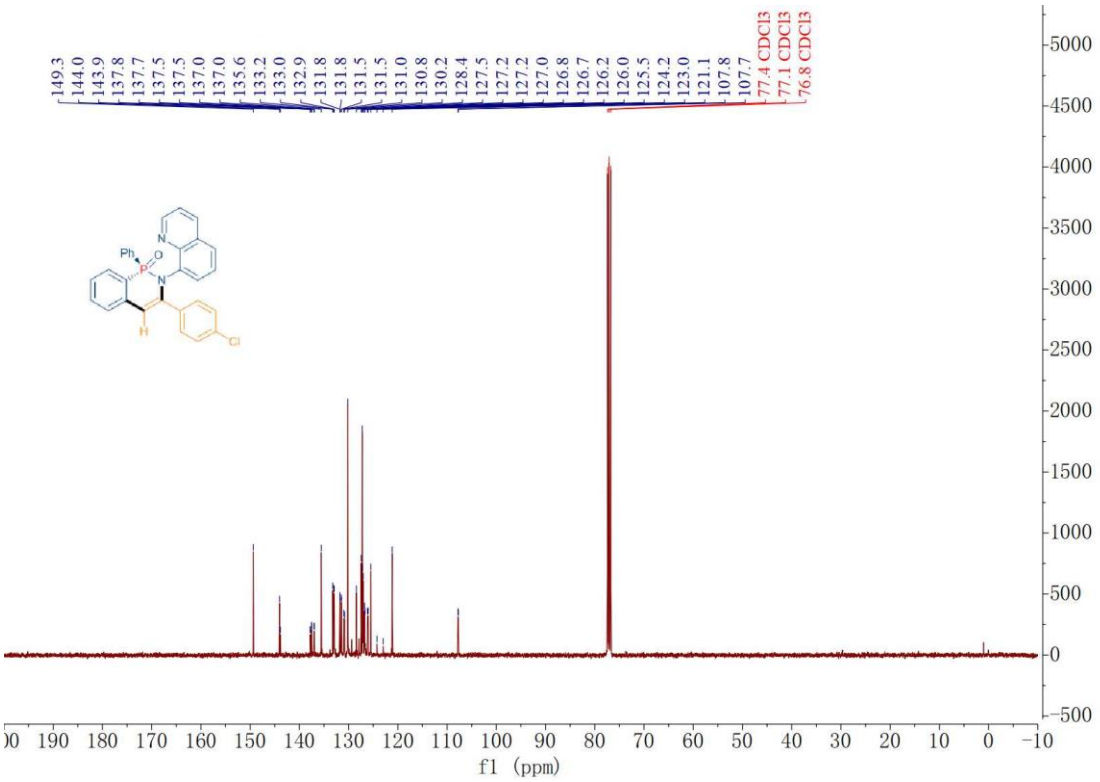
^{31}P NMR of 3m



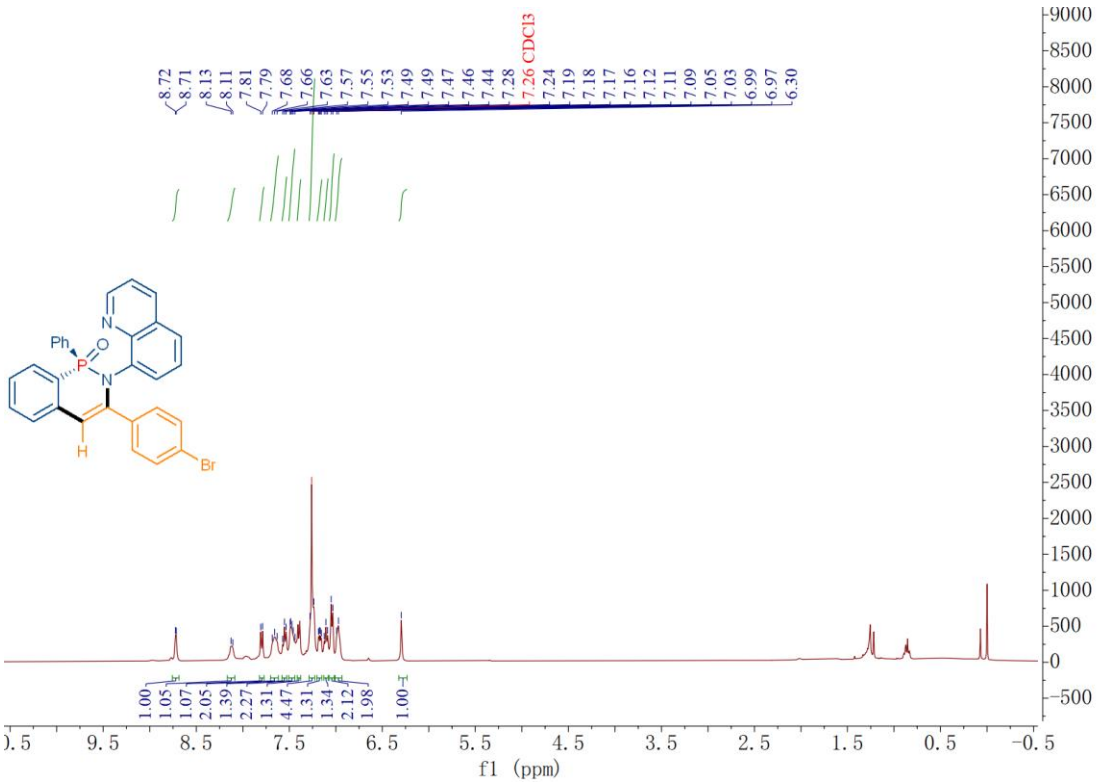
^{1}H NMR of 3n



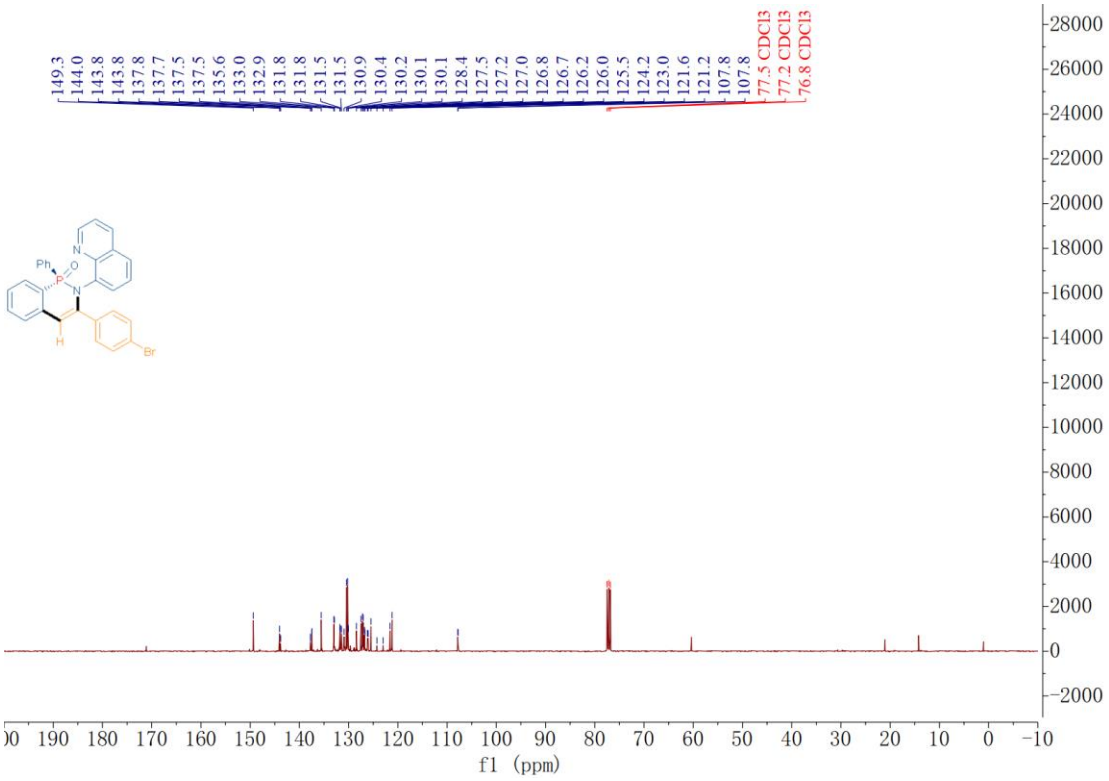
^{13}C NMR of 3n


149.3
144.0
143.9
137.8
137.7
137.5
137.5
137.0
137.0
135.6
133.2
133.0
132.9
131.8
131.8
131.5
131.5
131.0
130.8
130.2
128.4
127.5
127.2
127.2
127.0
126.8
126.7
126.2
126.0
125.5
124.2
123.0
121.1
107.8
107.7
77.4 CDCl3
77.1 CDCl3
76.8 CDCl3
Ph
O
P
N
N
H
Cl
f1 (ppm)

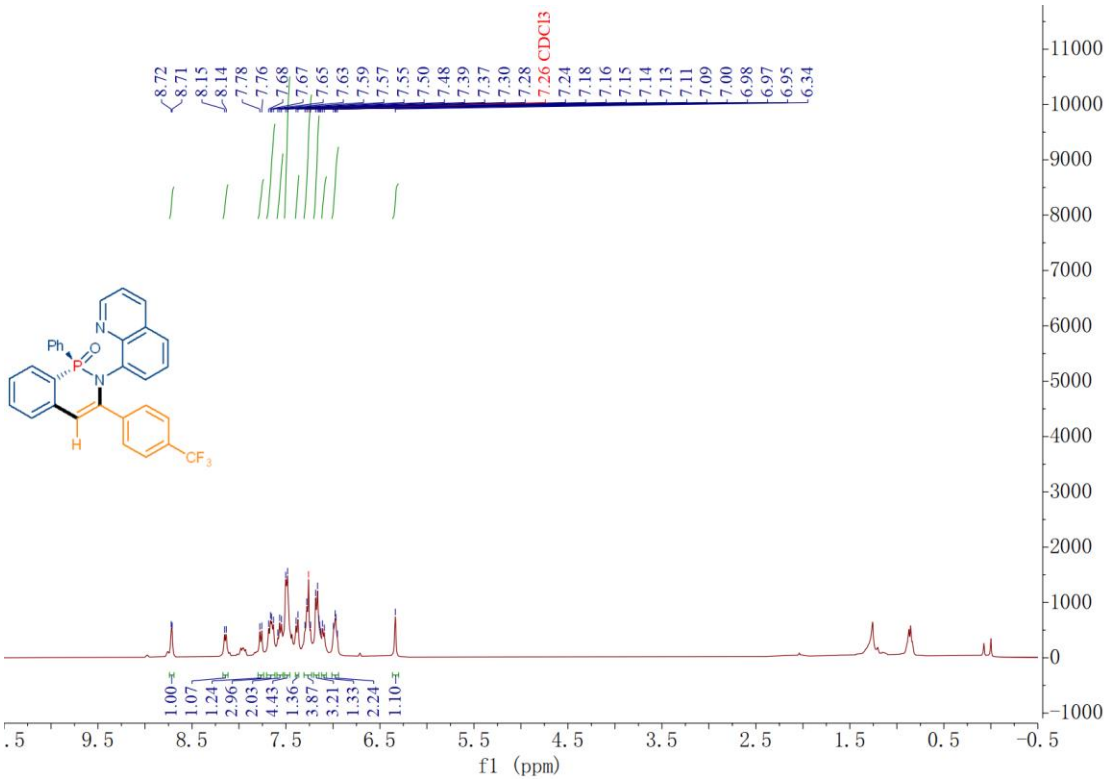
^{1}H NMR of 3o


8.72
8.71
8.13
8.11
7.81
7.79
7.68
7.66
7.63
7.57
7.55
7.53
7.49
7.49
7.47
7.46
7.44
7.28
7.26 CDCl3
7.24
7.19
7.18
7.17
7.16
7.12
7.11
7.09
7.05
7.03
6.99
6.97
6.30
Ph
O
P
N
N
H
Br
1.00
1.05
1.07
2.05
1.39
2.27
1.31
4.47
1.31
1.34
2.12
1.98
1.00
f1 (ppm)

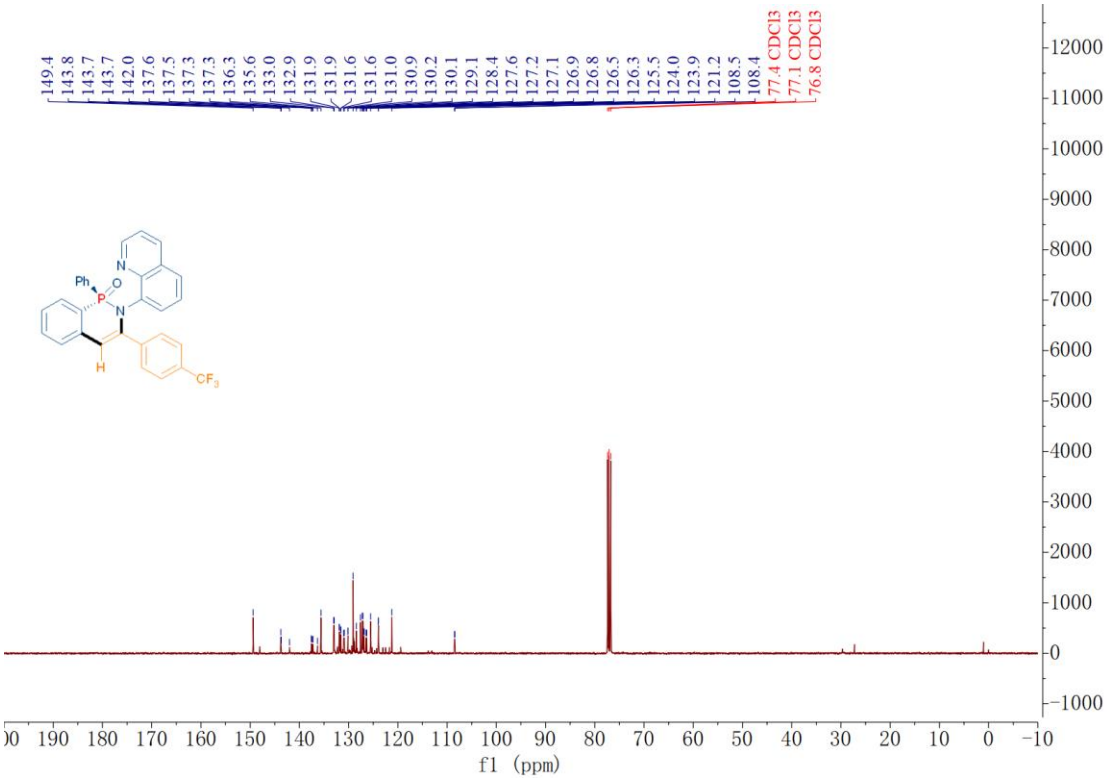
^{13}C NMR of 3o



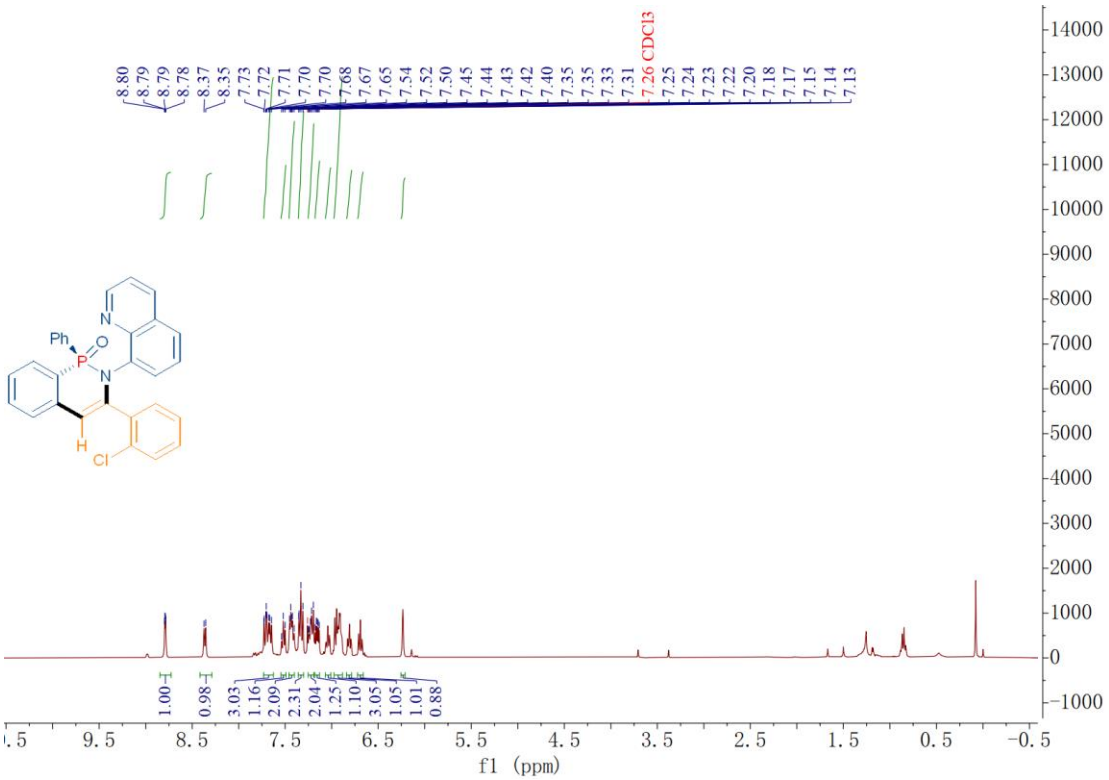
^{1}H NMR of 3p



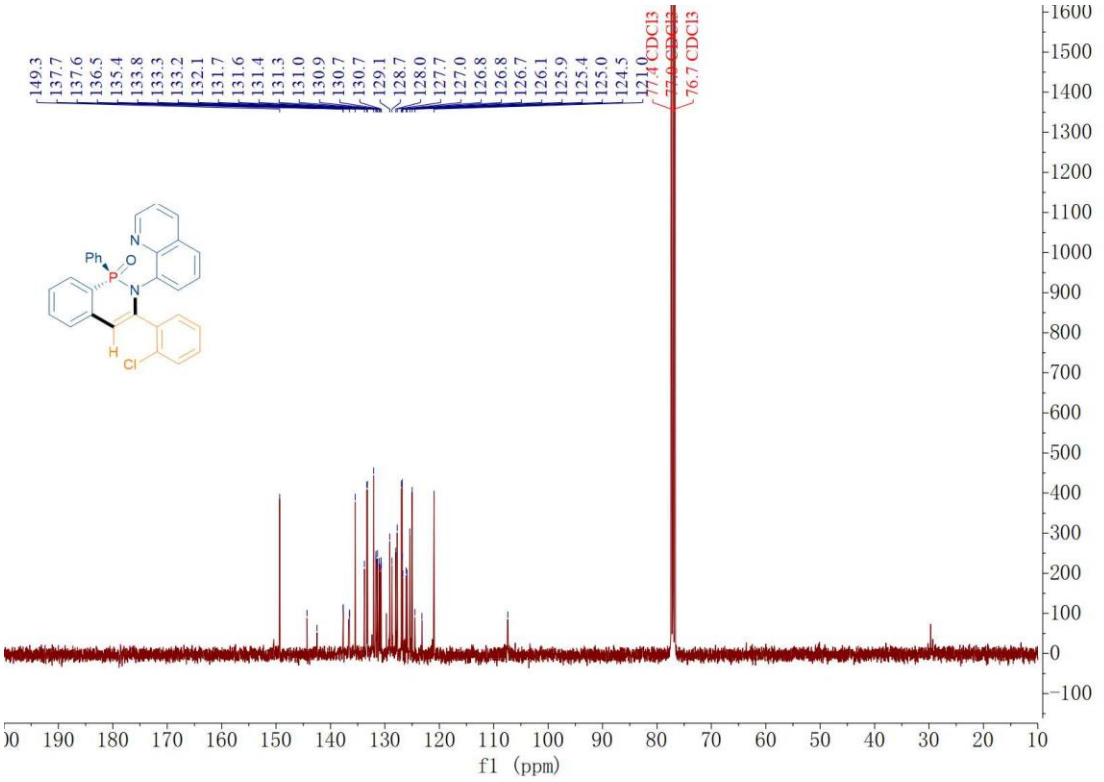
^{13}C NMR of 3p



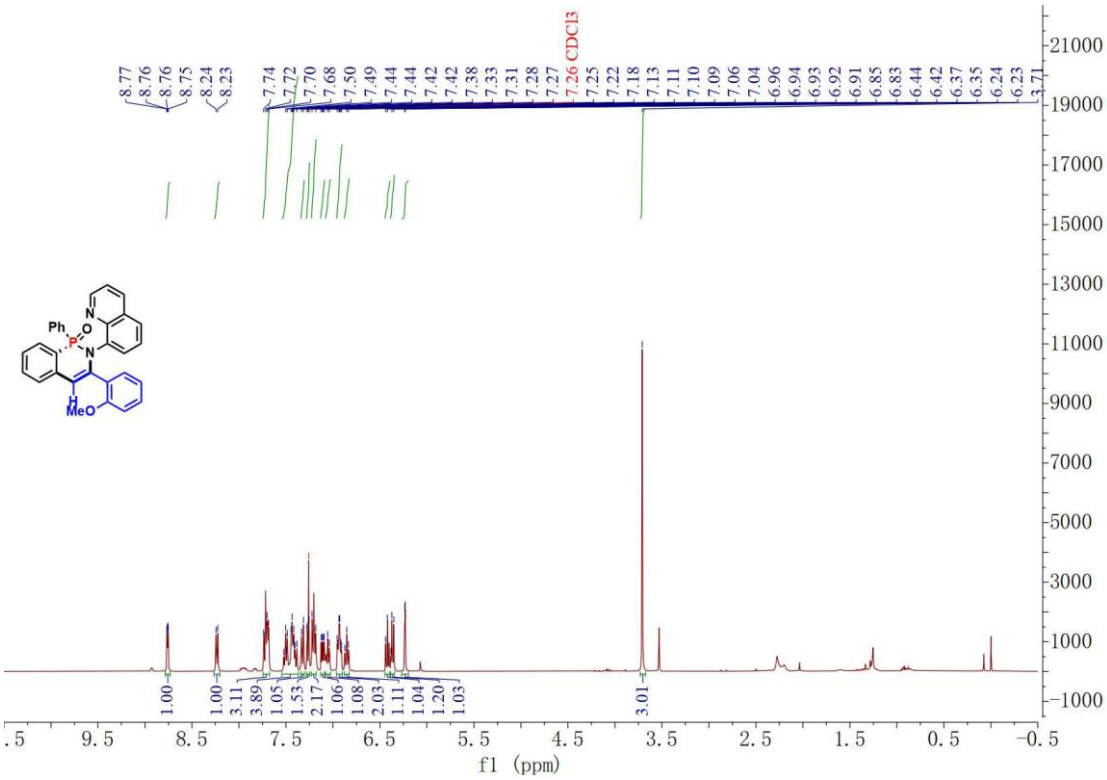
^{1}H NMR of 3q



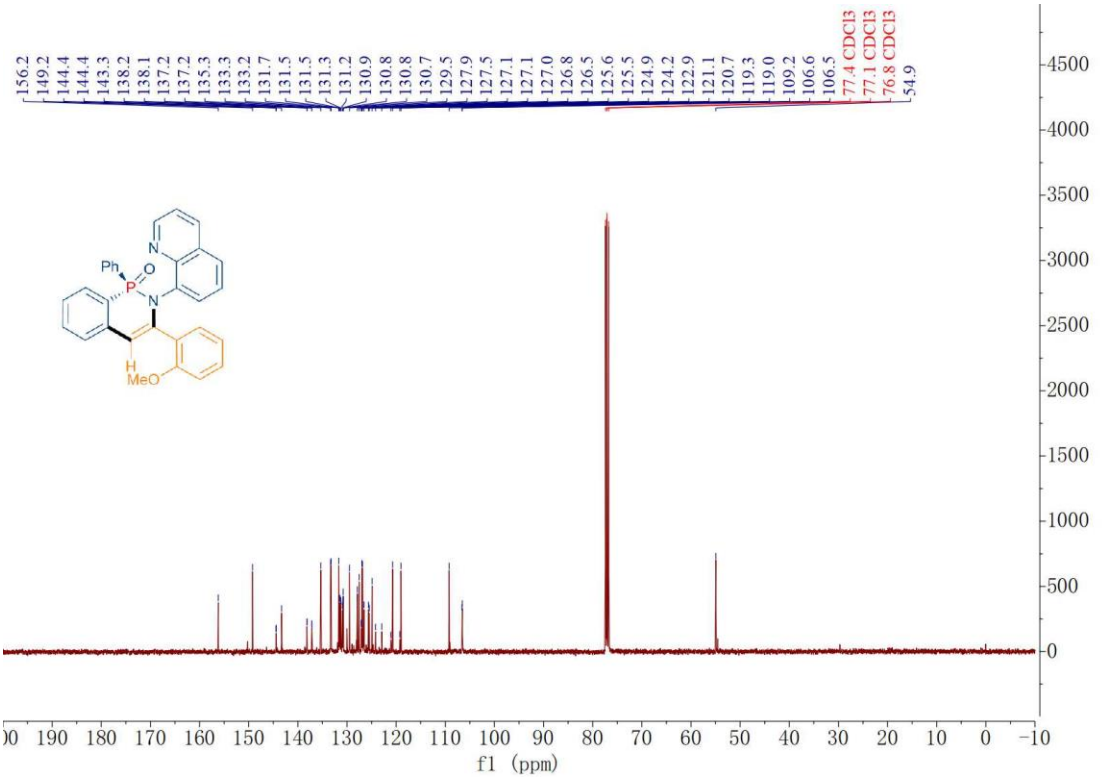
^{13}C NMR of 3q



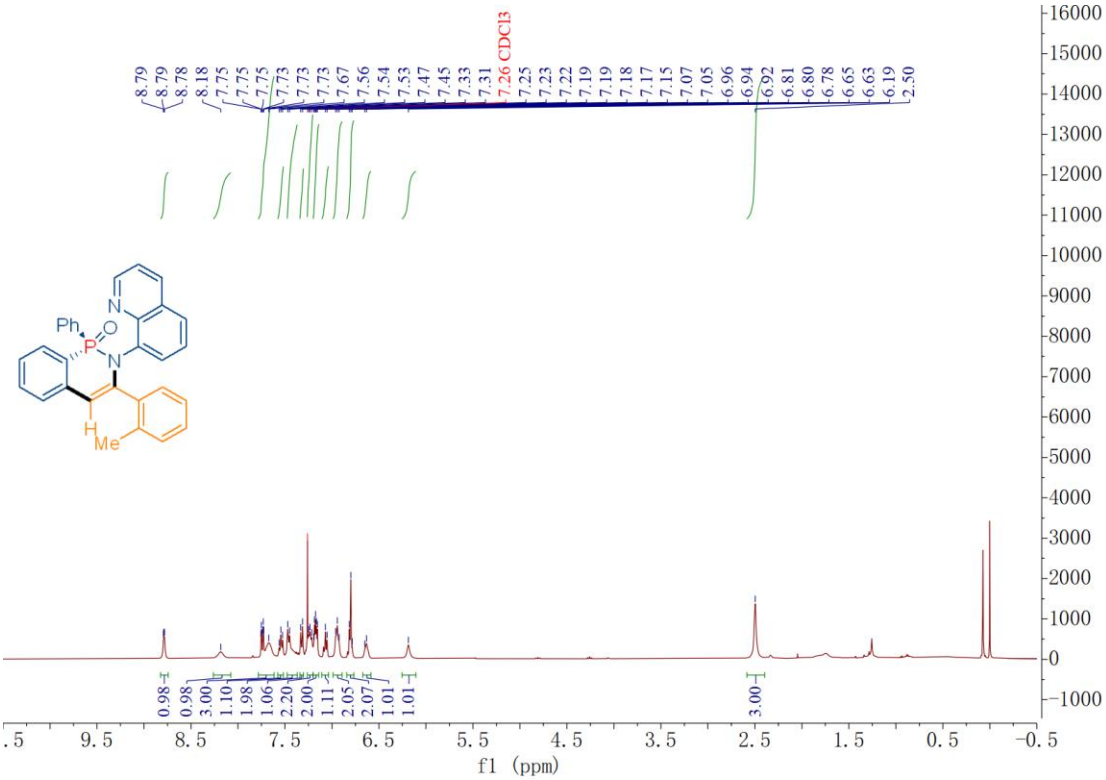
^{1}H NMR of 3r



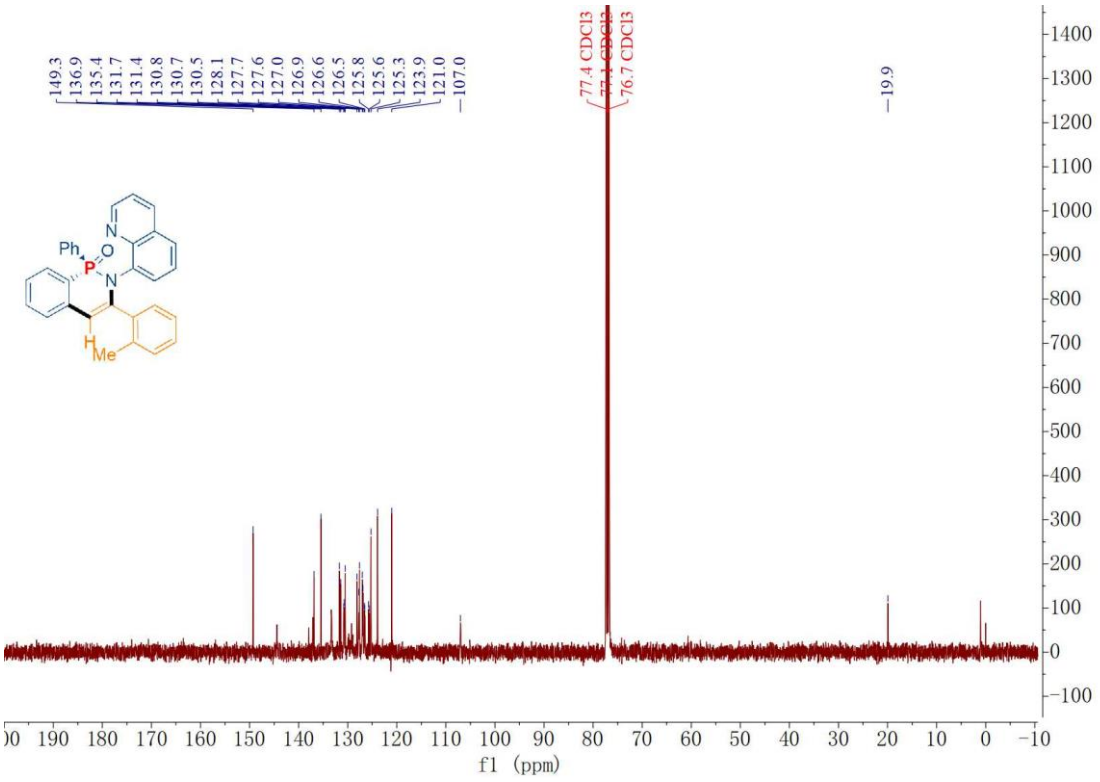
^{13}C NMR of 3r



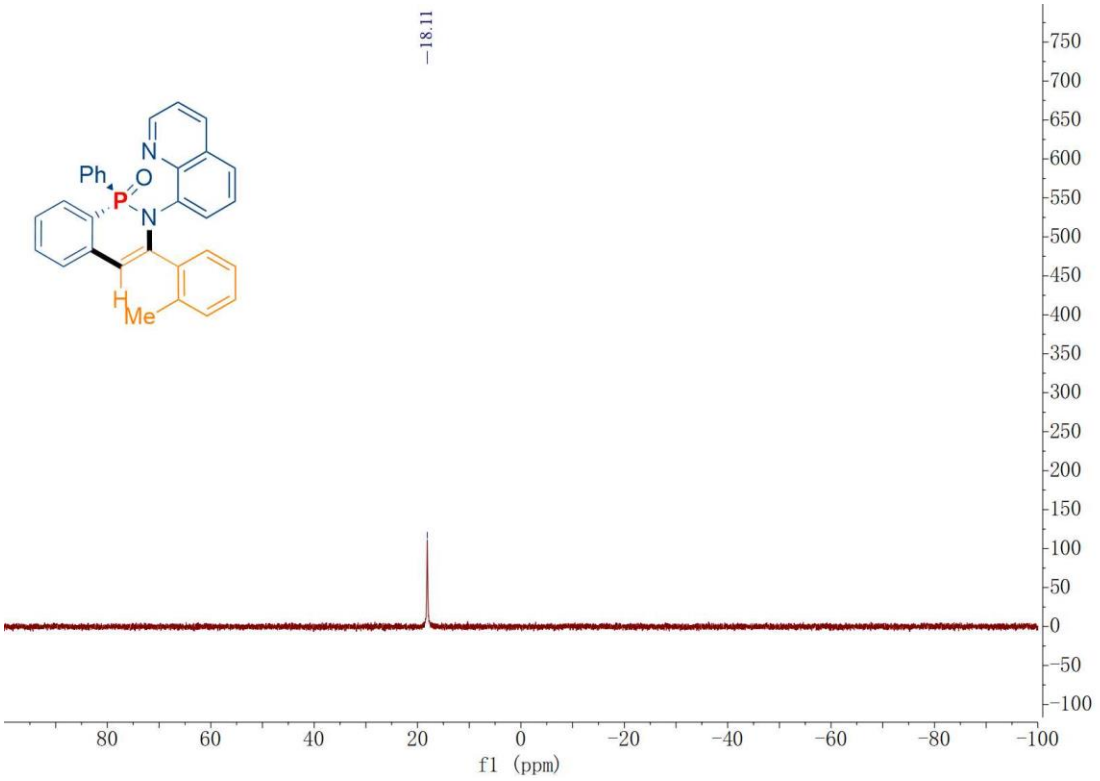
^{1}H NMR of 3s



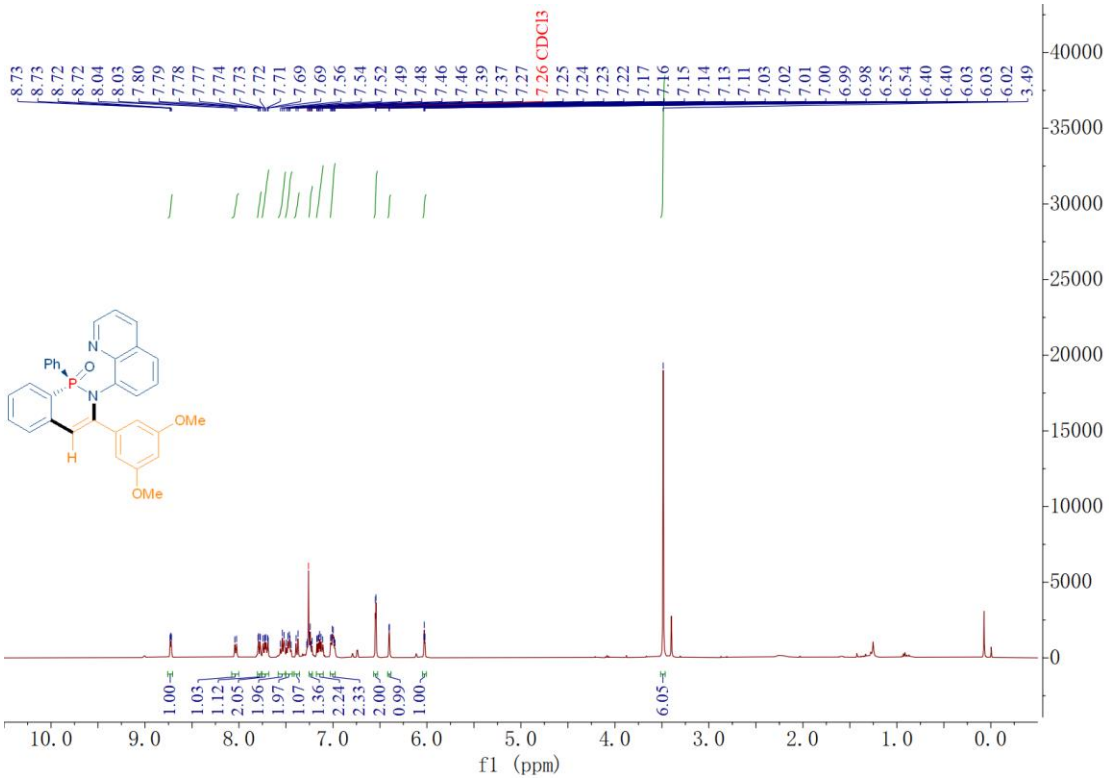
^{13}C NMR of 3s



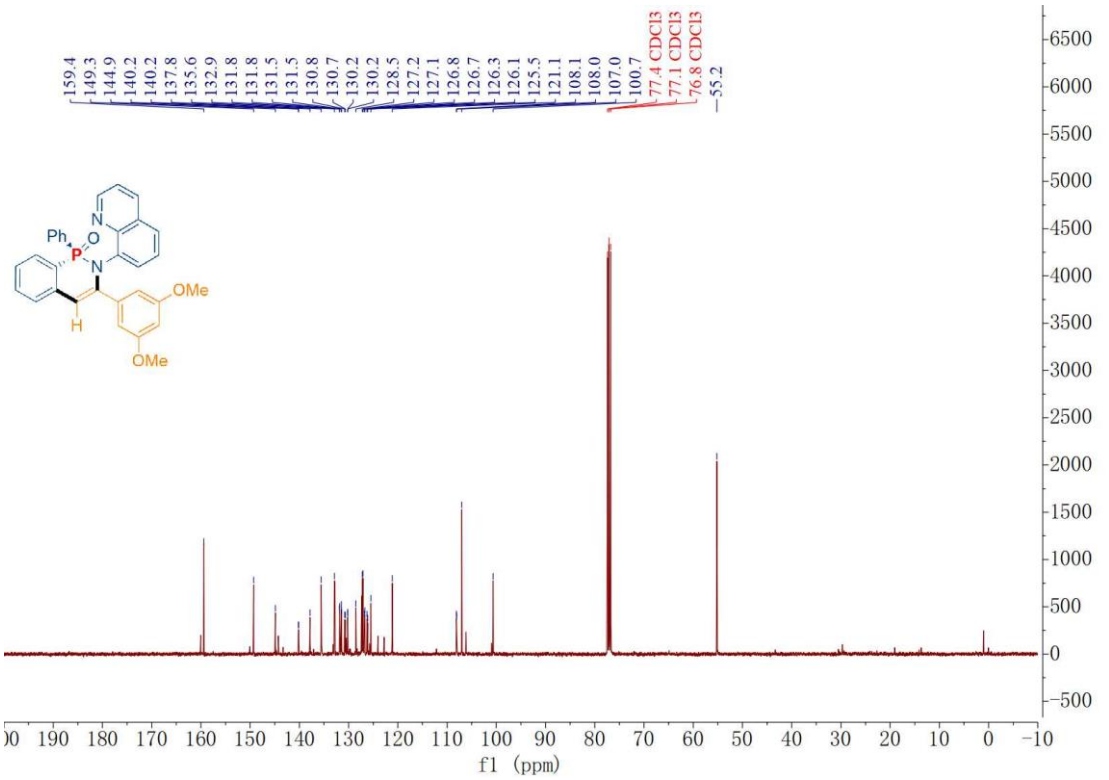
^{31}P NMR of 3s



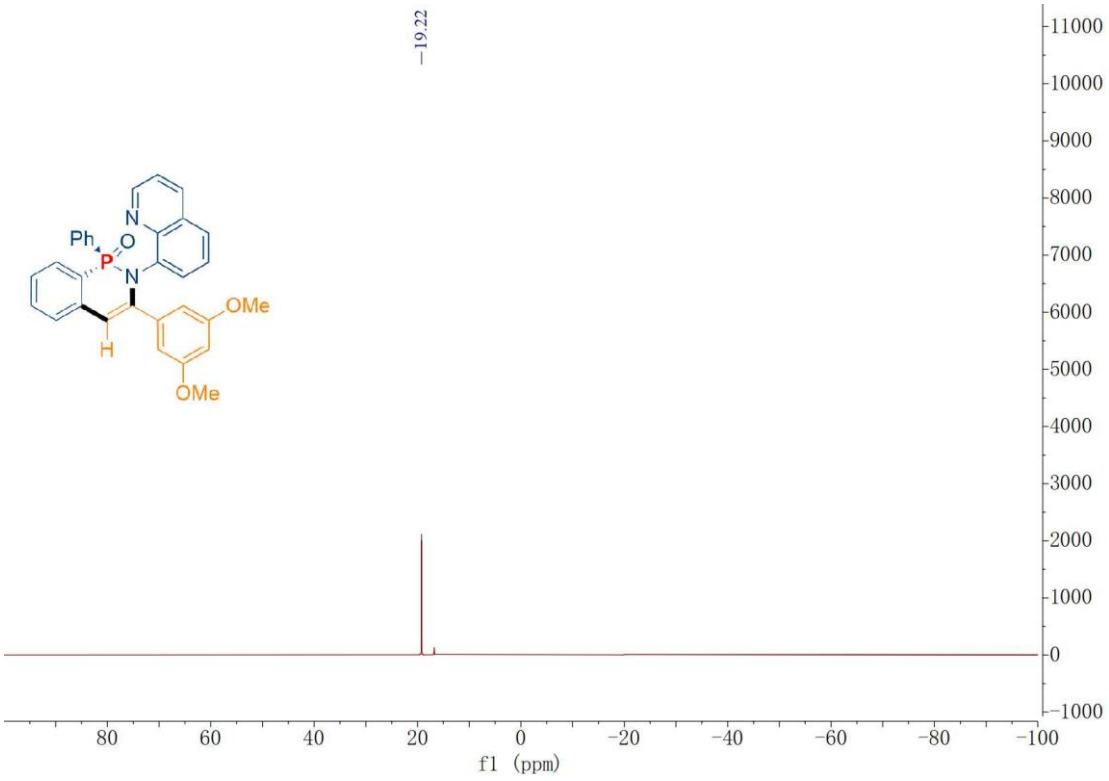
^{1}H NMR of 3t



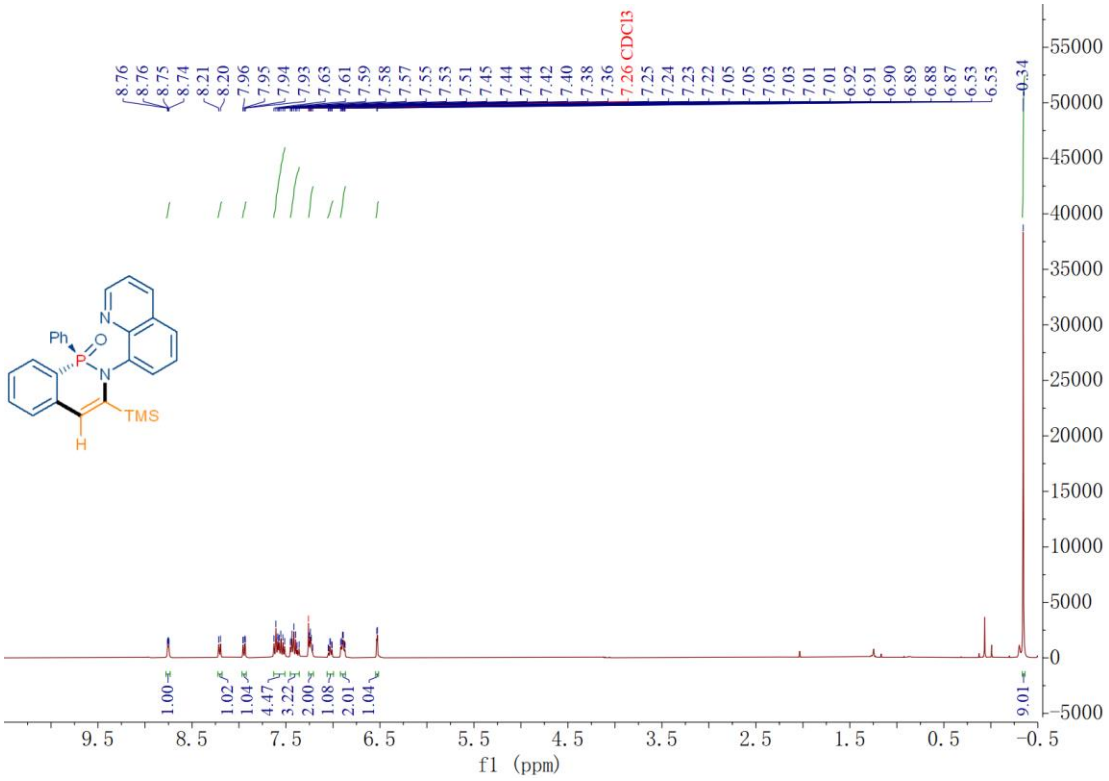
^{13}C NMR of 3t



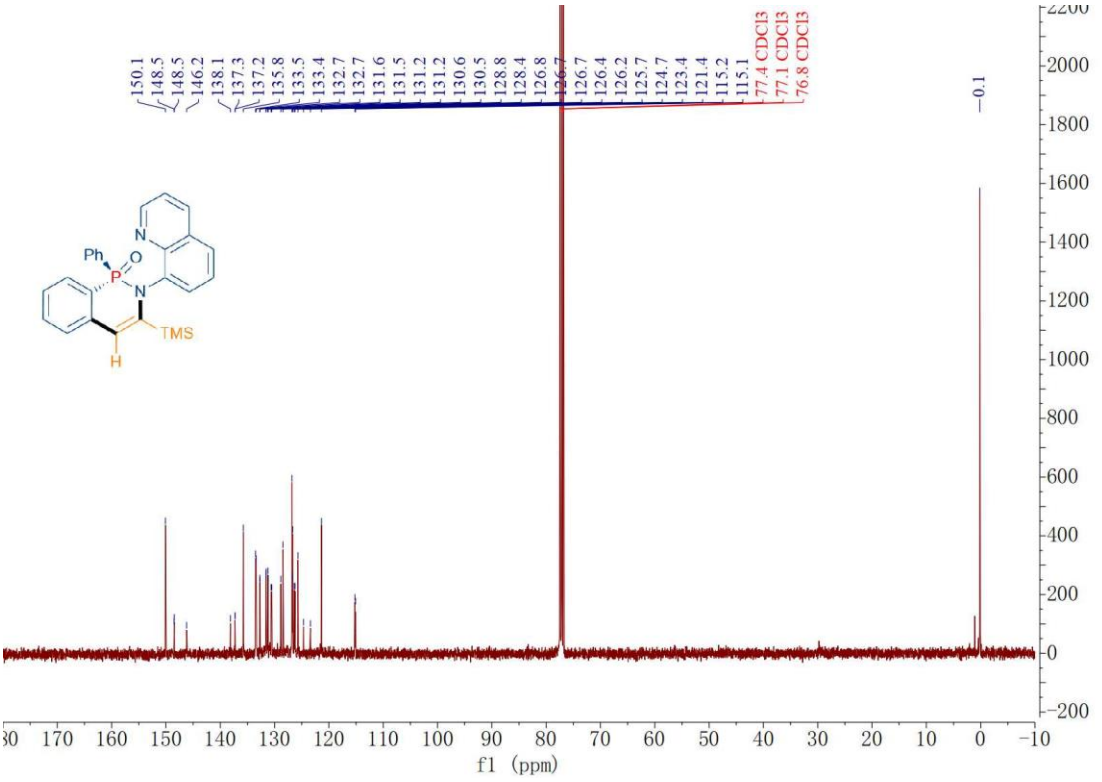
^{31}P NMR of 3t



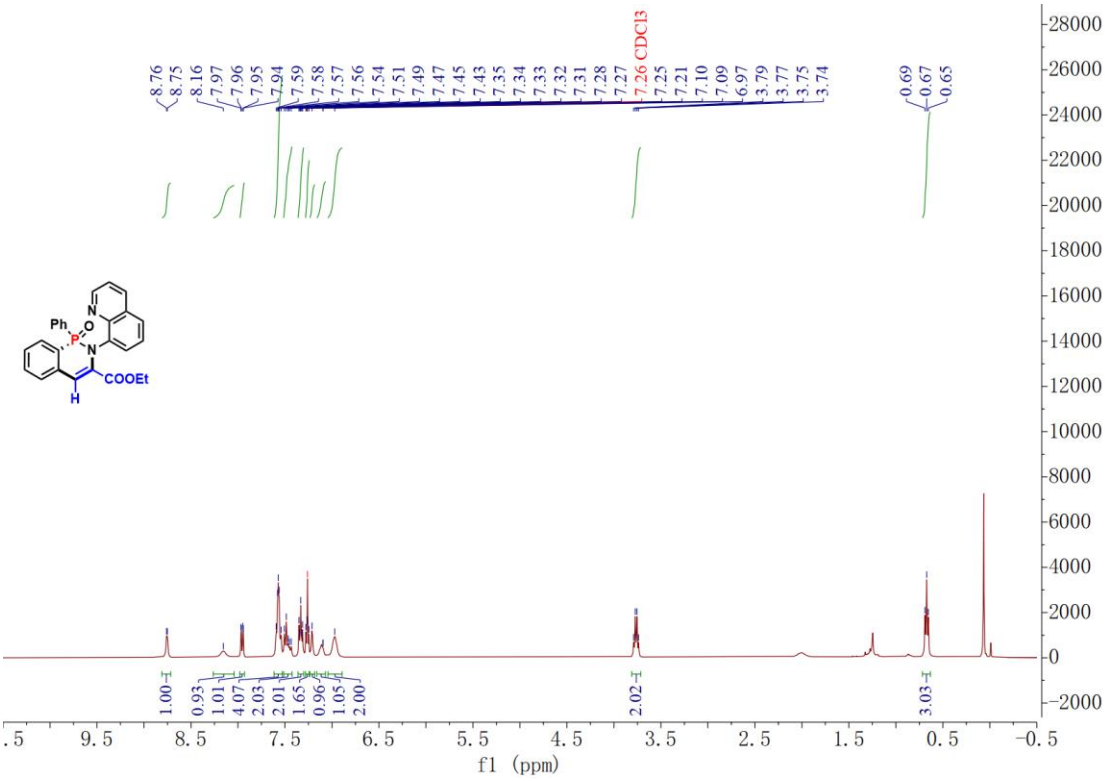
^{1}H NMR of 3u



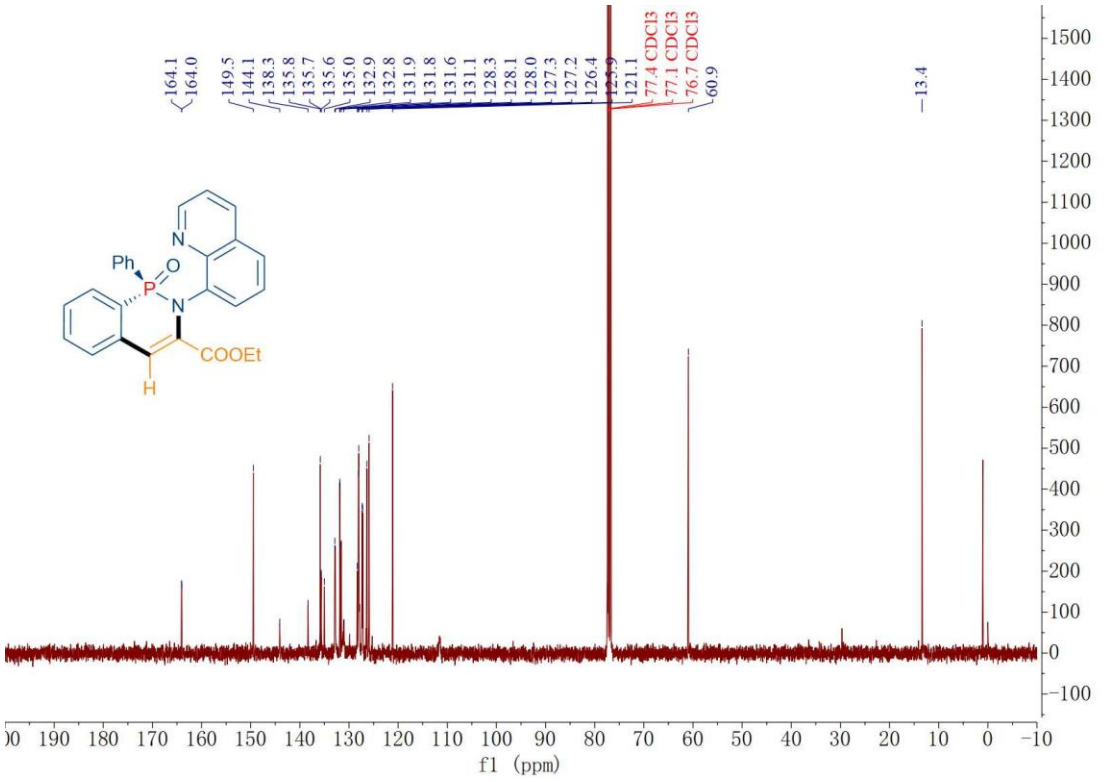
^{13}C NMR of 3u



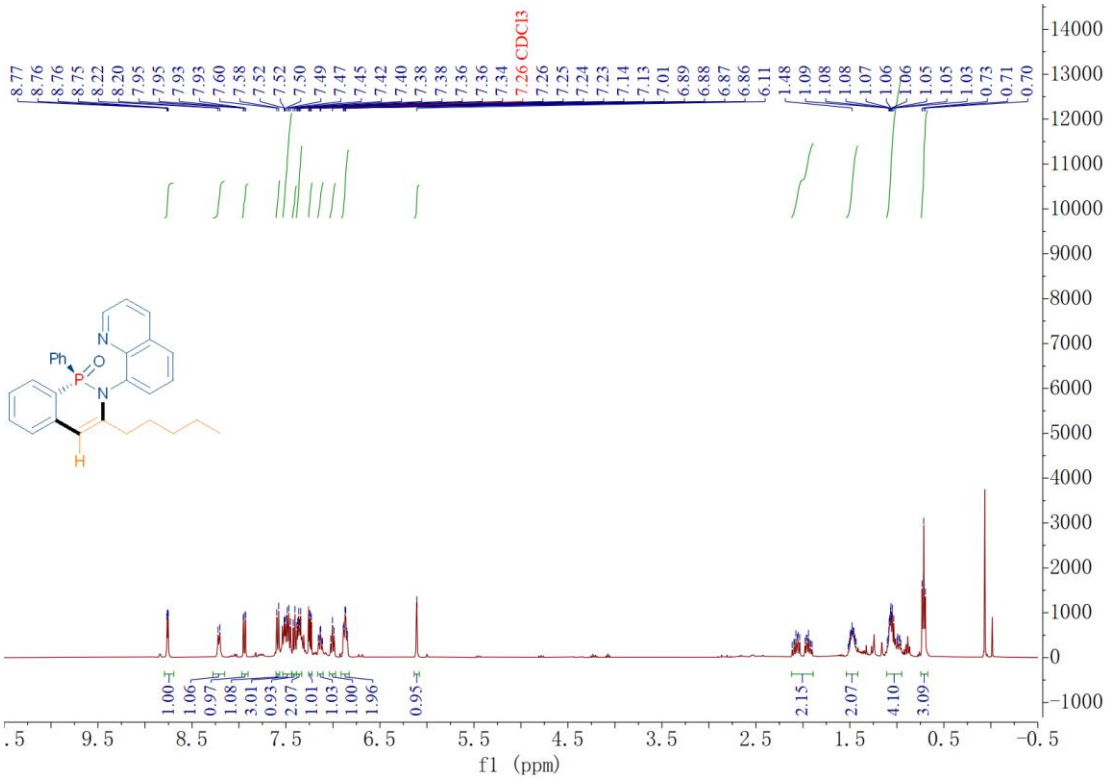
^{1}H NMR of 3v



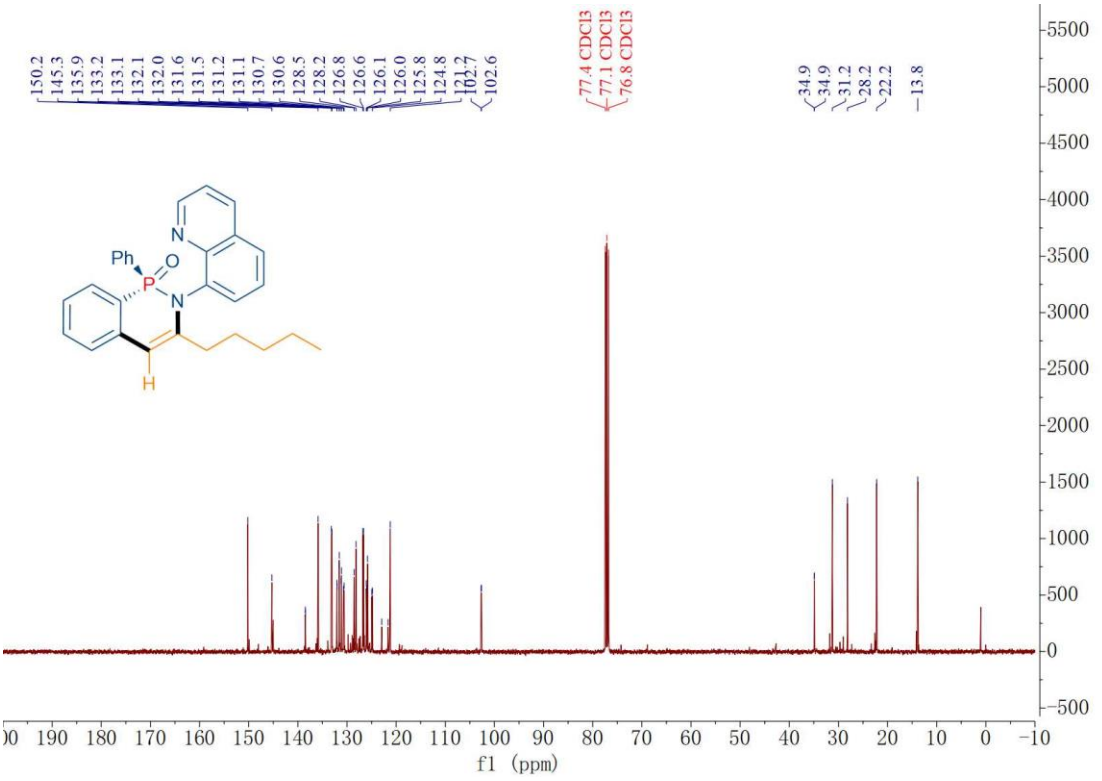
^{13}C NMR of 3v



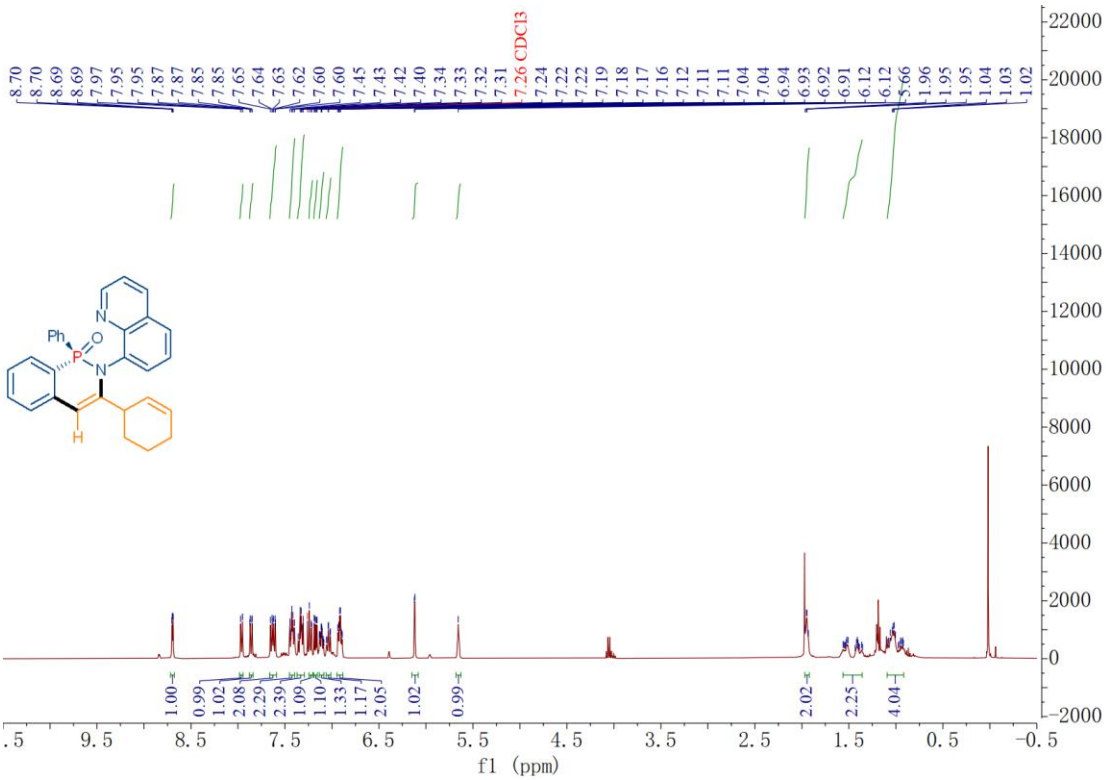
^{1}H NMR of 3w



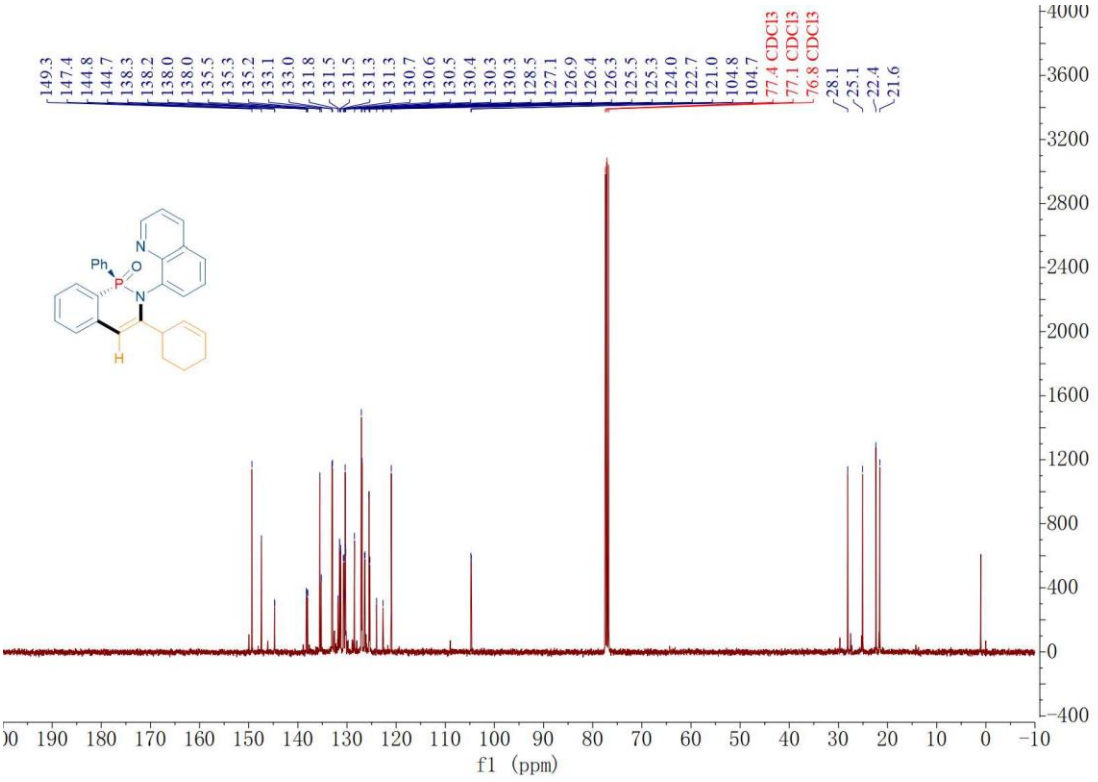
^{13}C NMR of 3w



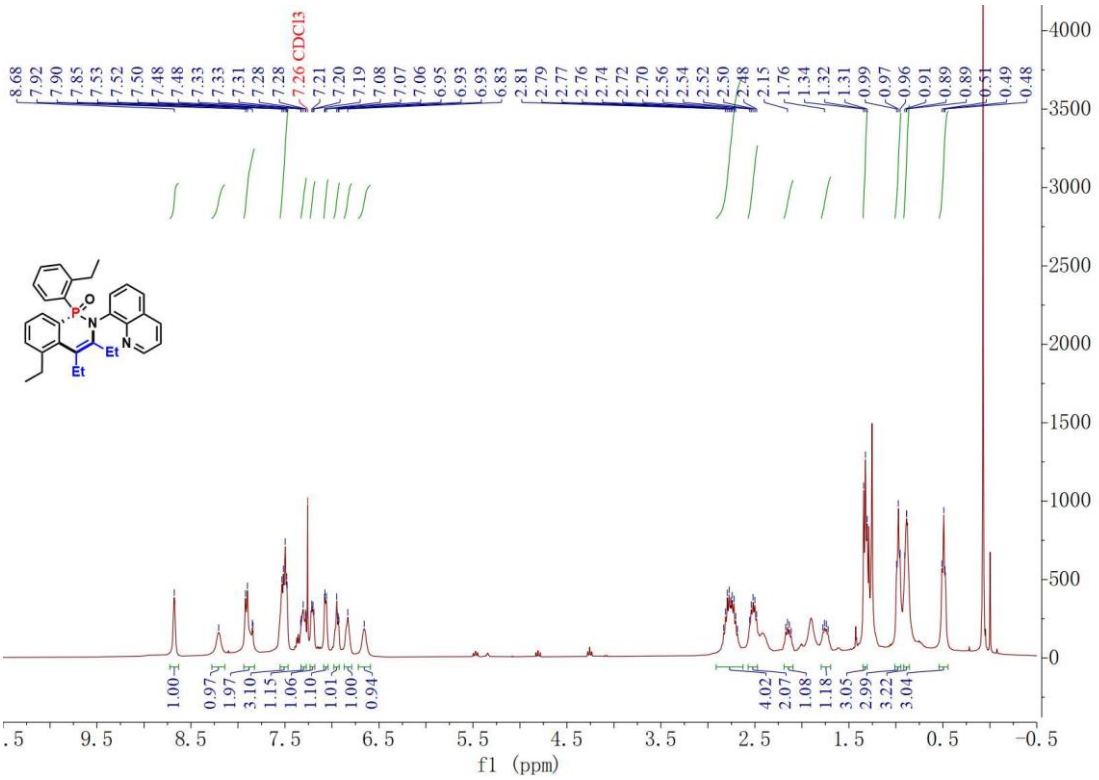
^{1}H NMR of 3x



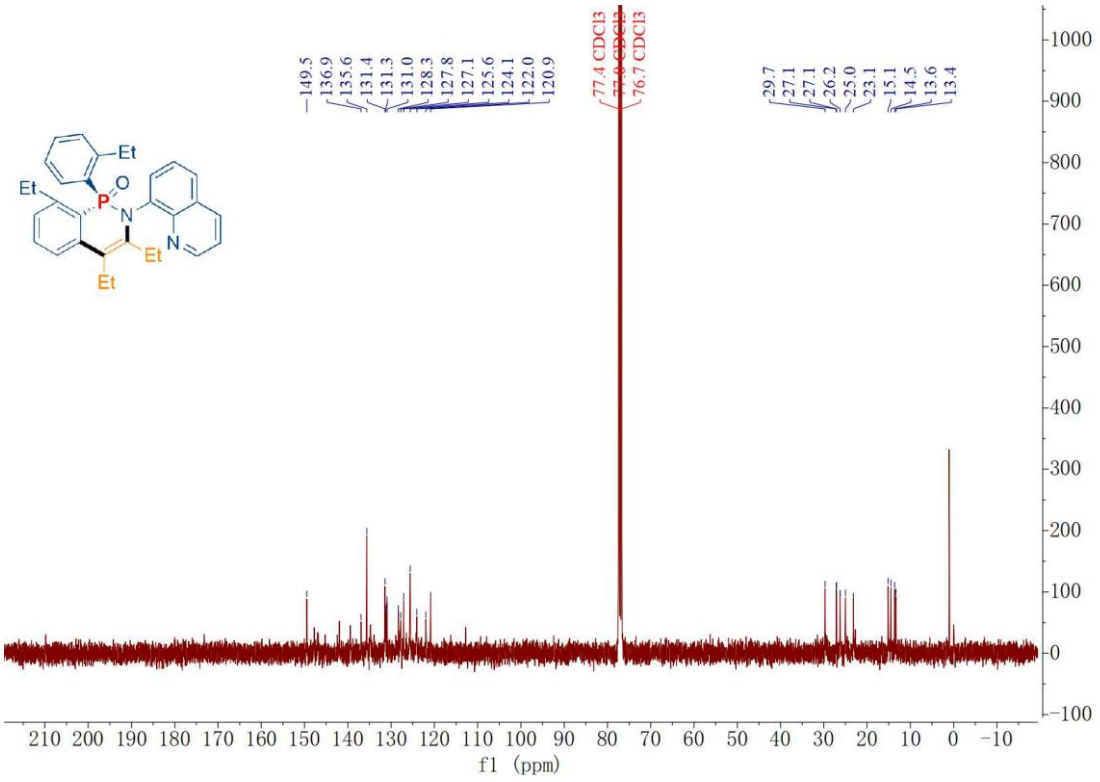
^{13}C NMR of 3x



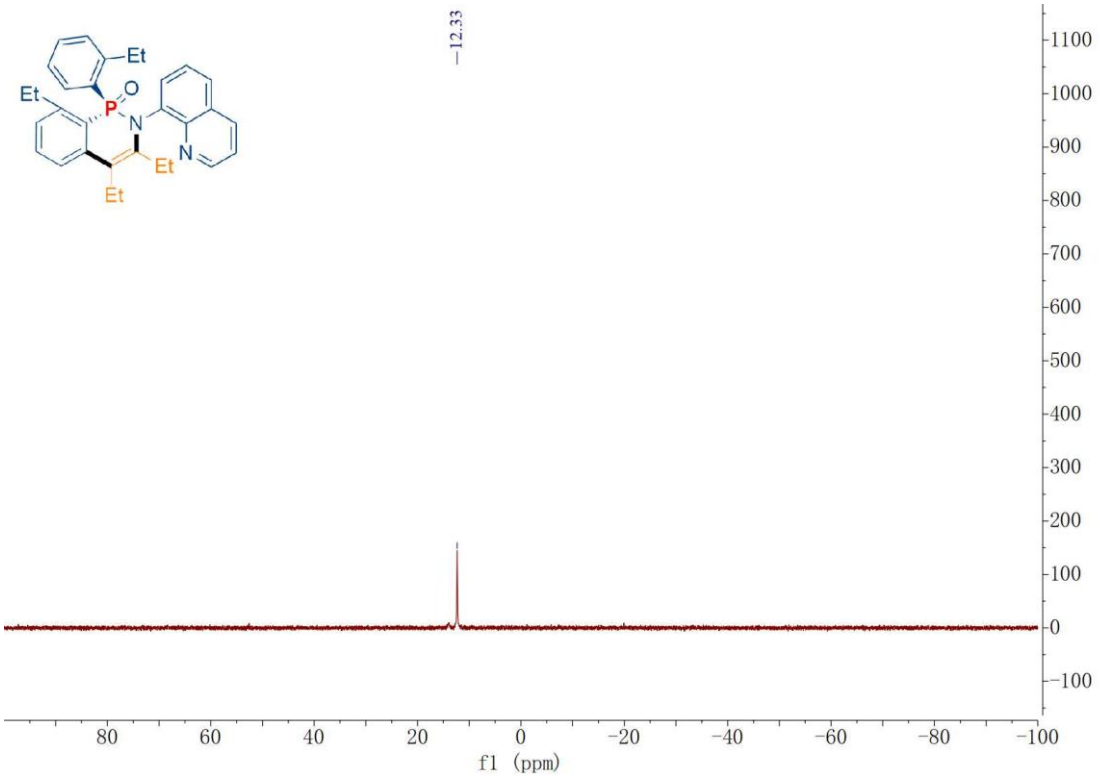
^{1}H NMR of 3y



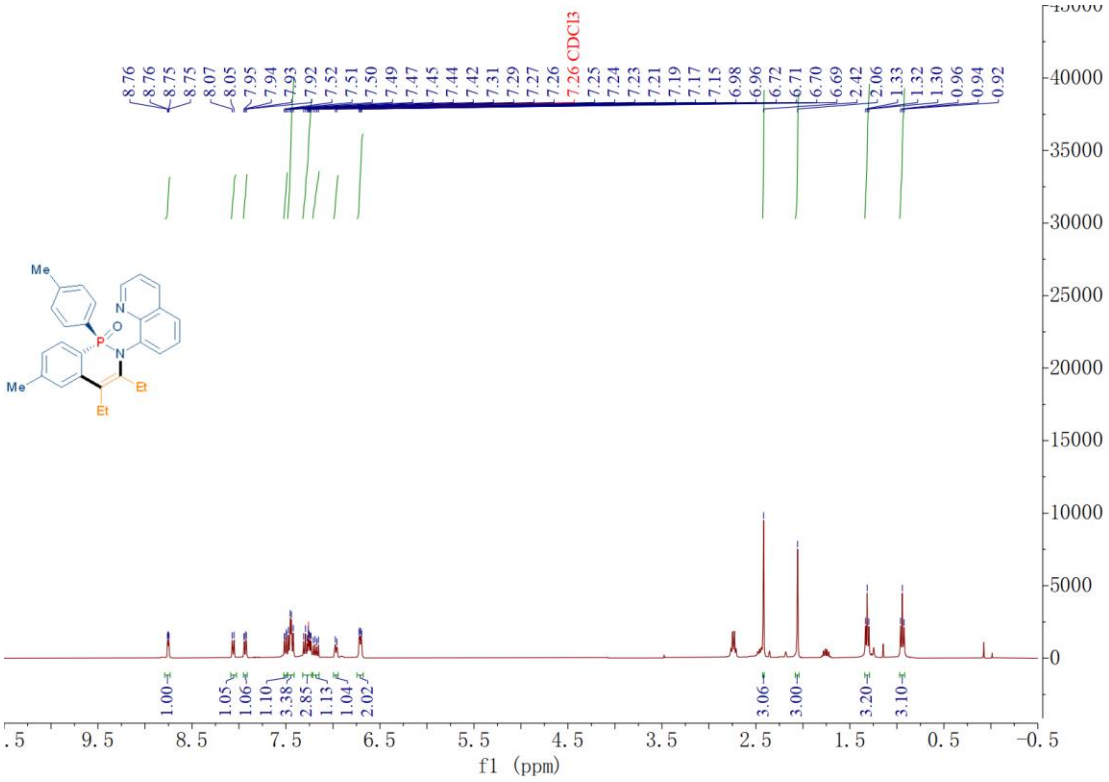
^{13}C NMR of 3y



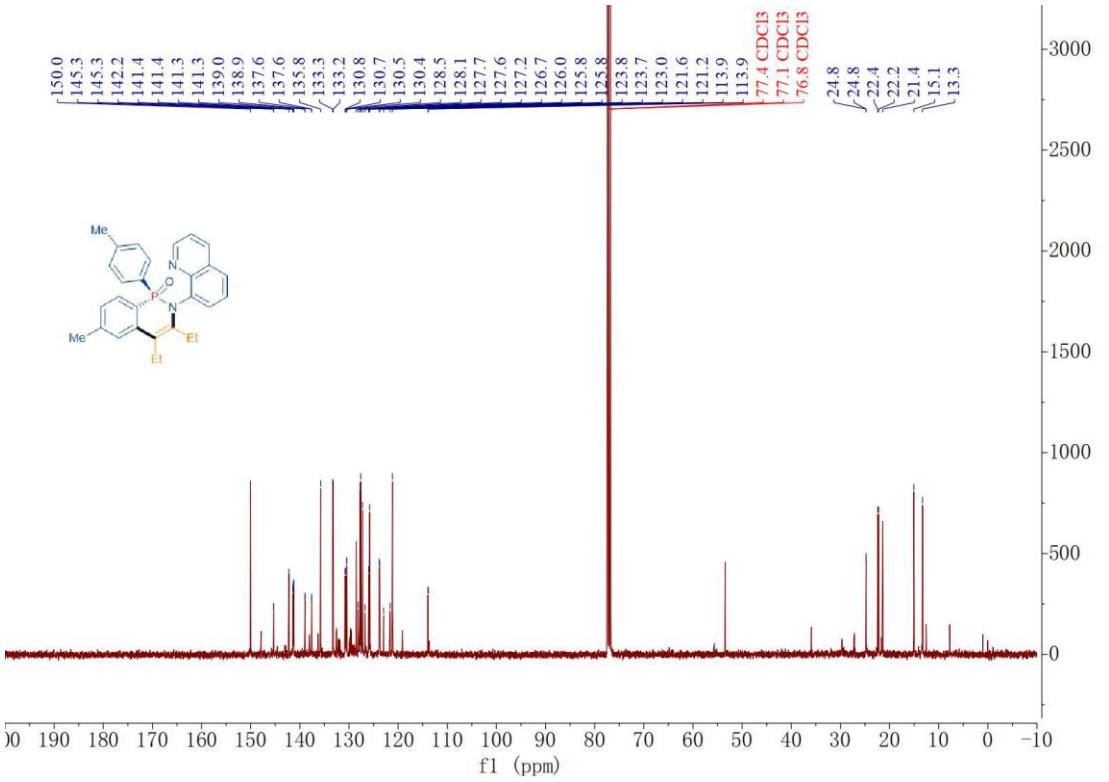
^{31}P NMR of 3y



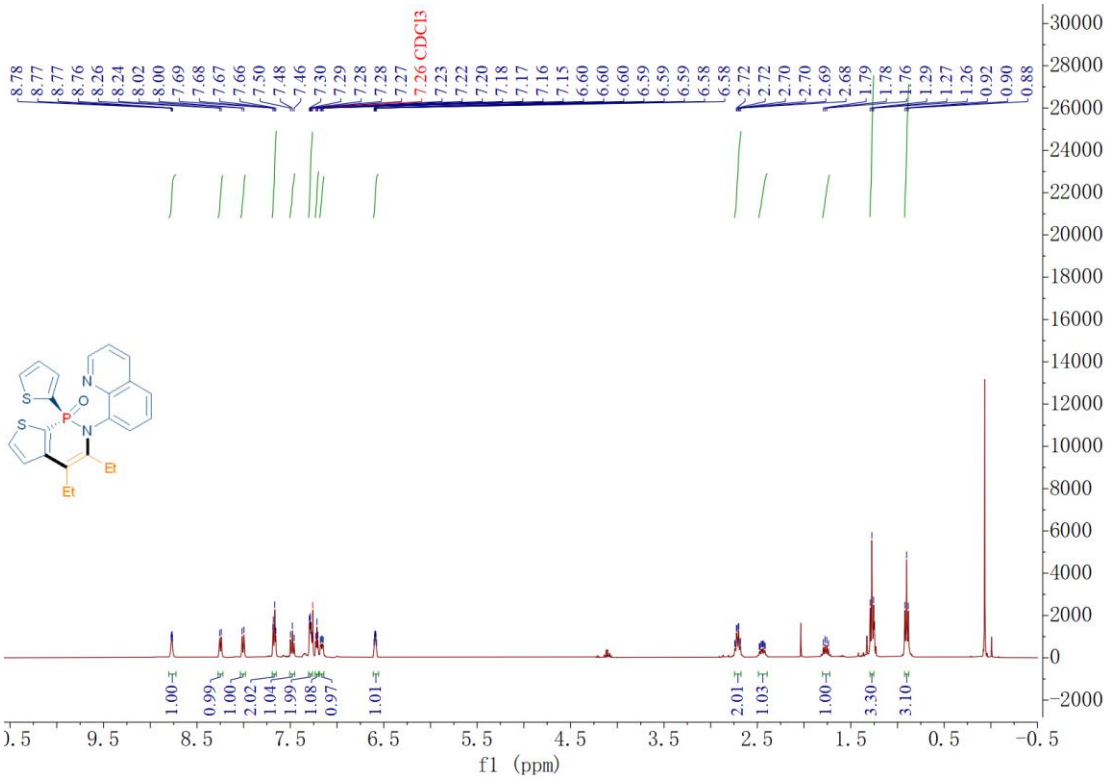
^{1}H NMR of 3z



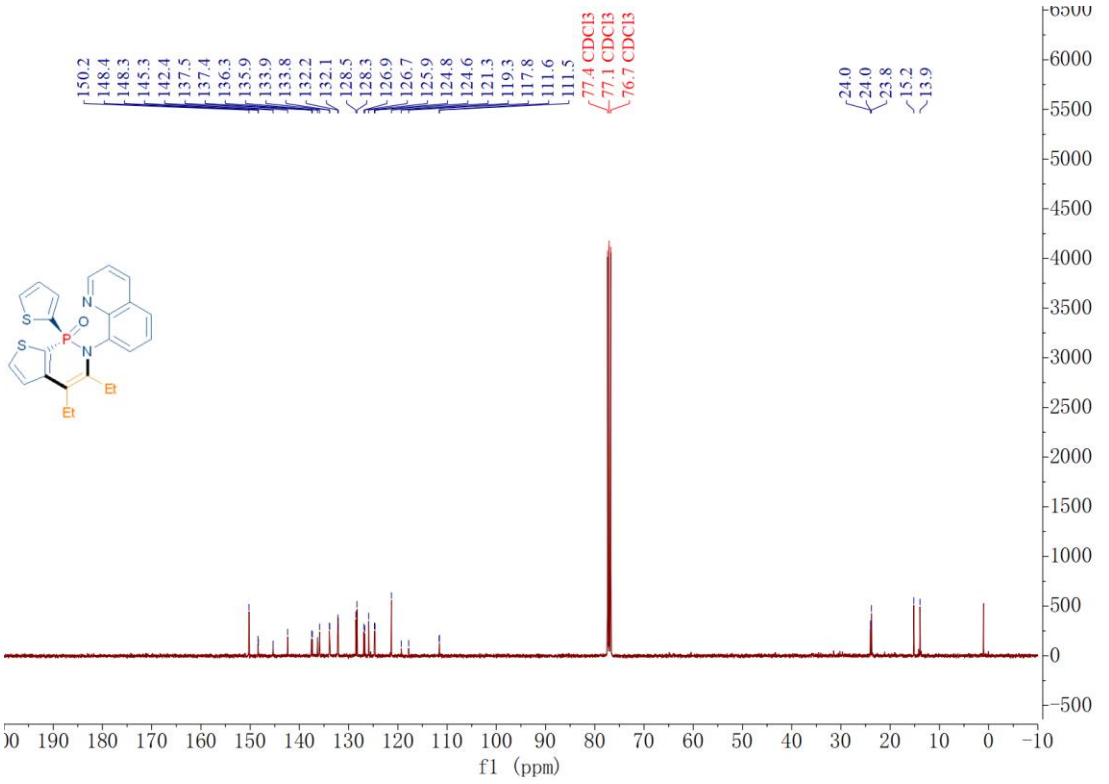
^{13}C NMR of 3z



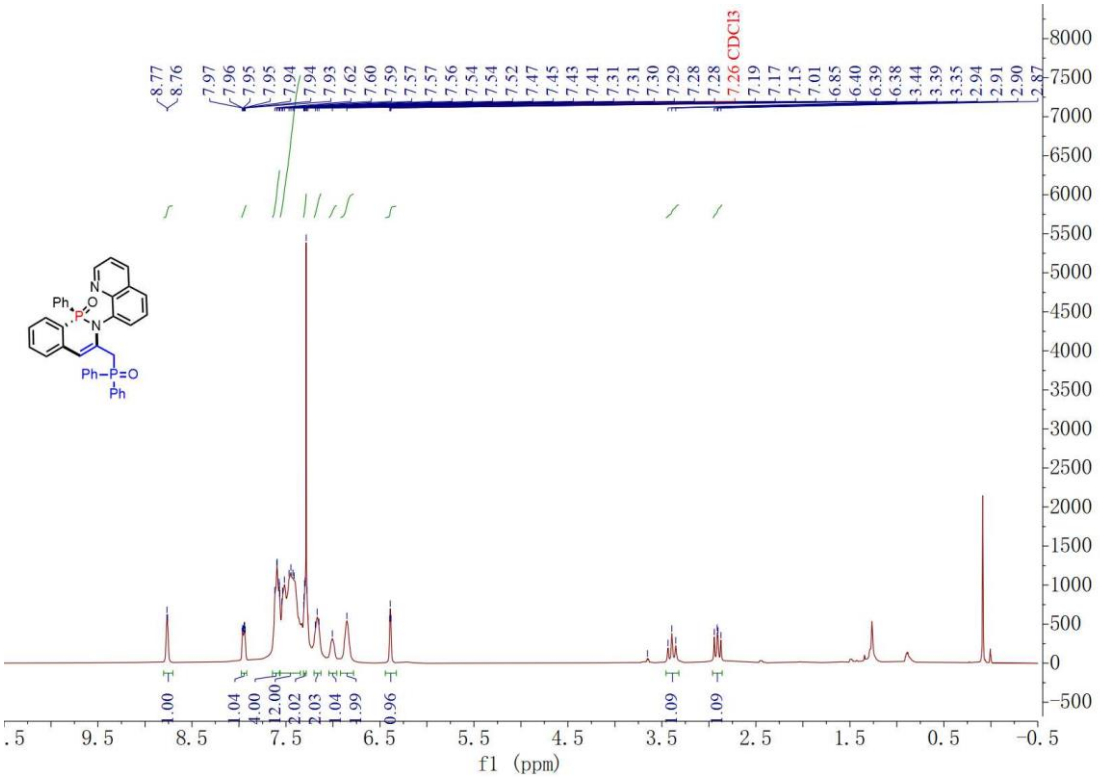
^{1}H NMR of 3aa



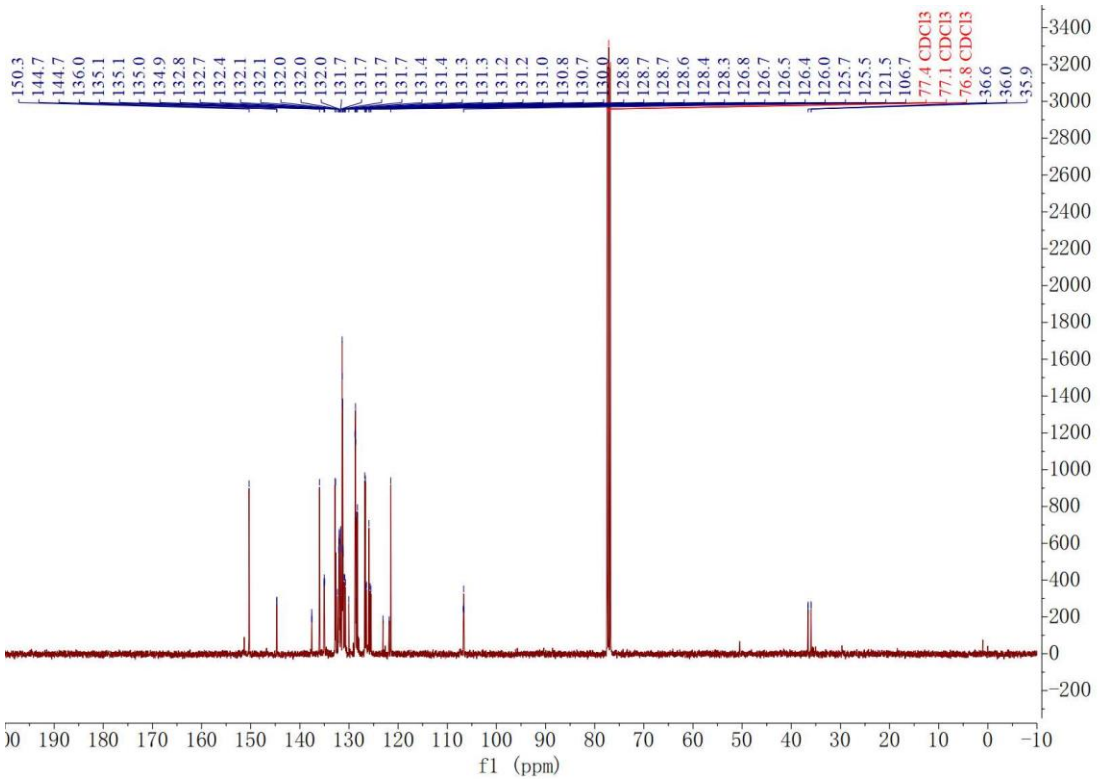
^{13}C NMR of 3aa



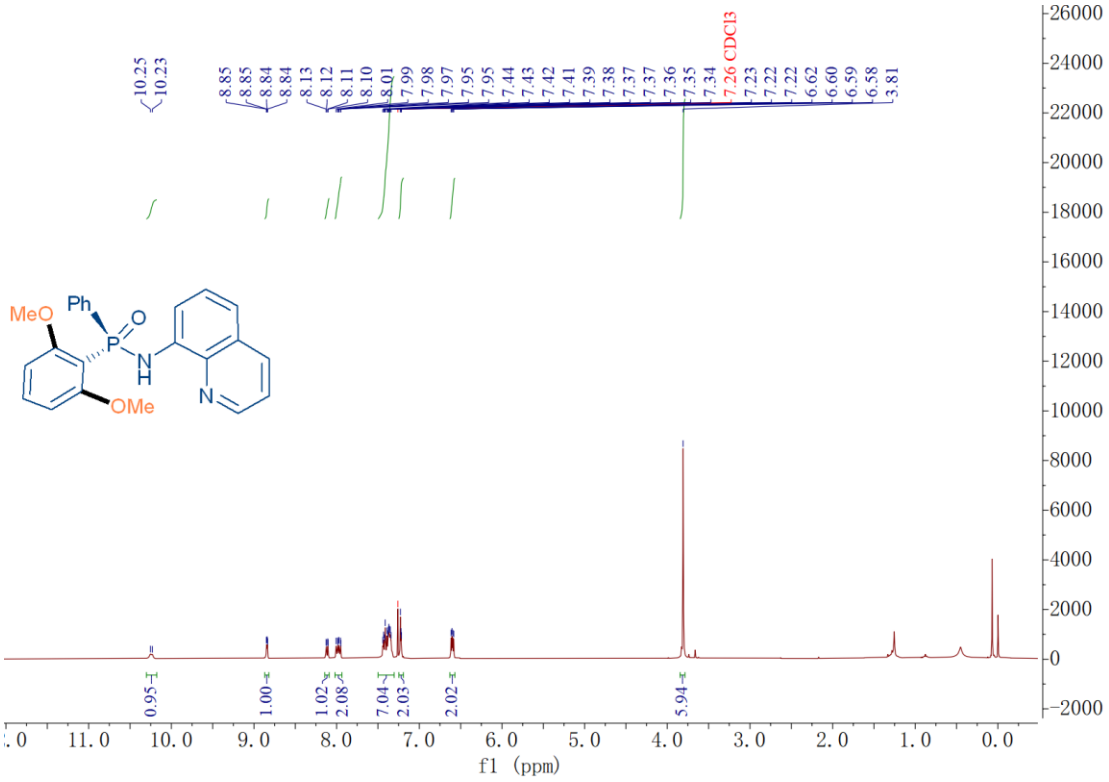
^{1}H NMR of 5a



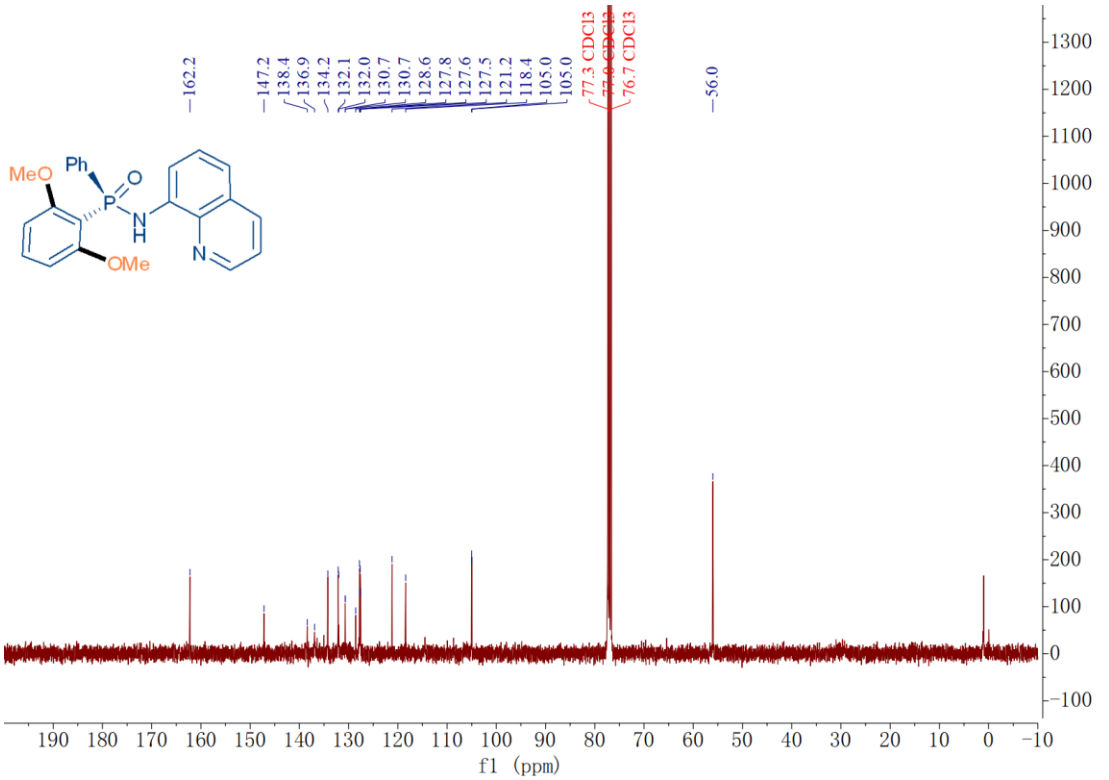
^{13}C NMR of 5a



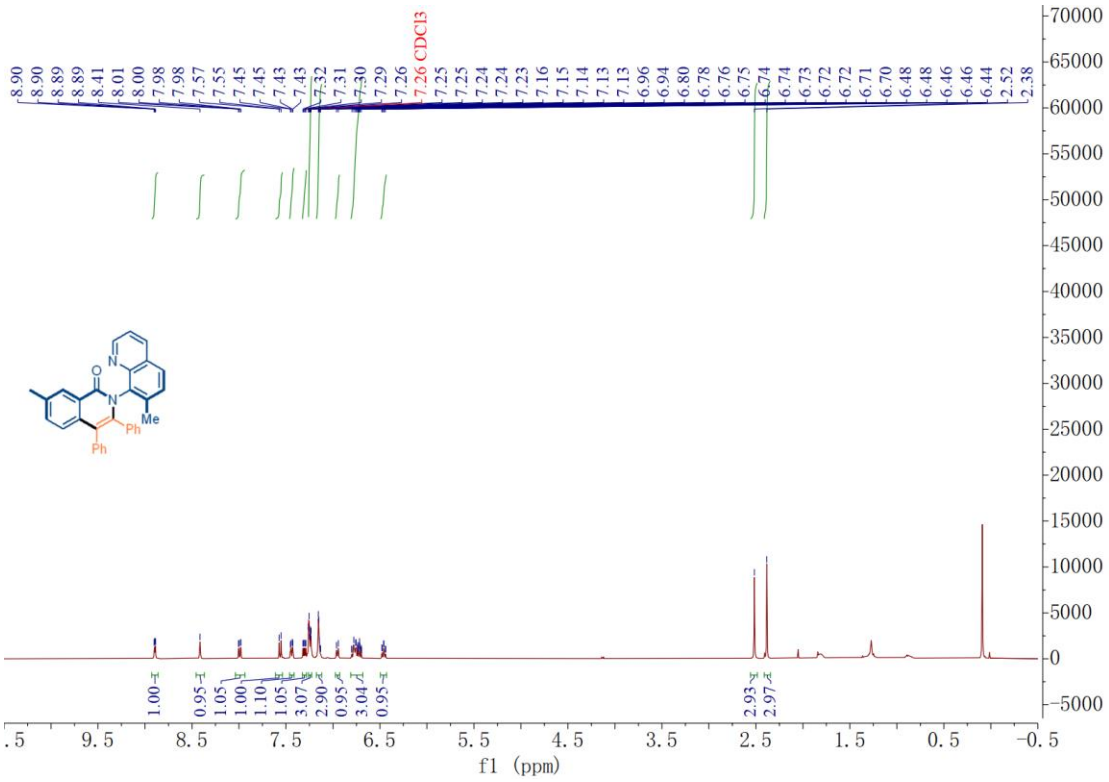
^{1}H NMR of 6a



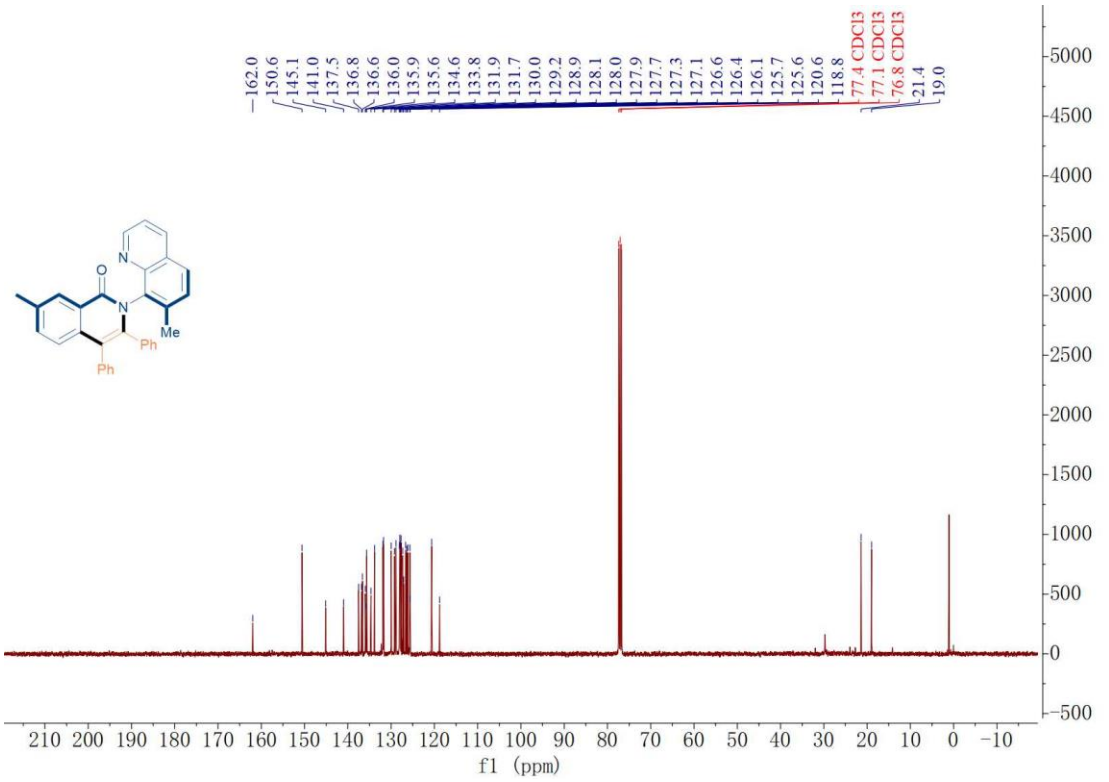
^{13}C NMR of 6a



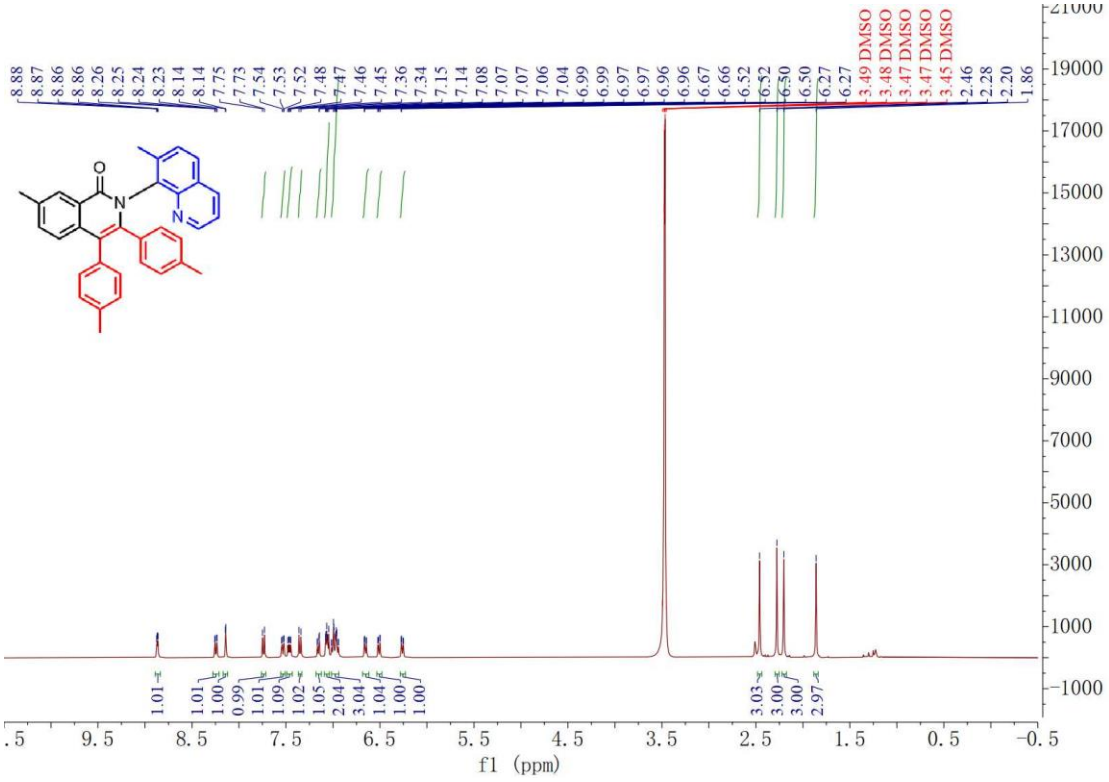
^{1}H NMR of 8a



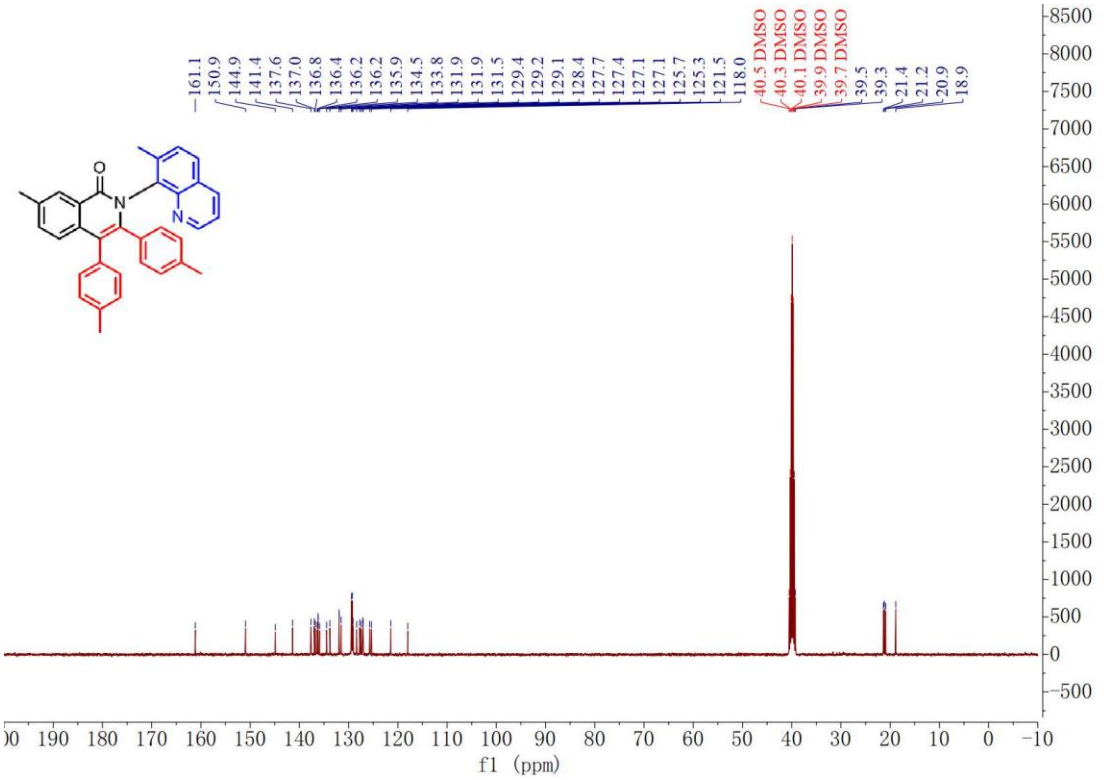
^{13}C NMR of 8a



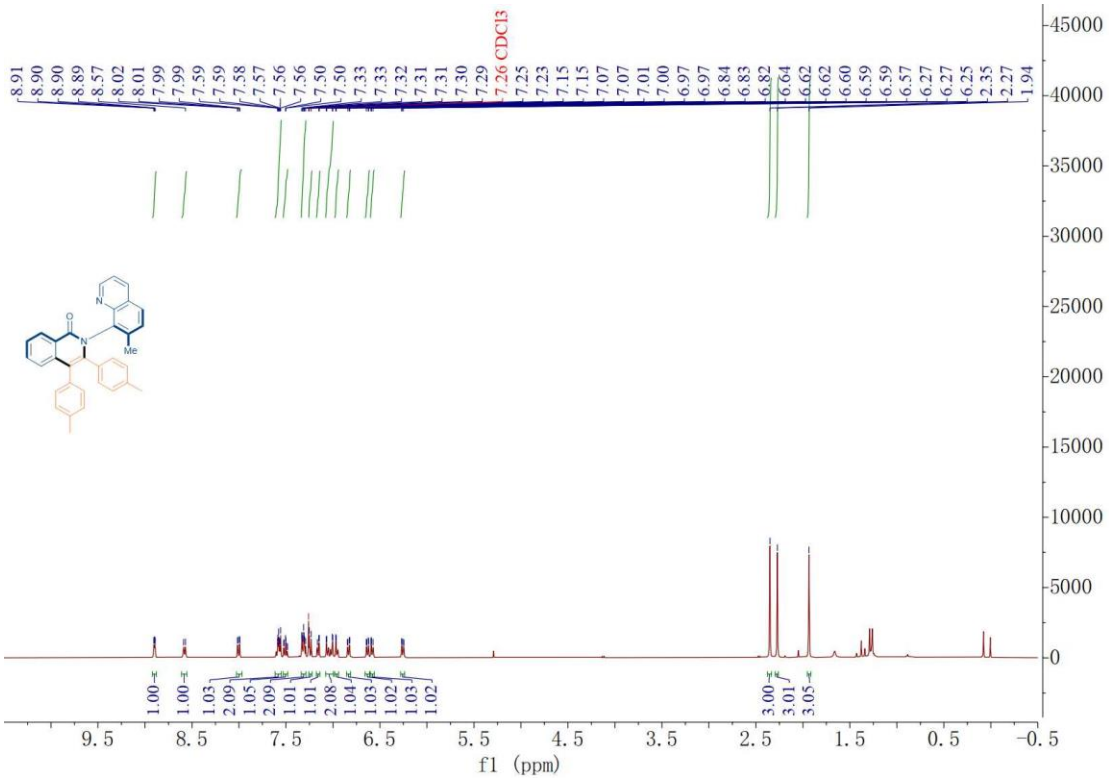
^{1}H NMR of 8b



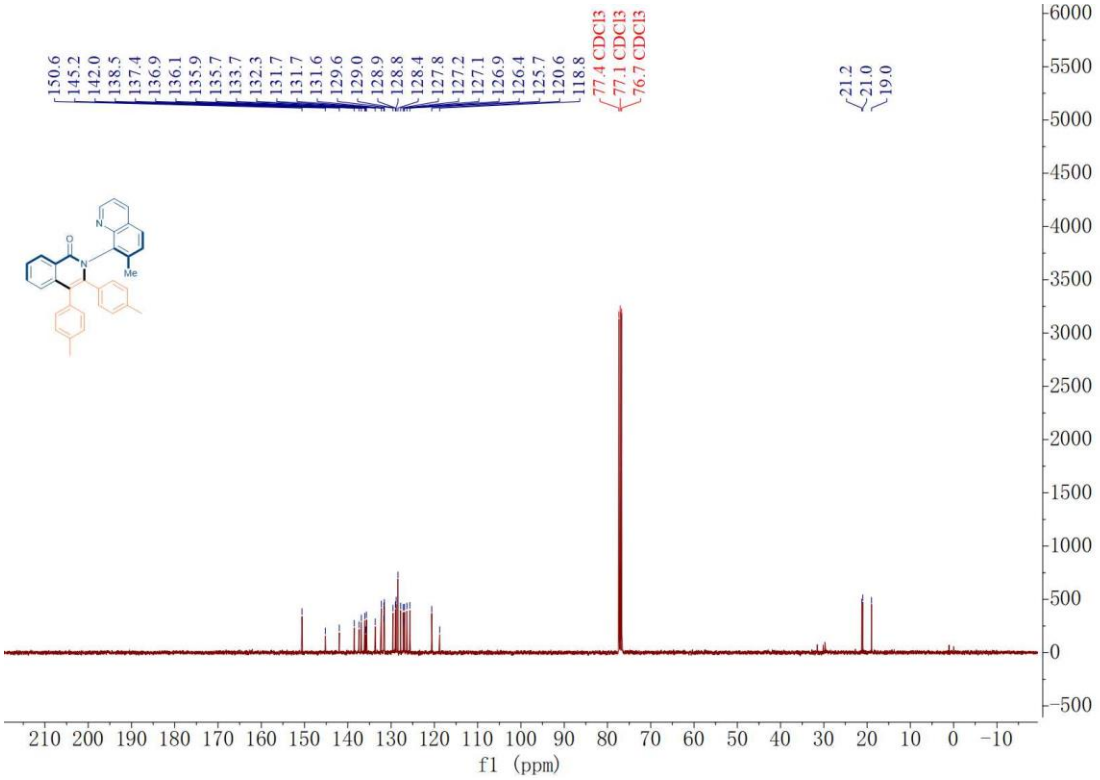
^{13}C NMR of 8b



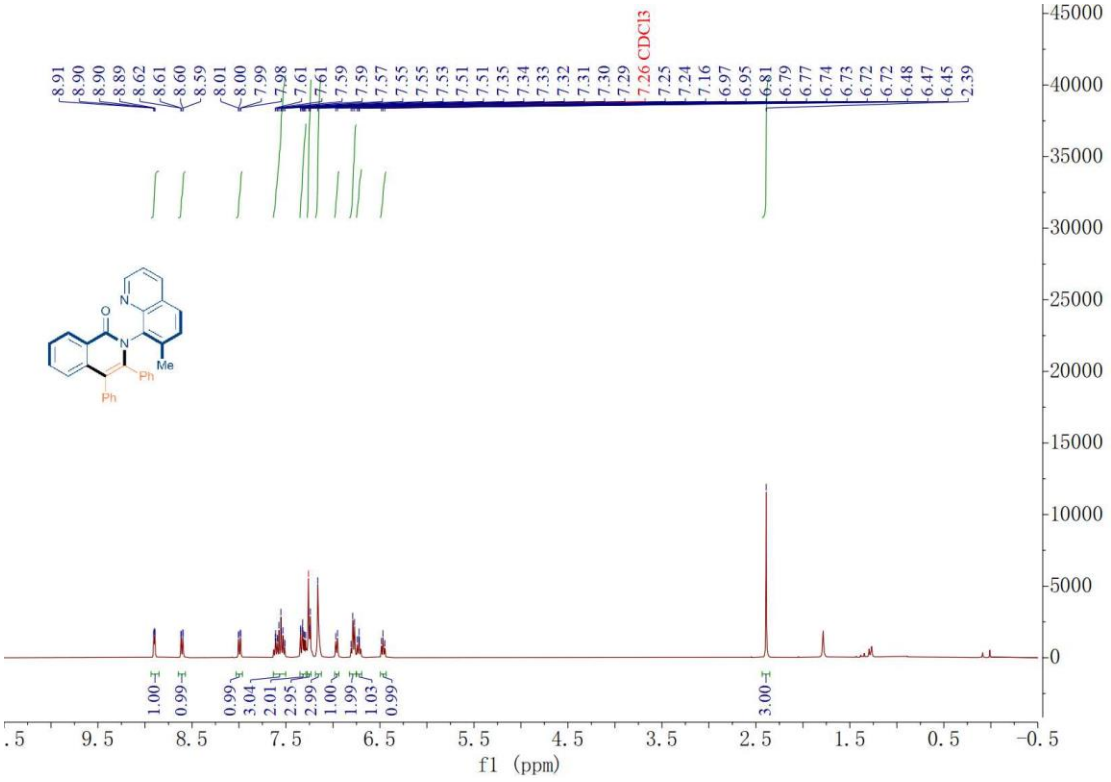
^{1}H NMR of 8c



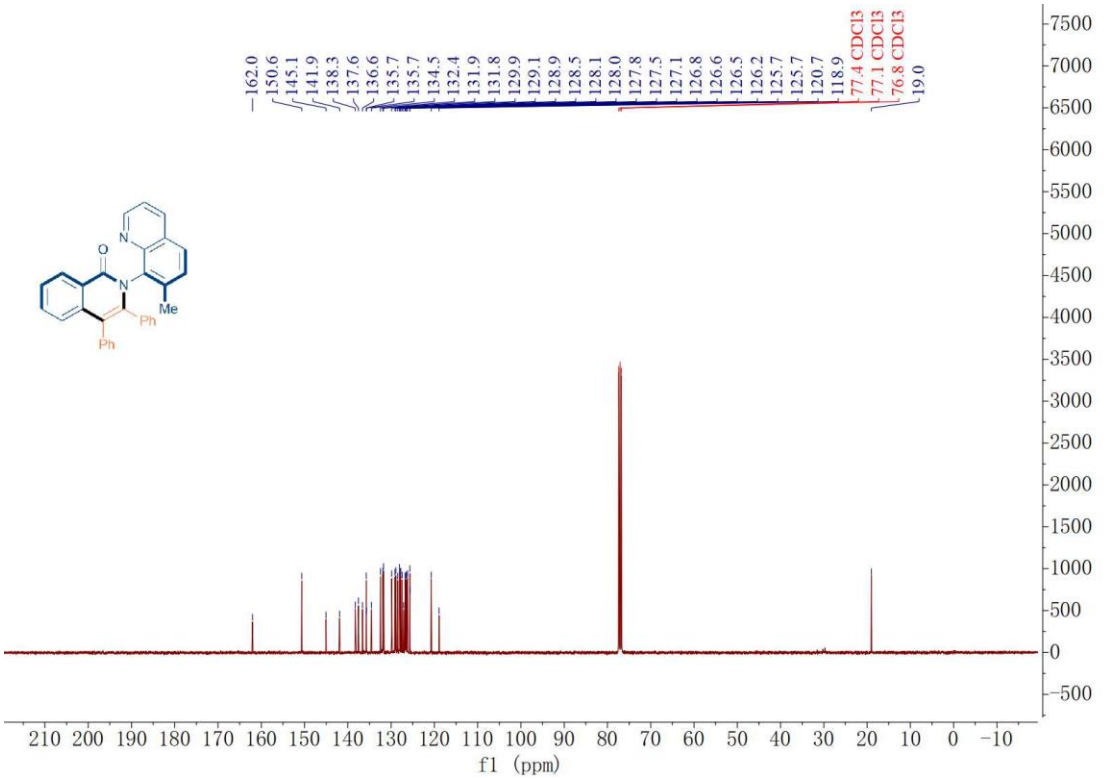
^{13}C NMR of 8c



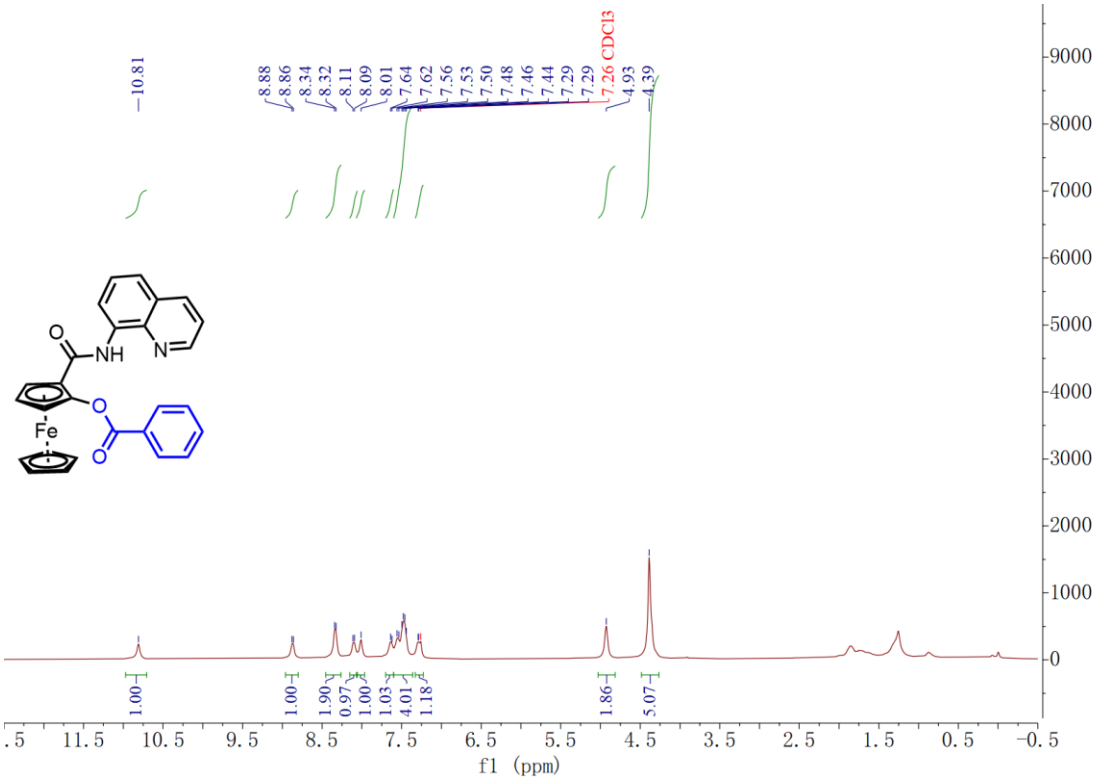
^{1}H NMR of 8d



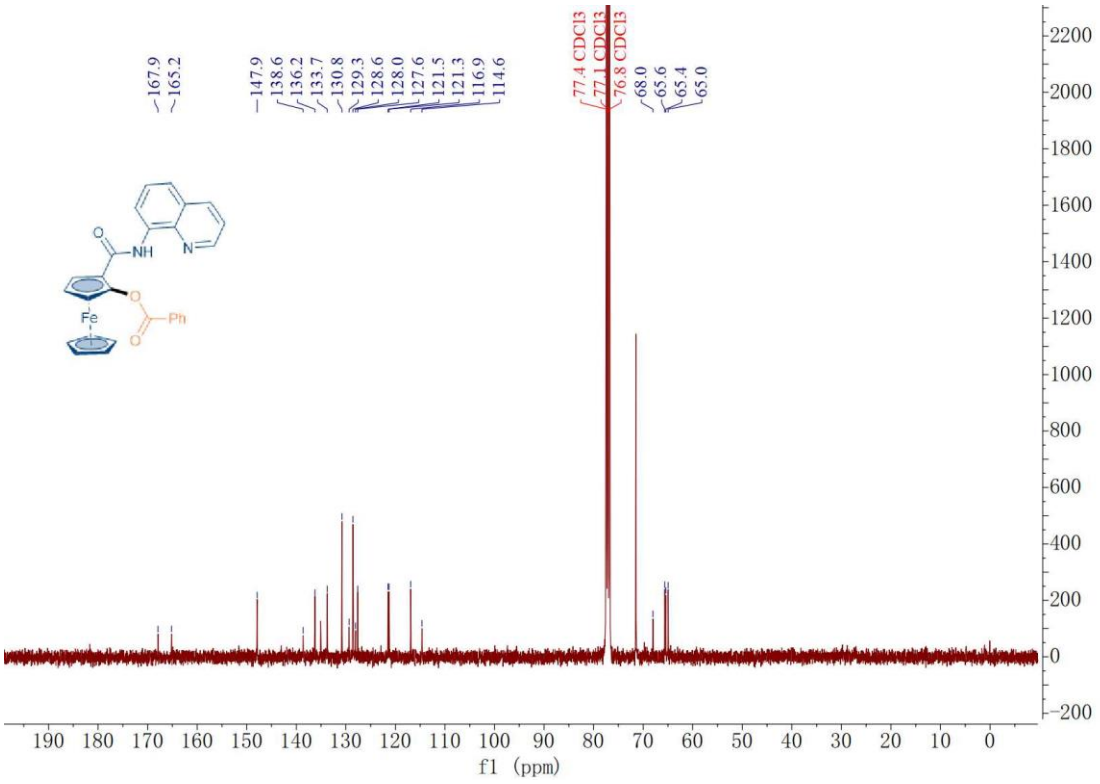
^{13}C NMR of 8d



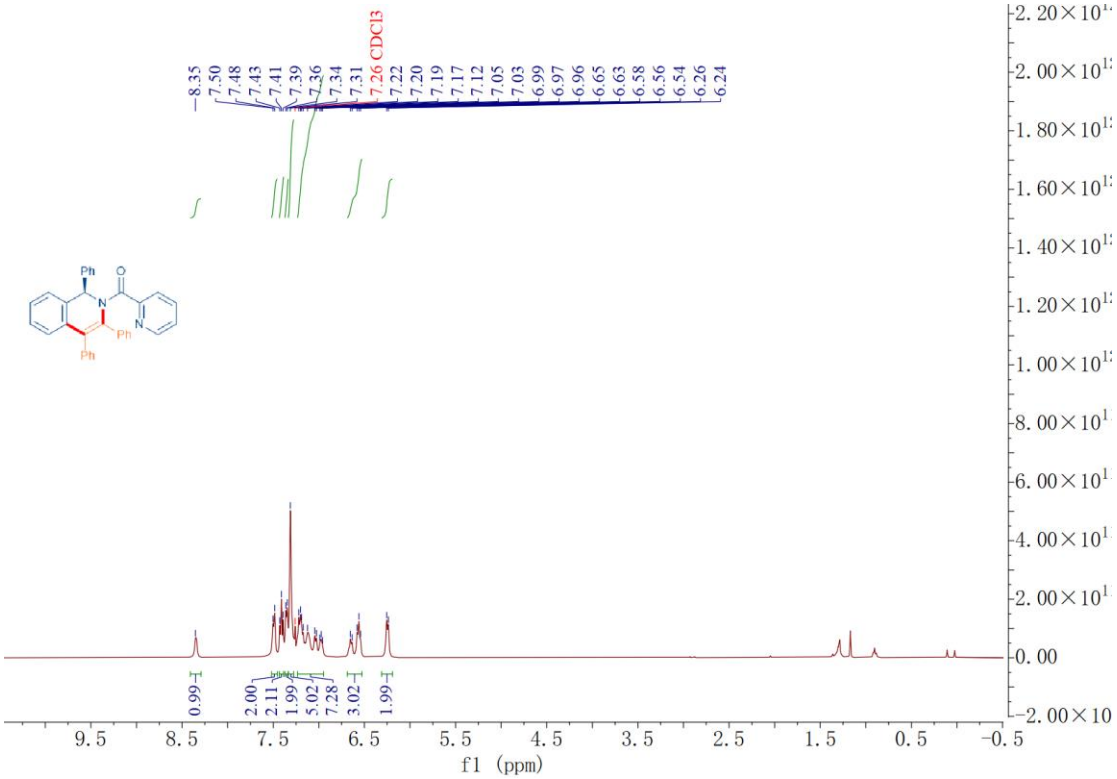
^{1}H NMR of 11a



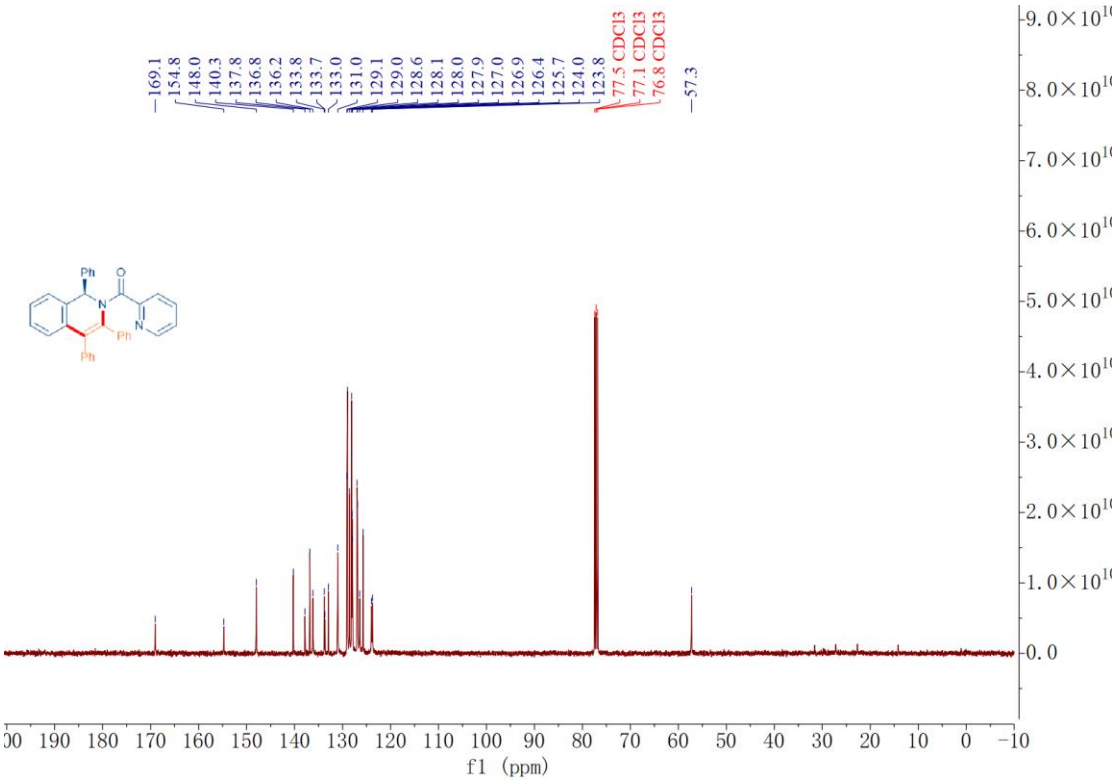
^{13}C NMR of 11a



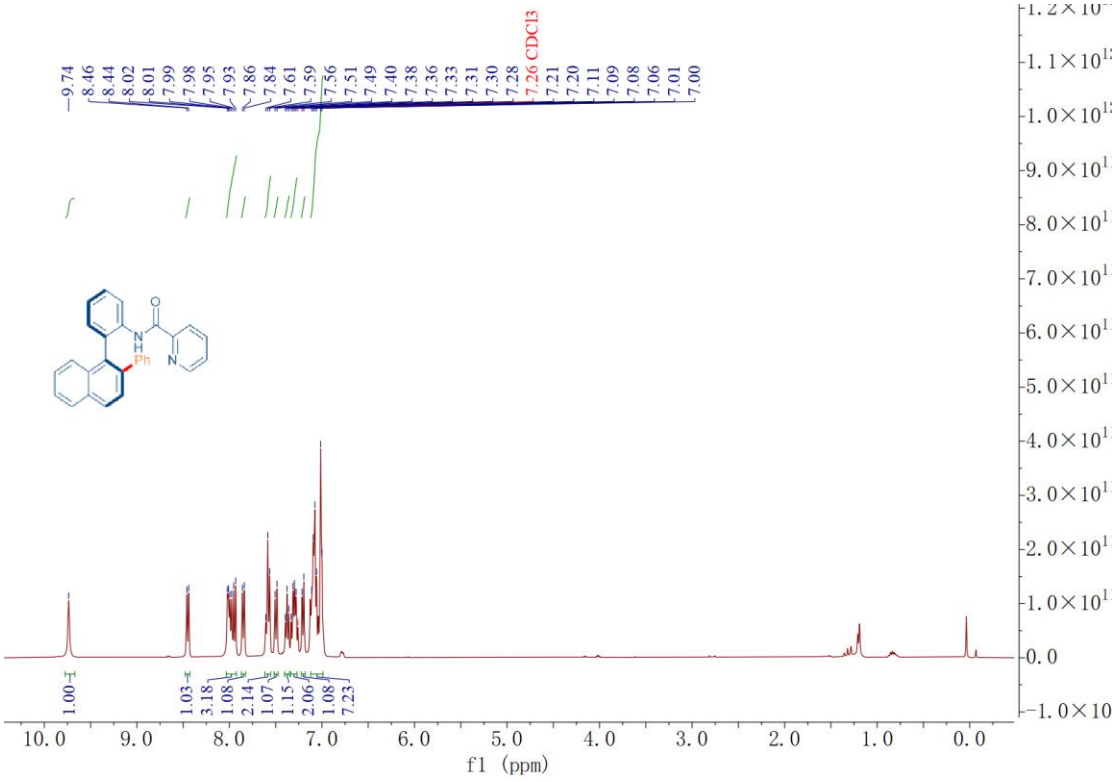
^{1}H NMR of 13a



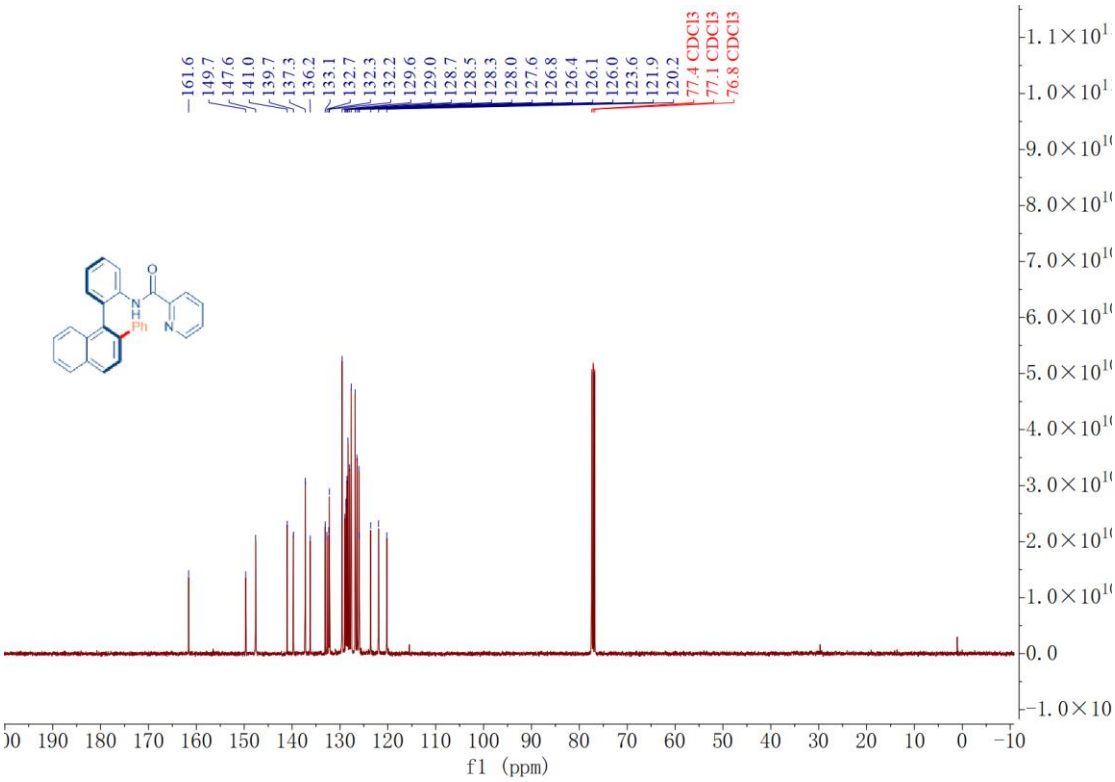
^{13}C NMR of 13a



^{1}H NMR of 16a

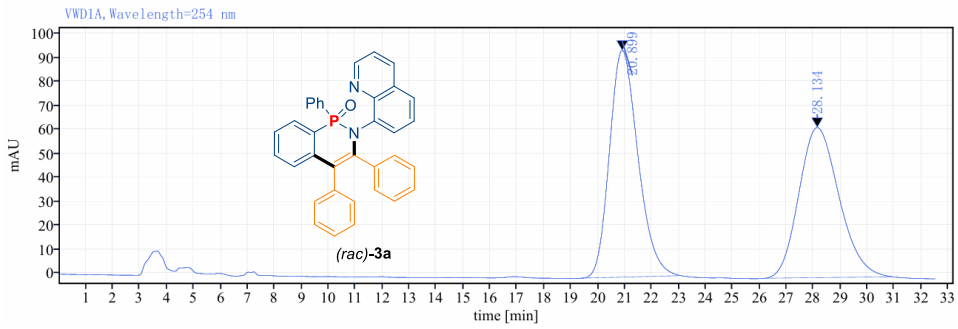


^{13}C NMR of 16a



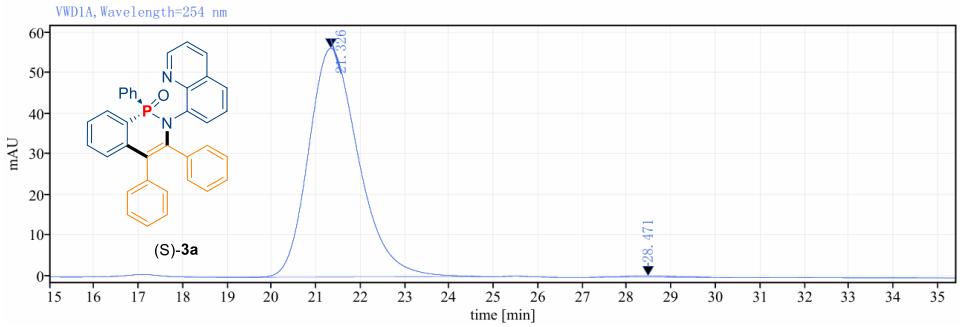
9. HPLC of products

HPLC spectra for racemic and chiral product **3a** (99% *ee*).



Signal VWD1A, Wavelength=254 nm

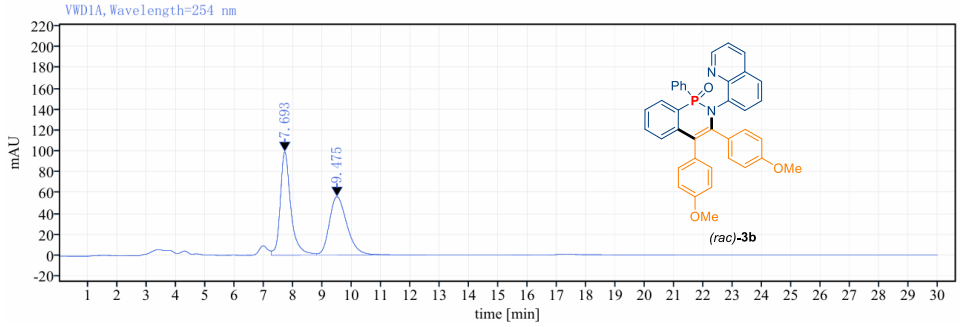
Ret. time [min]	Area	Height	Area%
20.899	6950.31	94.48	51.79
28.134	6469.27	62.55	48.21



Signal VWD1A, Wavelength=254 nm

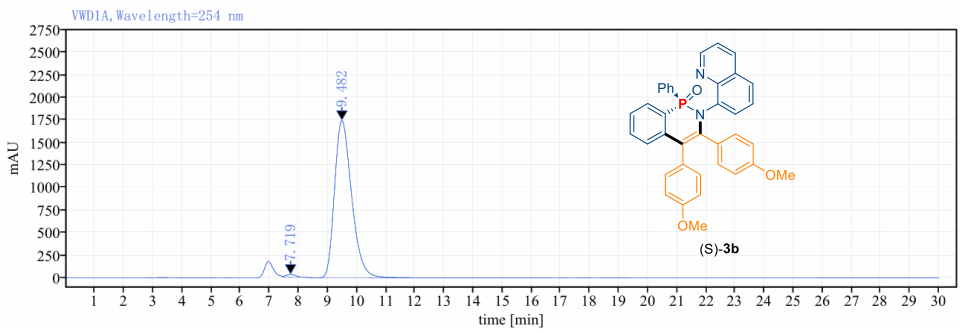
Ret. time [min]	Area	Height	Area%
21.326	4402.07	56.37	99.47
28.471	23.23	0.28	0.53

HPLC spectra for racemic and chiral product **3b** (98% *ee*).



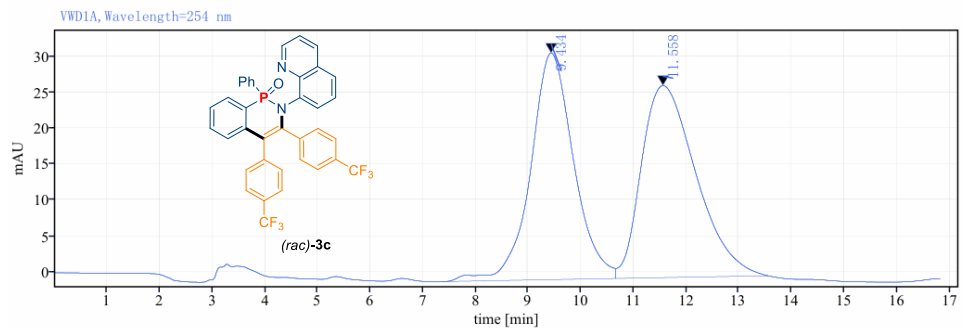
Signal VWD1A, Wavelength=254 nm

Ret. time [min]	Area	Height	Area%
7.693	2487.31	99.24	51.38
9.475	2353.86	56.06	48.62

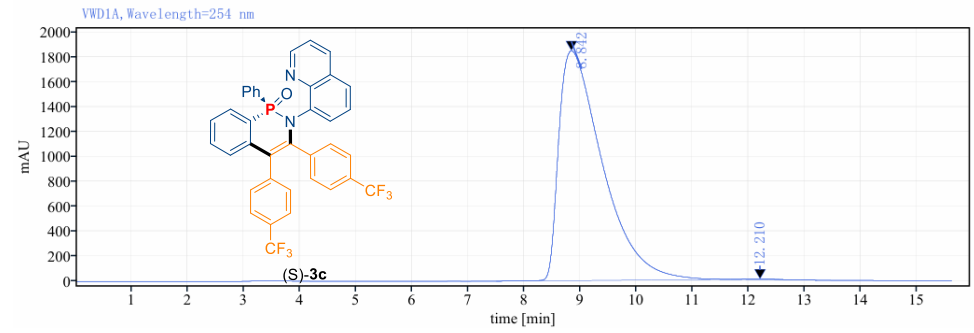


Signal	VWD1A, Wavelength=254 nm		
Ret. time [min]	Area	Height	Area%
7.719	649.15	30.97	0.90
9.482	71177.88	1745.21	99.10

HPLC spectra for racemic and chiral product **3c** (99% *ee*).

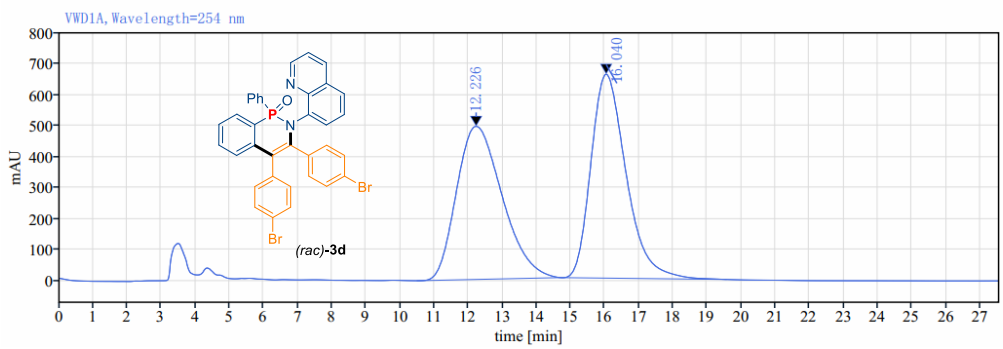


Signal	VWD1A, Wavelength=254 nm		
Ret. time [min]	Area	Height	Area%
9.434	1791.24	31.48	48.24
11.558	1922.29	26.69	51.76

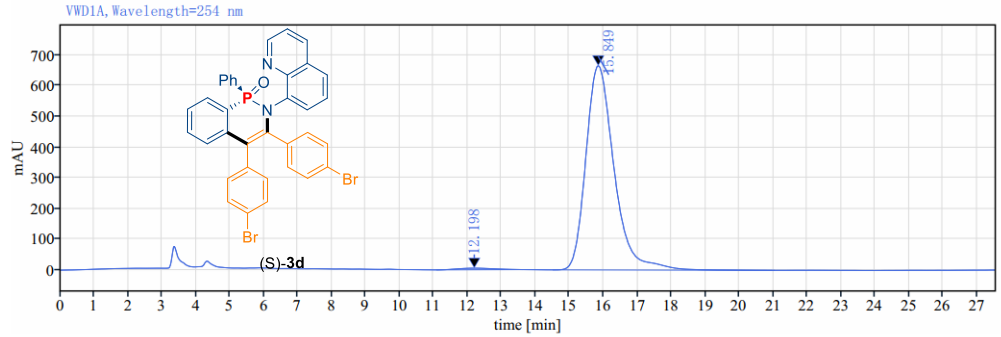


Signal	VWD1A, Wavelength=254 nm		
Ret. time [min]	Area	Height	Area%
8.842	99972.77	1842.34	99.79
12.210	205.78	4.26	0.21

HPLC spectra for racemic and chiral product **3d** (98% *ee*).

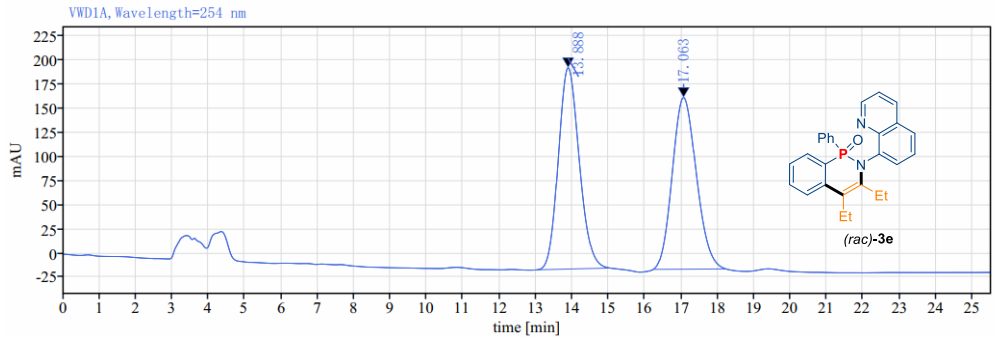


Signal	VWD1A, Wavelength=254 nm			
Ret. time [min]		Area	Height	Area%
12.226		45937.57	495.02	49.33
16.040		47187.55	659.25	50.67

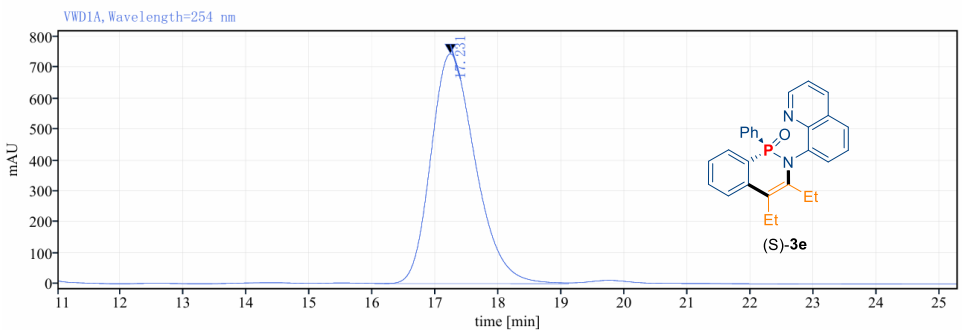


Signal	VWD1A, Wavelength=254 nm			
Ret. time [min]		Area	Height	Area%
12.198		380.35	5.11	0.99
15.849		38400.83	660.45	99.01

HPLC spectra for racemic and chiral product **3e** (99% *ee*).

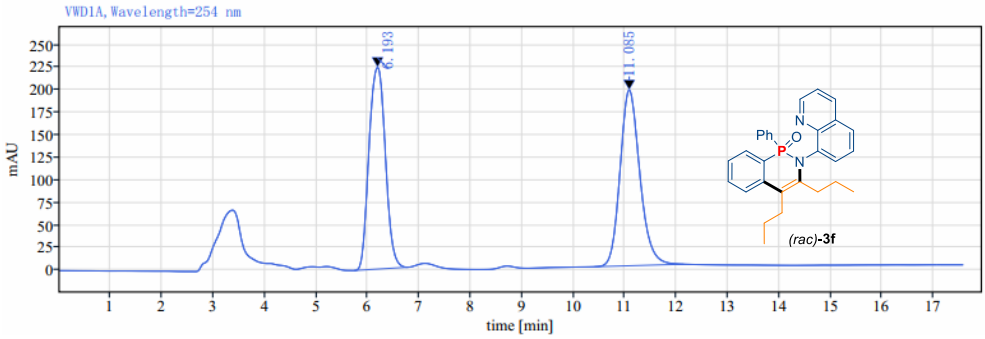


Signal	VWD1A, Wavelength=254 nm			
Ret. time [min]		Area	Height	Area%
13.888		8362.11	208.87	50.41
17.063		8226.43	178.08	49.59

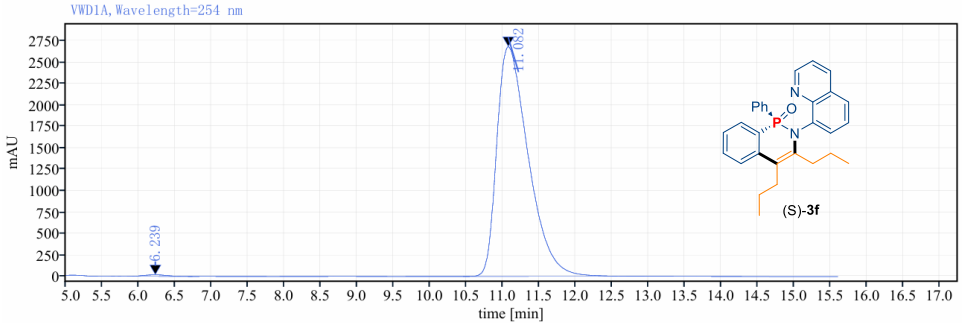


Signal	VWD1A, Wavelength=254 nm			
Ret. time [min]		Area	Height	Area%
17.231		36484.98	744.71	100.00

HPLC spectra for racemic and chiral product **3f** (99% *ee*).

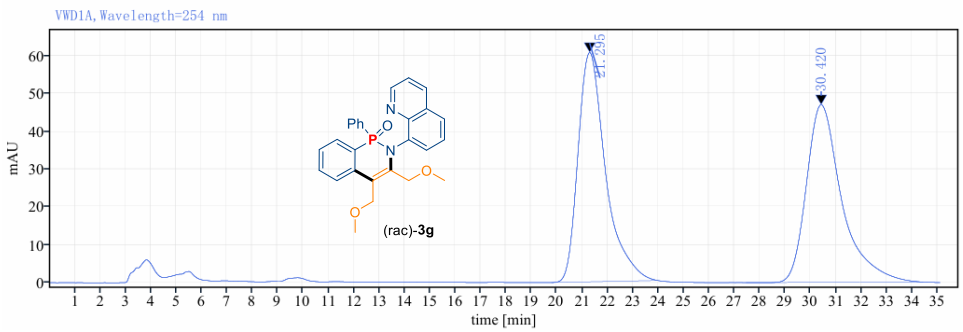


Signal	VWD1A, Wavelength=254 nm			
Ret. time [min]		Area	Height	Area%
6.193		4945.15	223.65	48.73
11.085		5203.57	194.83	51.27

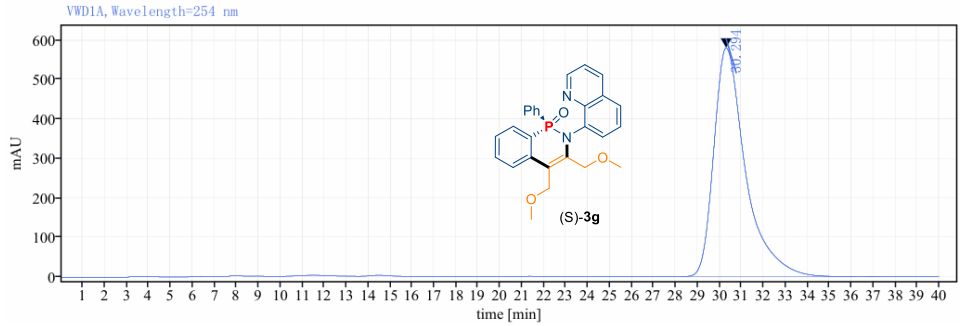


Signal	VWD1A, Wavelength=254 nm			
Ret. time [min]		Area	Height	Area%
6.239		420.80	18.52	0.52
11.082		80649.50	2686.88	99.48

HPLC spectra for racemic and chiral product **3g** (99% *ee*).

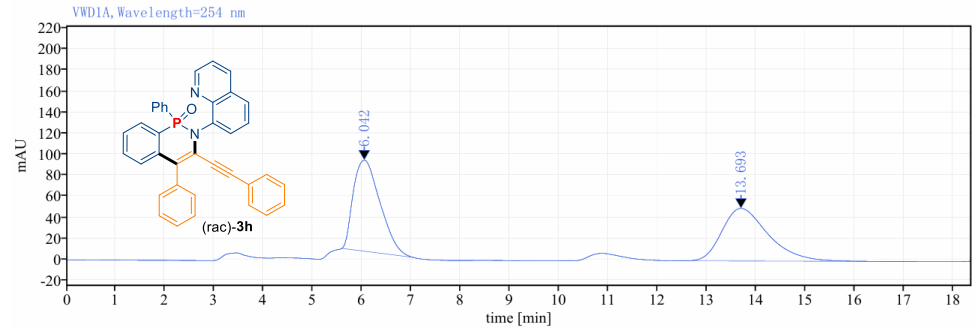


Signal	VWD1A, Wavelength=254 nm			
Ret. time [min]		Area	Height	Area%
21.295		4587.75	60.86	50.12
30.420		4565.18	47.14	49.88

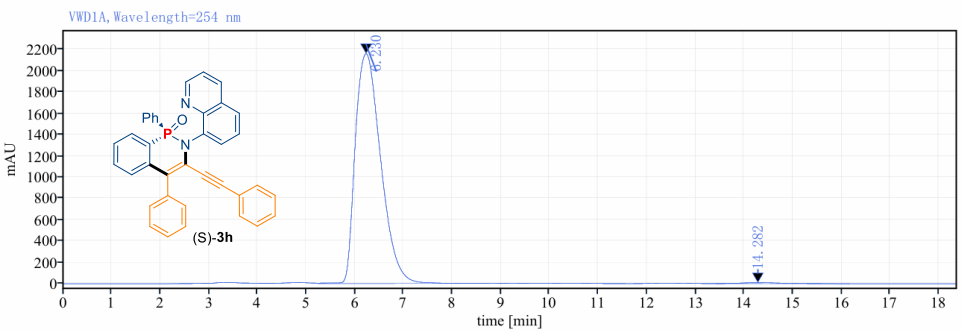


Signal	VWD1A, Wavelength=254 nm			
Ret. time [min]		Area	Height	Area%
30.294		57966.03	579.08	100.00

HPLC spectra for racemic and chiral product **3h** (99% *ee*).



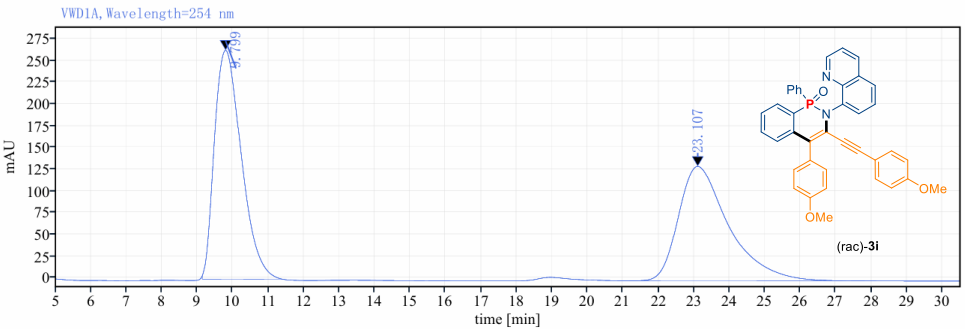
Signal	VWD1A, Wavelength=254 nm			
Ret. time [min]		Area	Height	Area%
6.042		3275.52	86.56	50.07
13.693		3265.88	50.02	49.93



Signal VWD1A, Wavelength=254 nm

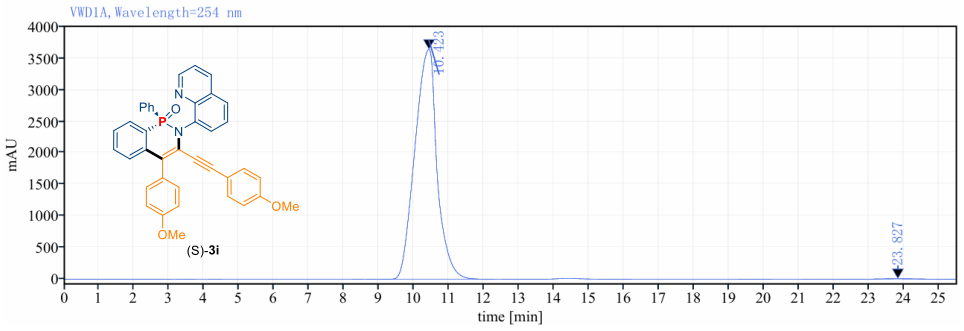
Ret. time [min]	Area	Height	Area%
6.230	78742.22	2163.19	99.31
14.282	548.75	9.51	0.69

HPLC spectra for racemic and chiral product **3i** (99% *ee*).



Signal VWD1A, Wavelength=254 nm

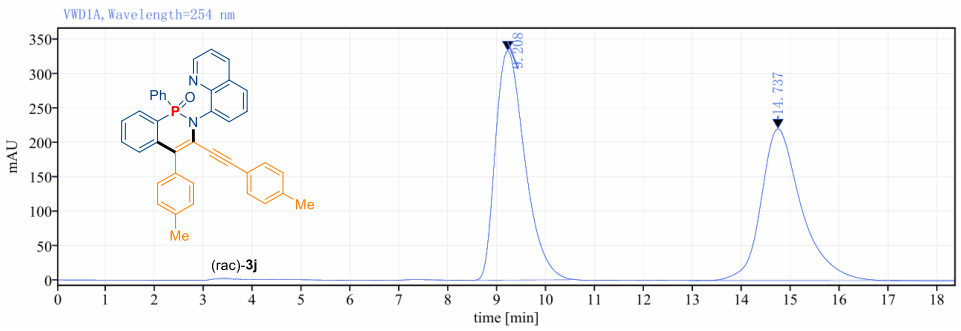
Ret. time [min]	Area	Height	Area%
9.799	13928.58	263.76	51.82
23.107	12948.55	131.72	48.18



Signal VWD1A, Wavelength=254 nm

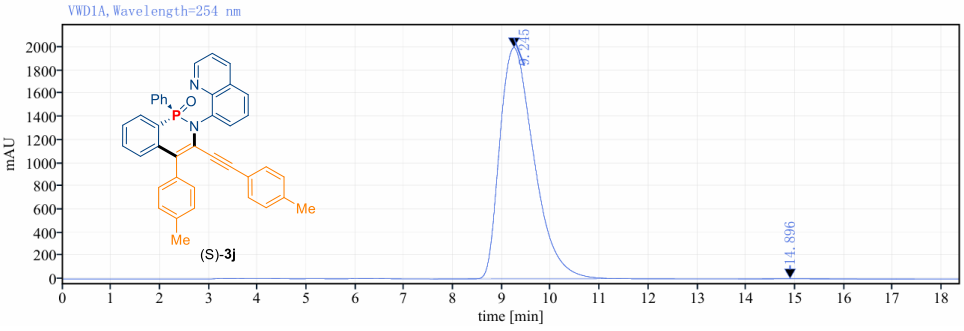
Ret. time [min]	Area	Height	Area%
10.423	160400.41	3637.87	99.46
23.827	863.13	8.61	0.54

HPLC spectra for racemic and chiral product **3j** (99% *ee*).



Signal VWD1A, Wavelength=254 nm

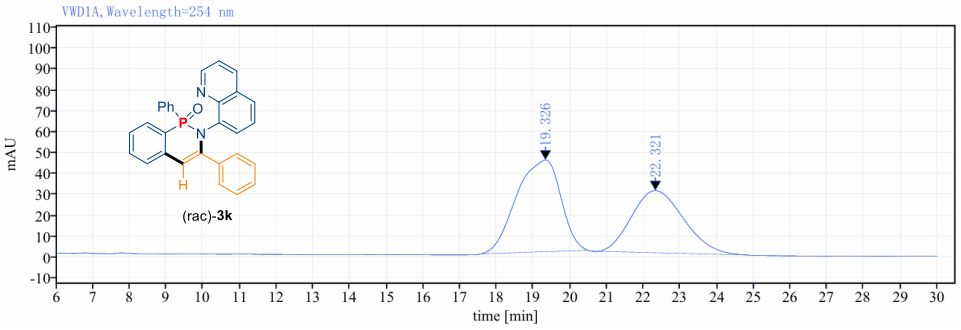
Ret. time [min]	Area	Height	Area%
9.208	13993.06	333.67	52.48
14.737	12668.97	220.95	47.52



Signal VWD1A, Wavelength=254 nm

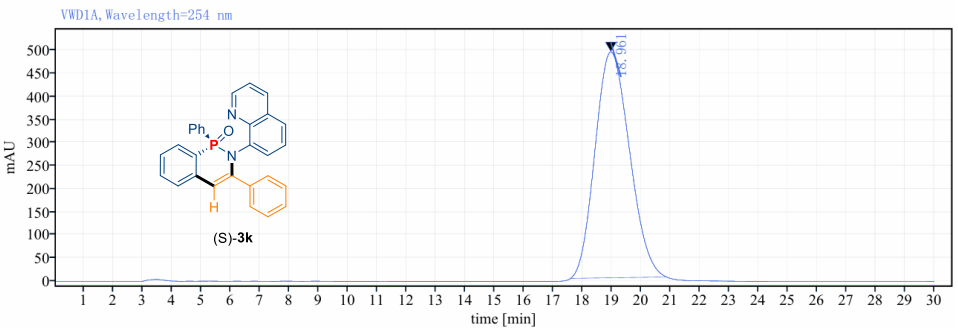
Ret. time [min]	Area	Height	Area%
9.245	97239.18	1996.89	99.88
14.896	114.94	2.00	0.12

HPLC spectra for racemic and chiral product **3k** (99% *ee*).



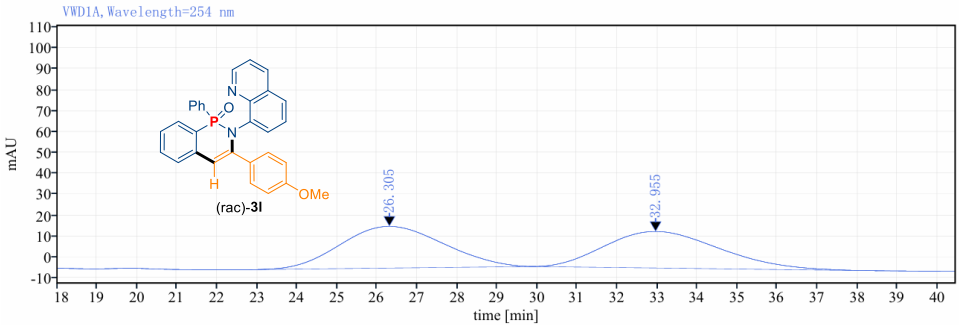
Signal VWD1A, Wavelength=254 nm

Ret. time [min]	Area	Height	Area%
19.326	3669.88	43.81	55.64
22.321	2925.54	29.70	44.36

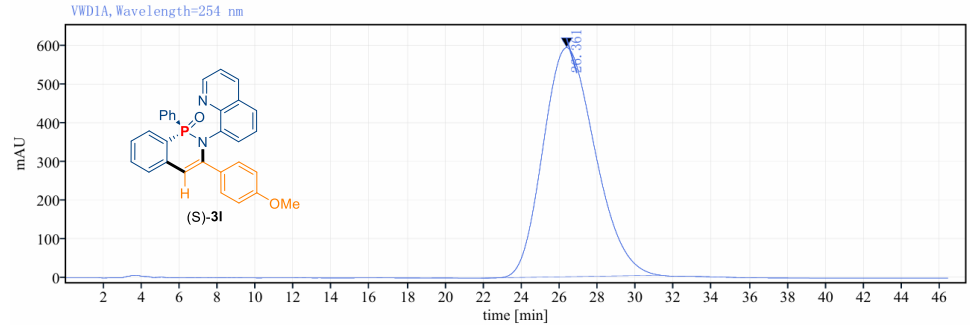


Signal	VWD1A, Wavelength=254 nm			
Ret. time [min]		Area	Height	Area%
	18.961	39986.74	489.92	100.00

HPLC spectra for racemic and chiral product **3l** (99% *ee*).

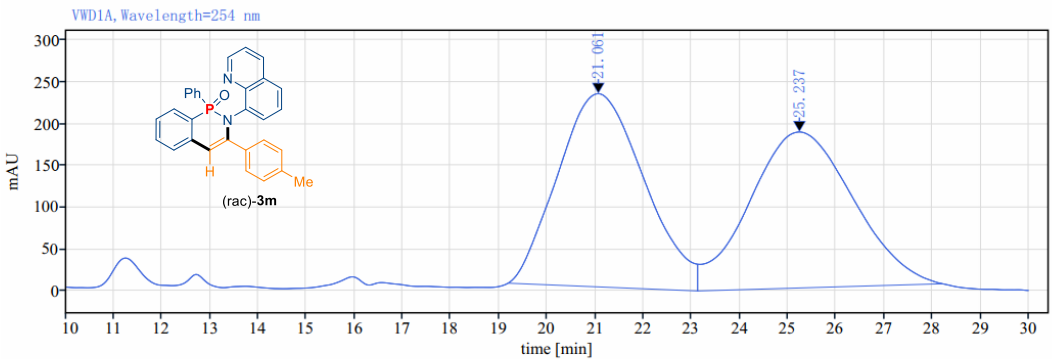


Signal	VWD1A, Wavelength=254 nm			
Ret. time [min]		Area	Height	Area%
	26.305	3568.38	19.98	50.53
	32.955	3492.85	17.46	49.47

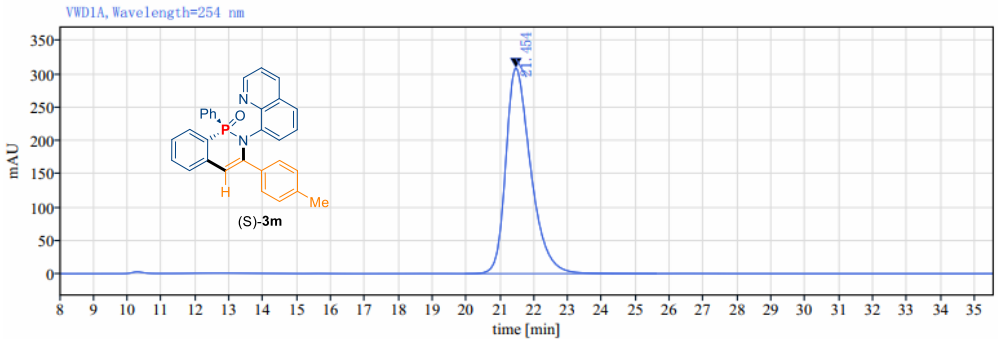


Signal	VWD1A, Wavelength=254 nm			
Ret. time [min]		Area	Height	Area%
	26.361	112185.11	590.92	100.00

HPLC spectra for racemic and chiral product **3m** (99% *ee*).

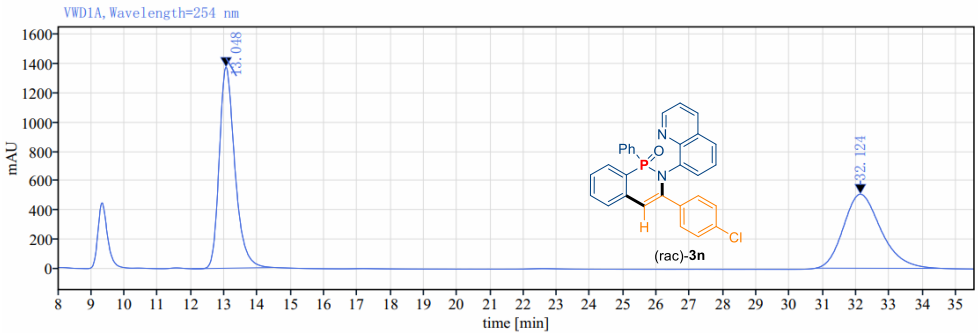


Signal	VWD1A, Wavelength=254 nm		
Ret. time [min]	Area	Height	Area%
21.061	28802.61	230.12	50.77
25.237	27931.50	18.67	49.23

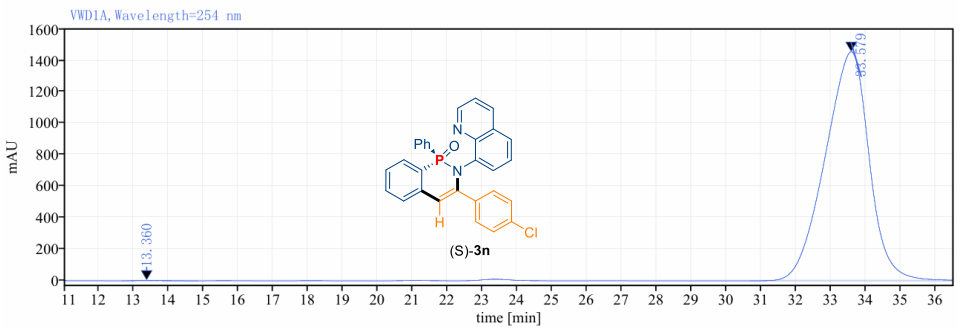


Signal	VWD1A, Wavelength=254 nm		
Ret. time [min]	Area	Height	Area%
21.454	15813.29	308.05	100.00

HPLC spectra for racemic and chiral product **3n** (99% *ee*).

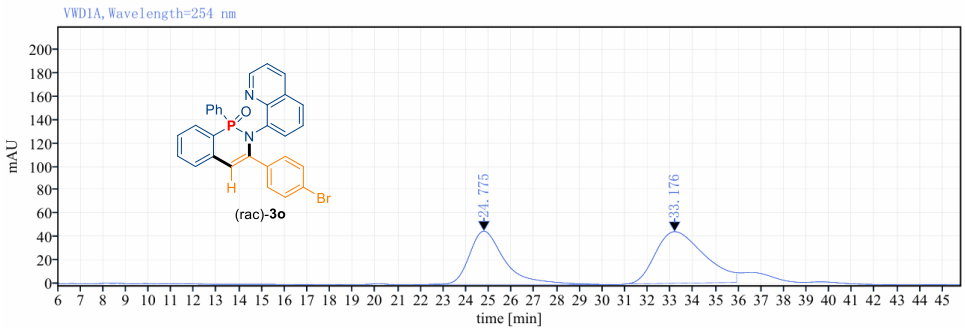


Signal	VWD1A, Wavelength=254 nm		
Ret. time [min]	Area	Height	Area%
13.048	44812.42	1373.27	53.14
32.124	39521.27	502.58	46.86

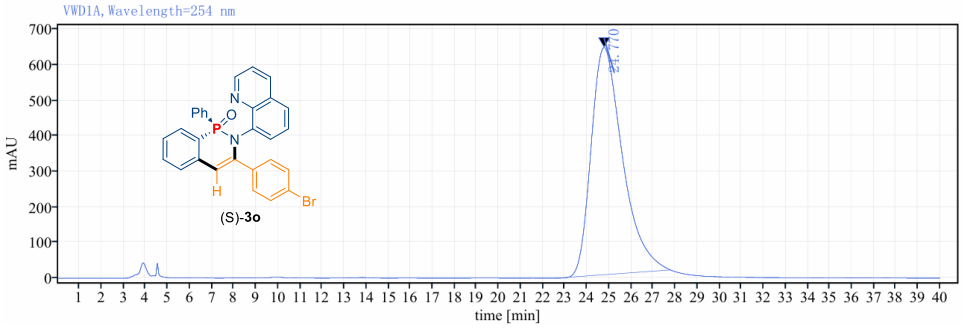


Signal	VWD1A, Wavelength=254 nm			
Ret. time [min]		Area	Height	Area%
13.360		127.52	3.48	0.10
33.579		128381.82	1455.44	99.90

HPLC spectra for racemic and chiral product **3o** (99% *ee*).

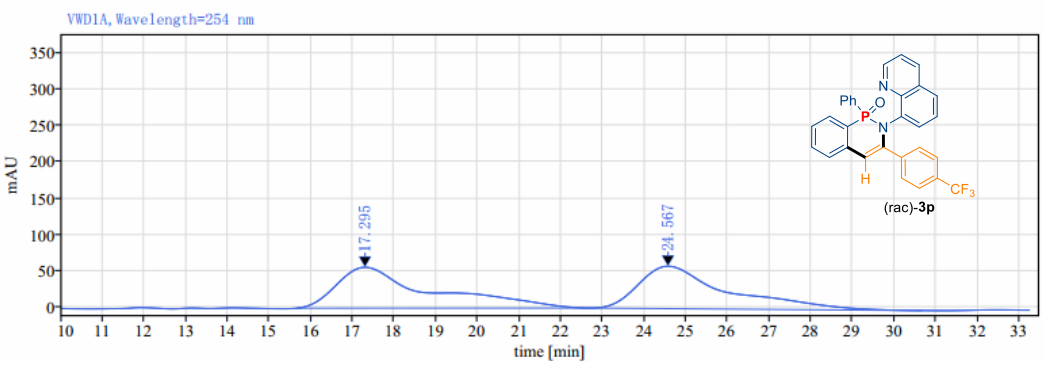


Signal	VWD1A, Wavelength=254 nm			
Ret. time [min]		Area	Height	Area%
24.775		4902.85	45.62	42.60
33.176		6606.02	44.25	57.40



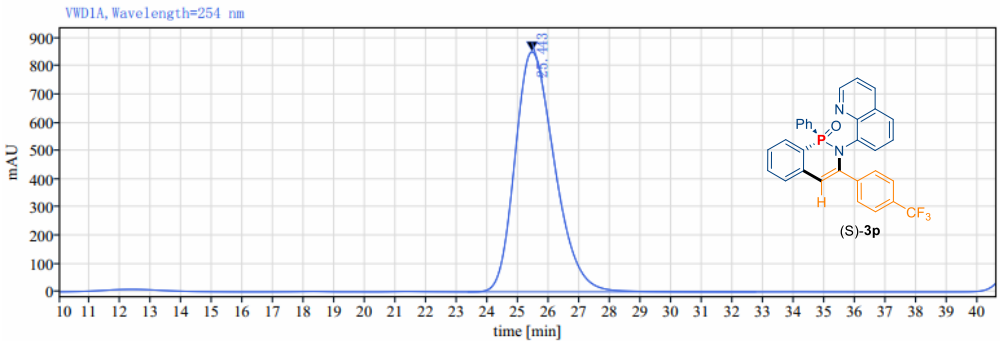
Signal	VWD1A, Wavelength=254 nm			
Ret. time [min]		Area	Height	Area%
24.770		63287.96	639.30	100.00

HPLC spectra for racemic and chiral product **3p** (99% *ee*).



Signal VWD1A, Wavelength=254 nm

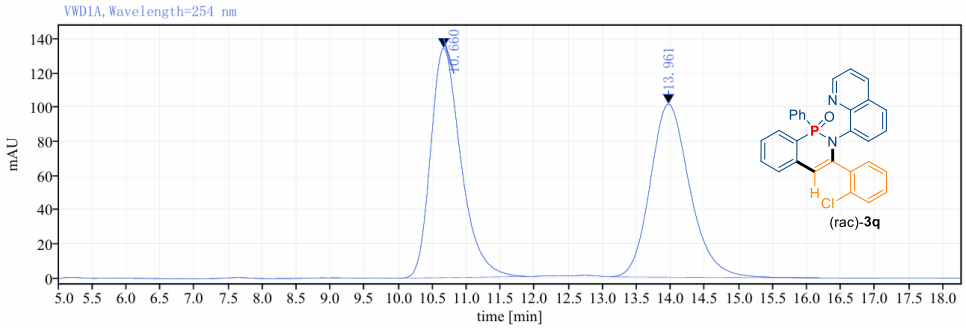
Ret. time [min]	Area	Height	Area%
17.295	8784.40	56.23	50.65
24.567	8557.38	58.28	49.35



Signal VWD1A, Wavelength=254 nm

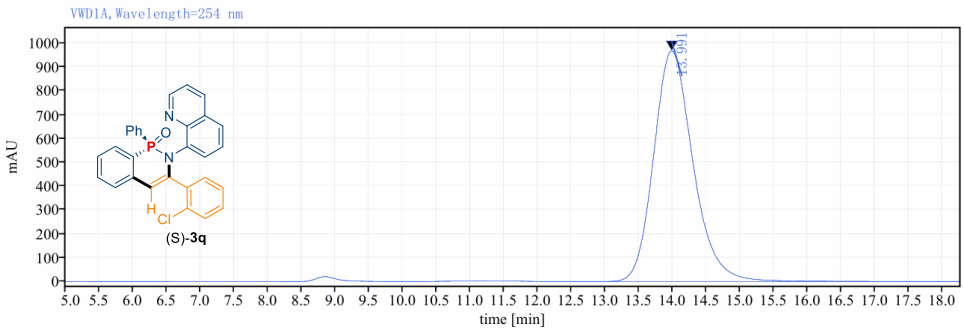
Ret. time [min]	Area	Height	Area%
25.443	76515.41	851.35	100.00

HPLC spectra for racemic and chiral product **3q** (99% *ee*).



Signal VWD1A, Wavelength=254 nm

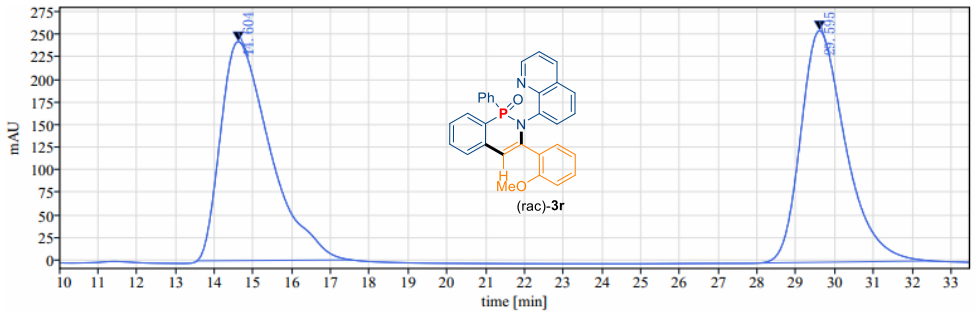
Ret. time [min]	Area	Height	Area%
10.660	4154.82	134.44	50.39
13.961	4090.02	101.35	49.61



Signal VWD1A, Wavelength=254 nm

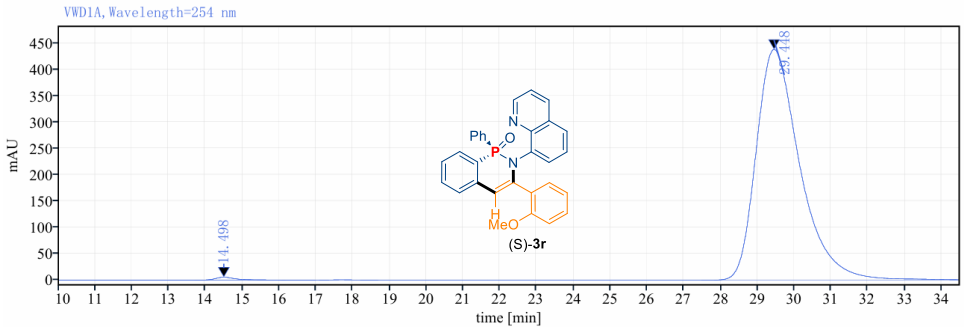
Ret. time [min]	Area	Height	Area%
13.991	39386.49	970.01	100.00

HPLC spectra for racemic and chiral product **3r** (99% *ee*).



Signal VWD1A, Wavelength=254 nm

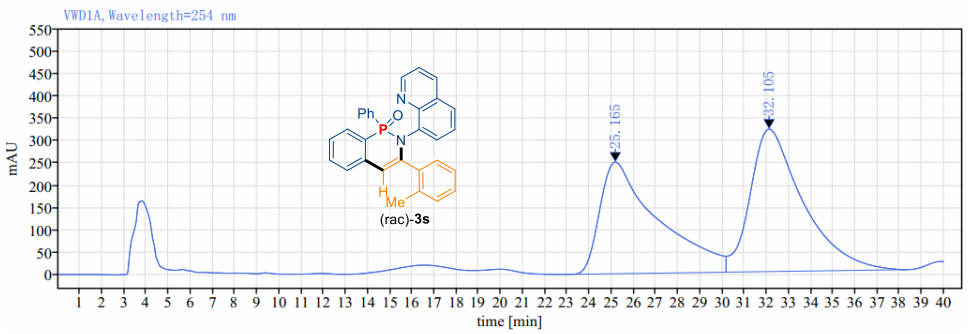
Ret. time [min]	Area	Height	Area%
14.604	21509.91	242.25	51.16
29.595	20536.74	256.18	48.84



Signal VWD1A, Wavelength=254 nm

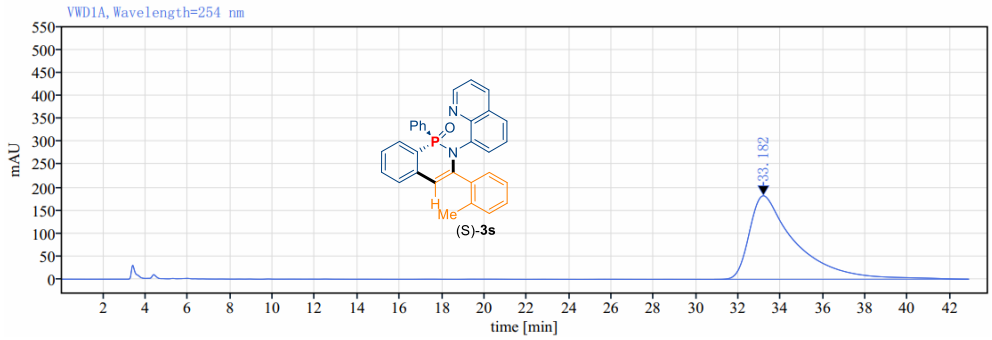
Ret. time [min]	Area	Height	Area%
14.498	208.08	5.52	0.57
29.448	36298.99	438.58	99.43

HPLC spectra for racemic and chiral product **3s** (99% *ee*).



Signal VWD1A, Wavelength=254 nm

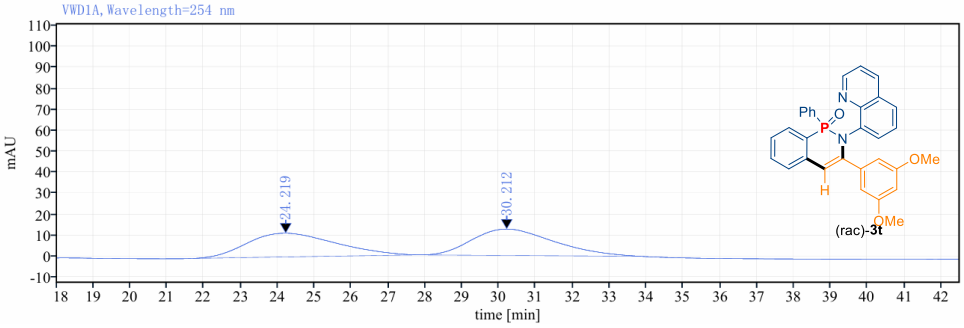
Ret. time [min]	Area	Height	Area%
25.165	45765.54	250.69	46.34
32.105	53002.98	320.07	53.66



Signal VWD1A, Wavelength=254 nm

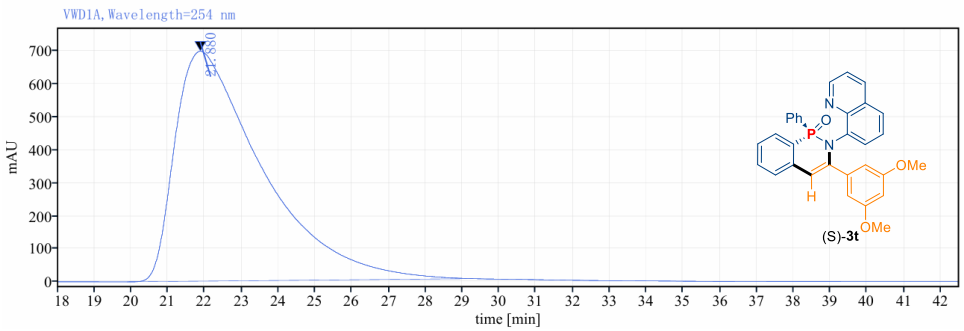
Ret. time [min]	Area	Height	Area%
33.182	27642.24	182.72	100.00

HPLC spectra for racemic and chiral product **3t** (99% *ee*).



Signal VWD1A, Wavelength=254 nm

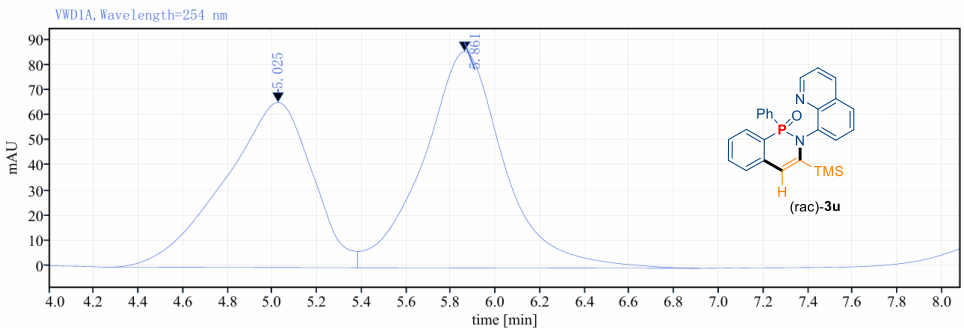
Ret. time [min]	Area	Height	Area%
24.219	1893.29	11.32	49.35
30.212	1942.98	12.54	50.65



Signal VWD1A, Wavelength=254 nm

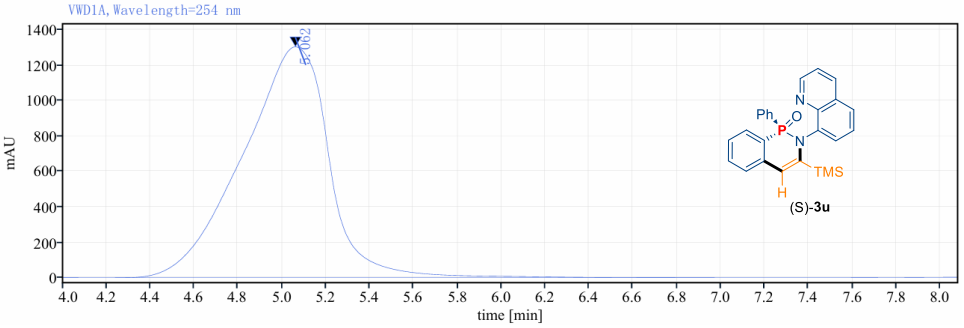
Ret. time [min]	Area	Height	Area%
21.880	115089.42	698.88	100.00

HPLC spectra for racemic and chiral product **3u** (99% *ee*).



Signal VWD1A, Wavelength=254 nm

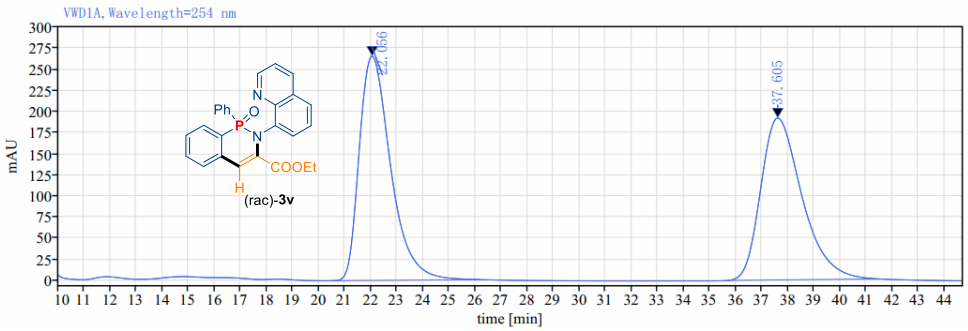
Ret. time [min]	Area	Height	Area%
5.025	1804.73	65.86	45.37
5.861	2172.81	86.29	54.63



Signal VWD1A, Wavelength=254 nm

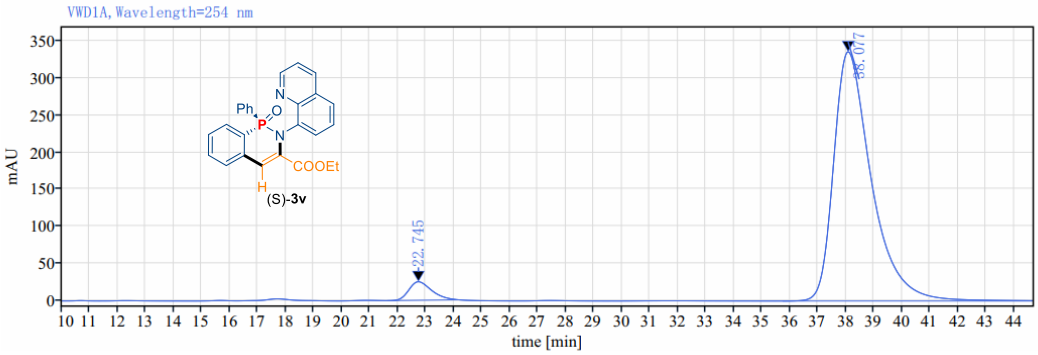
Ret. time [min]	Area	Height	Area%
5.062	35846.72	1303.49	100.00

HPLC spectra for racemic and chiral product **3v** (91% *ee*).



Signal VWD1A, Wavelength=254 nm

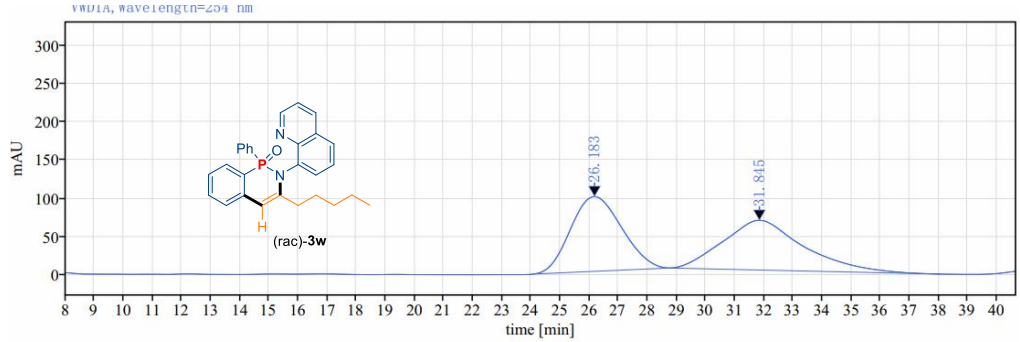
Ret. time [min]	Area	Height	Area%
22.056	22233.59	265.67	51.35
37.605	21067.07	191.75	48.65



Signal VWD1A, Wavelength=254 nm

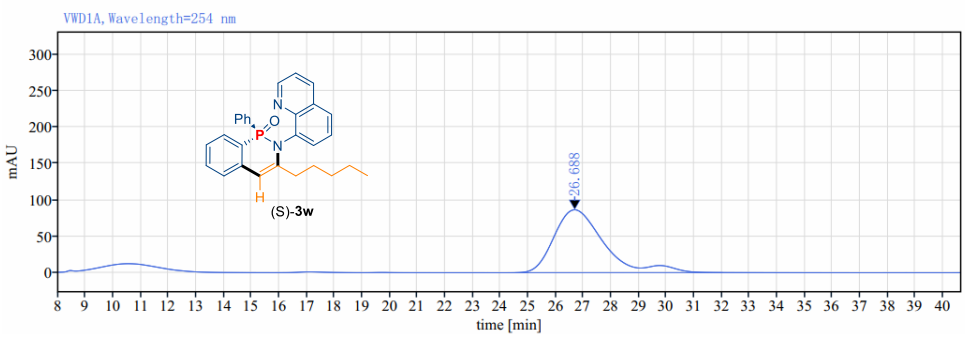
Ret. time [min]	Area	Height	Area%
22.745	1417.59	25.09	4.30
38.077	31584.26	337.27	95.70

HPLC spectra for racemic and chiral product **3w** (99% *ee*).



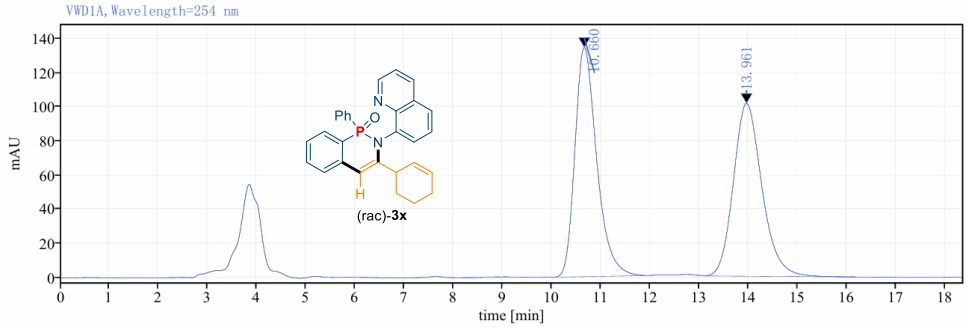
Signal VWD1A, Wavelength=254 nm

Ret. time [min]	Area	Height	Area%
26.183	11941.33	98.07	48.75
31.845	12551.58	65.16	51.25

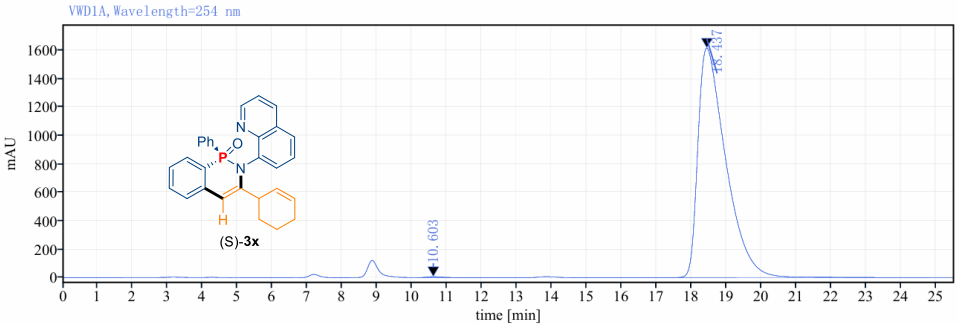


Signal	VWD1A, Wavelength=254 nm		
Ret. time [min]	Area	Height	Area%
26.688	10885.69	86.73	100.00

HPLC spectra for racemic and chiral product **3x** (99% *ee*).

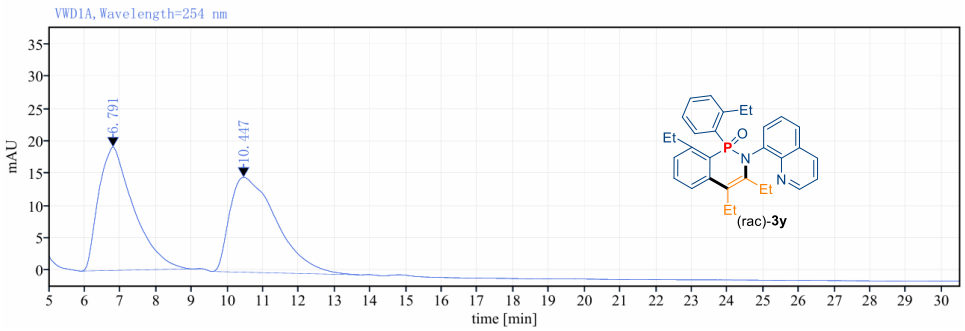


Signal	VWD1A, Wavelength=254 nm		
Ret. time [min]	Area	Height	Area%
10.660	4154.82	134.44	50.39
13.961	4090.02	101.35	49.61

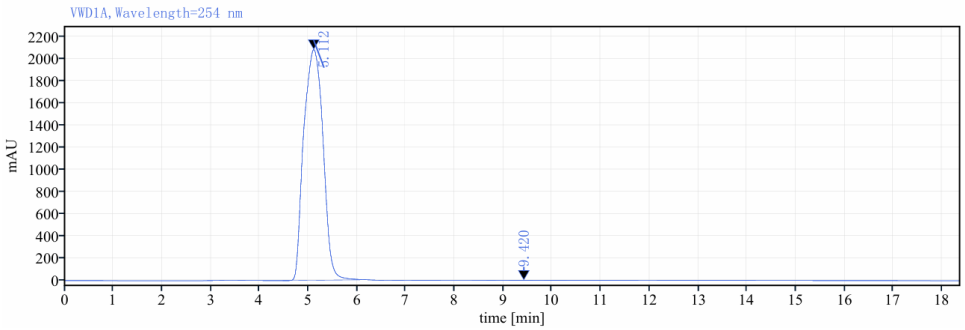


Signal	VWD1A, Wavelength=254 nm		
Ret. time [min]	Area	Height	Area%
10.603	212.62	7.31	0.24
18.437	89376.66	1616.80	99.76

HPLC spectra for racemic and chiral product **3y** (99% *ee*).

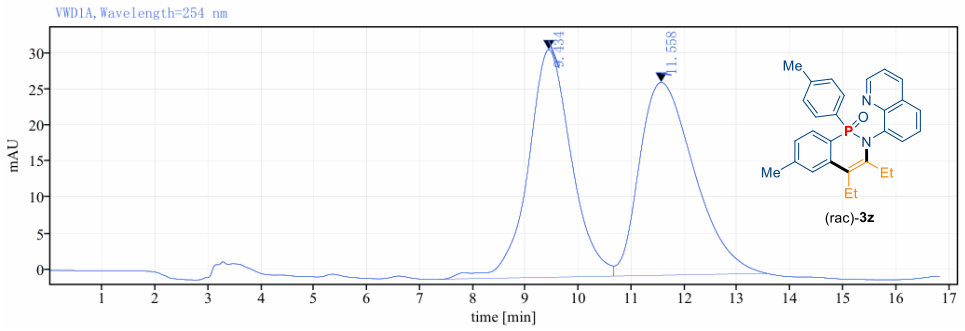


Signal	VWD1A, Wavelength=254 nm			
Ret. time [min]	Area	Height	Area%
6.791	1300.51	19.09	49.25
10.447	1340.37	14.68	50.75

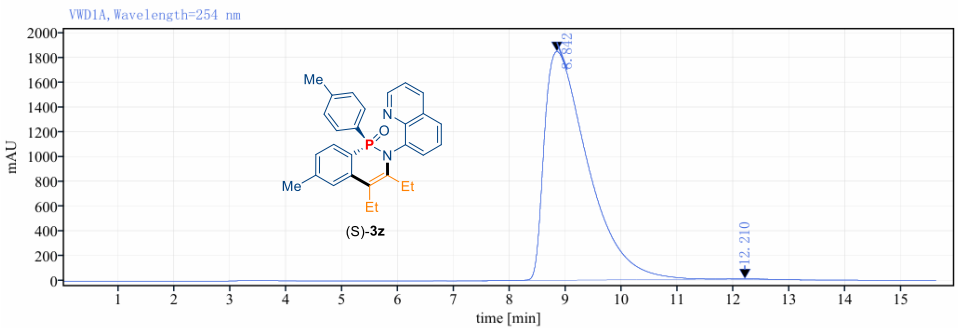


Signal	VWD1A, Wavelength=254 nm			
Ret. time [min]	Area	Height	Area%
5.112	57282.27	2080.31	99.81
9.420	108.57	2.16	0.19

HPLC spectra for racemic and chiral product **3z** (99% *ee*).



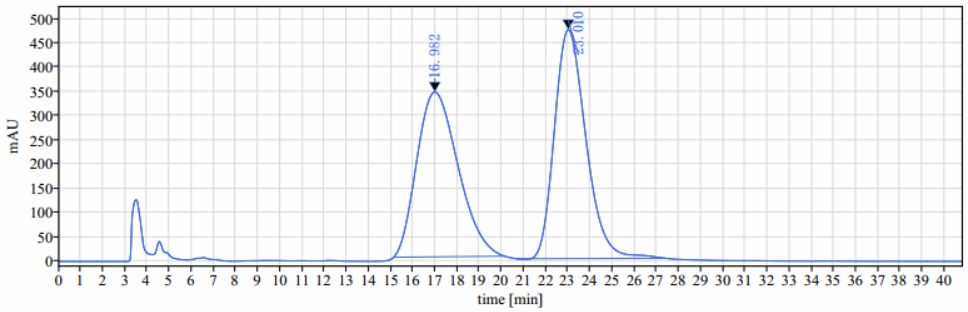
Signal	VWD1A, Wavelength=254 nm			
Ret. time [min]	Area	Height	Area%
9.434	1791.24	31.48	48.24
11.558	1922.29	26.69	51.76



Signal VWD1A, Wavelength=254 nm

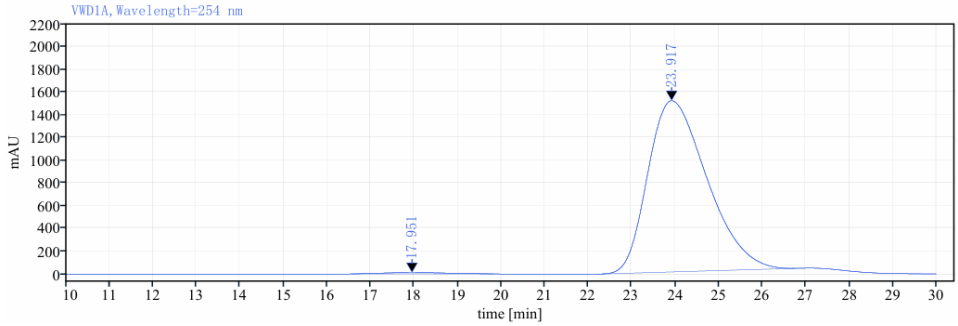
Ret. time [min]	Area	Height	Area%
8.842	99972.77	1842.34	99.79
12.210	205.78	4.26	0.21

HPLC spectra for racemic and chiral product **3aa** (98% *ee*).



Signal VWD1A, Wavelength=254 nm

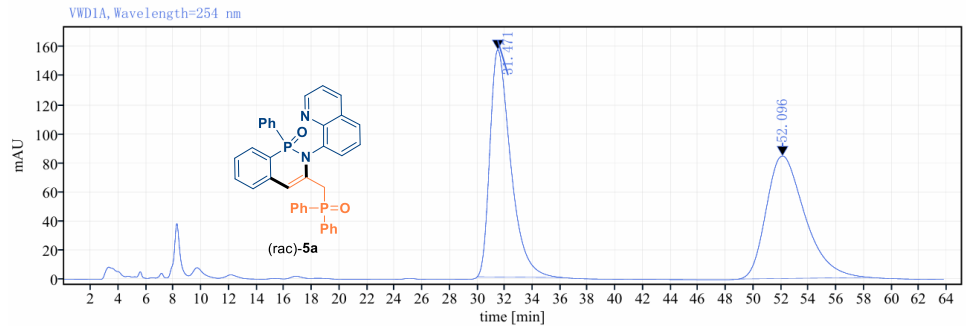
Ret. time [min]	Area	Height	Area%
16.982	44024.94	340.04	48.58
23.010	46597.34	472.11	51.42



Signal VWD1A, Wavelength=254 nm

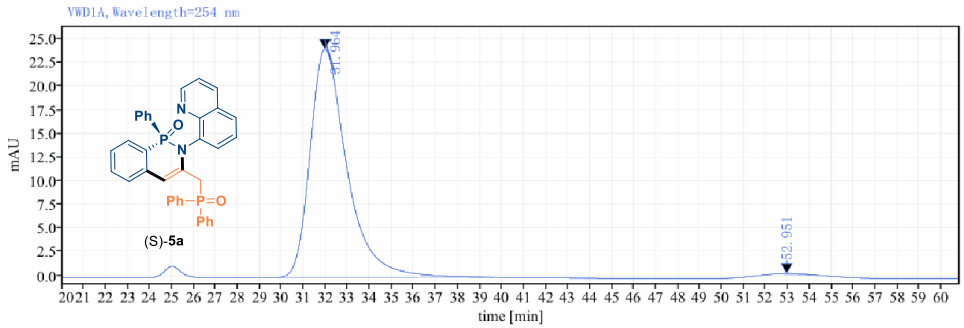
Ret. time [min]	Area	Height	Area%
17.951	1265.53	11.88	0.88
23.917	142068.47	1507.99	99.12

HPLC spectra for racemic and chiral product **5a** (99% *ee*).



Signal VWD1A, Wavelength=254 nm

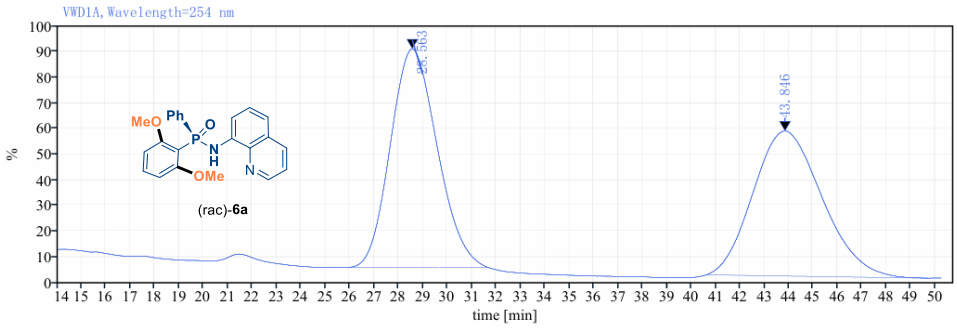
Ret. time [min]	Area	Height	Area%
31.471	16378.99	156.79	49.91
52.096	16439.69	84.51	50.09



Signal VWD1A, Wavelength=254 nm

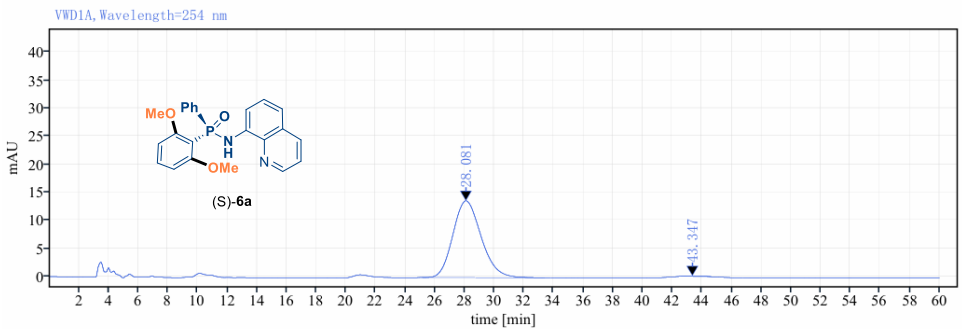
Ret. time [min]	Area	Height	Area%
31.964	2796.11	24.14	99.79
52.951	5.79	0.08	0.21

HPLC spectra for racemic and chiral product **6a** (99% *ee*).



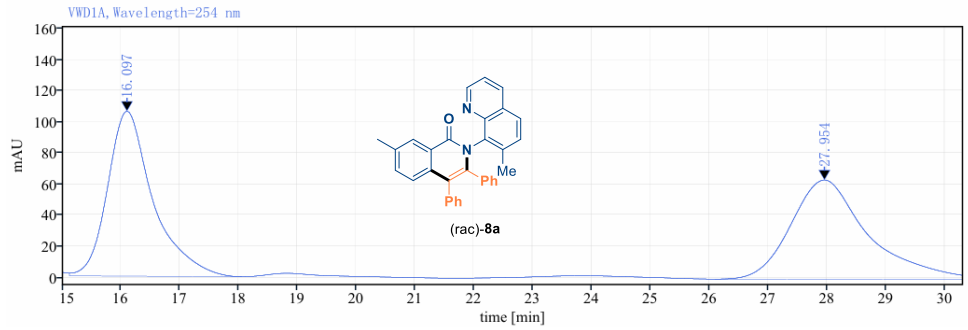
Signal VWD1A, Wavelength=254 nm

Ret. time [min]	Area	Height	Area%
28.563	1515.52	11.36	50.54
43.846	1483.31	7.53	49.46

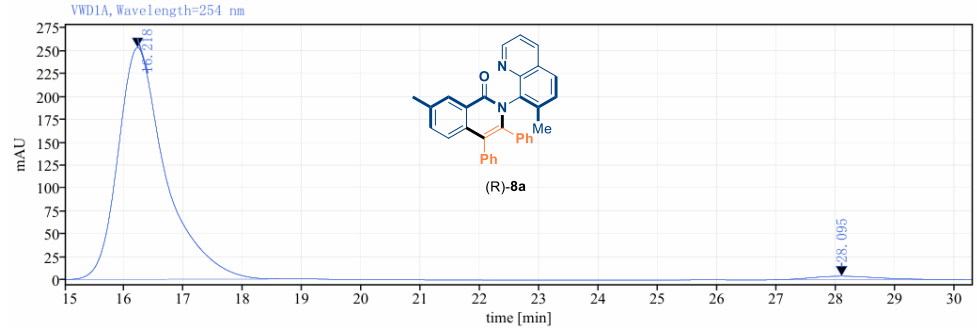


Signal	VWD1A, Wavelength=254 nm			
Ret. time [min]	Area	Height	Area%
28.081	1806.15	13.68	99.62
43.347	6.96	0.09	0.38

HPLC spectra for racemic and chiral product **8a** (95% *ee*).

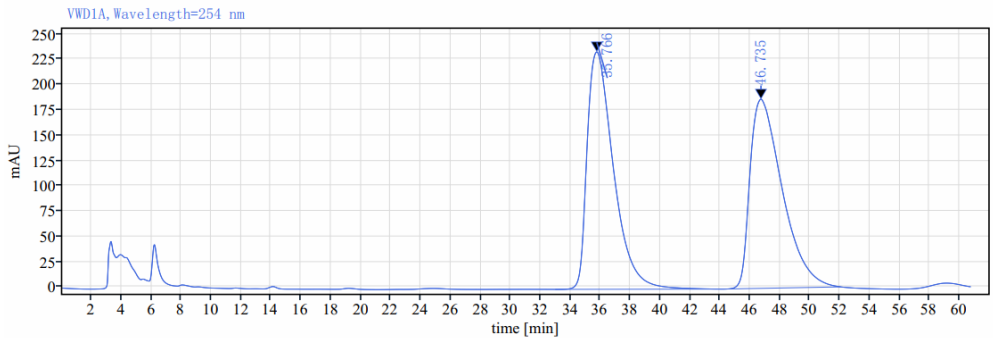


Signal	VWD1A, Wavelength=254 nm			
Ret. time [min]	Area	Height	Area%
16.097	5671.82	105.87	49.27
27.954	5840.99	63.80	50.73

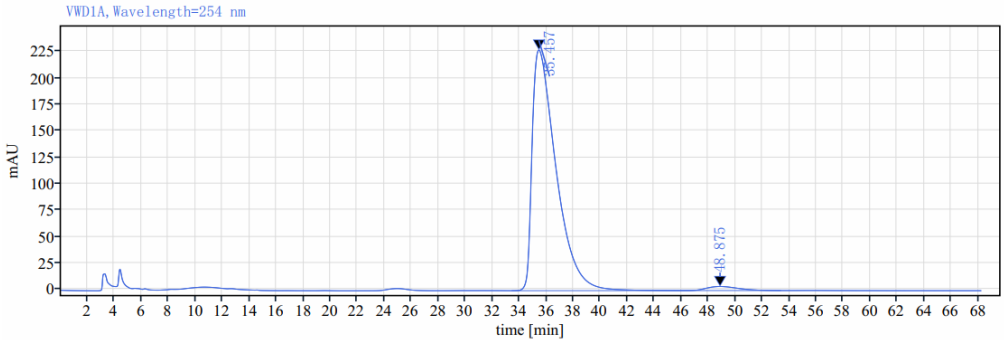


Signal	VWD1A, Wavelength=254 nm			
Ret. time [min]	Area	Height	Area%
16.218	14054.89	253.02	97.71
28.095	329.34	4.00	2.29

HPLC spectra for racemic and chiral product **8b** (95% *ee*).

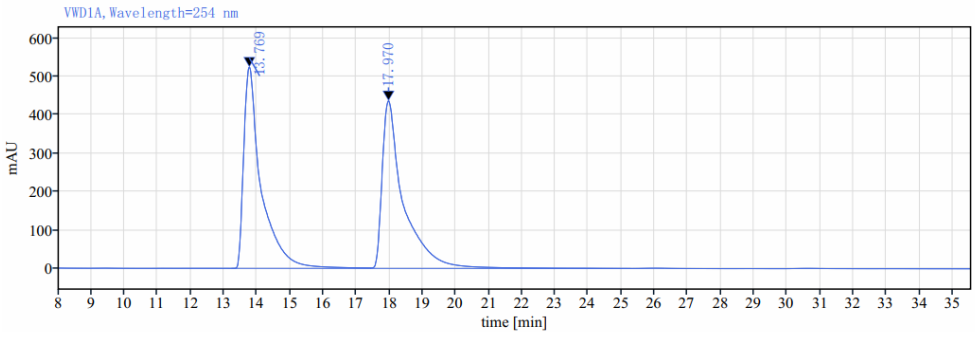


Signal	VWD1A, Wavelength=254 nm			
Ret. time [min]	Area	Height	Area%
35.766	28746.95	234.47	50.69
46.735	27968.49	186.83	49.31

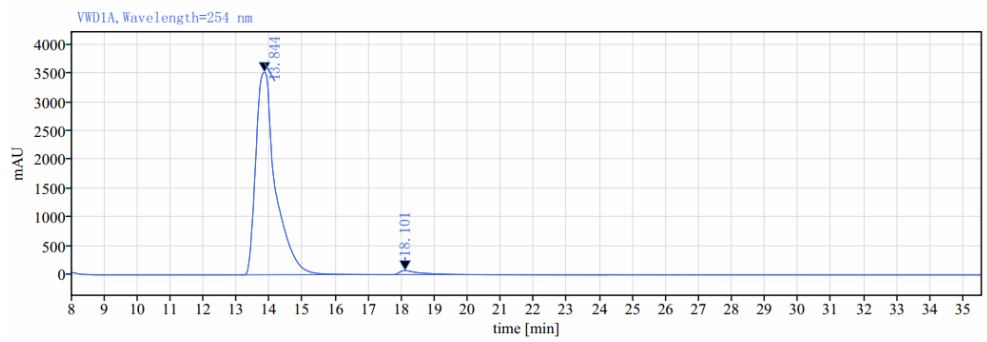


Signal	VWD1A, Wavelength=254 nm			
Ret. time [min]	Area	Height	Area%
35.457	28078.76	227.78	97.84
48.875	620.87	3.85	2.16

HPLC spectra for racemic and chiral product **8c** (96% *ee*).



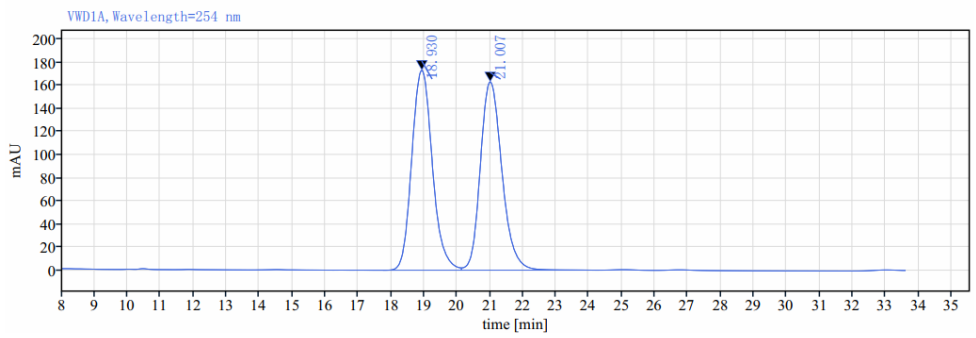
Signal	VWD1A, Wavelength=254 nm			
Ret. time [min]	Area	Height	Area%
13.769	19223.84	523.50	49.74
17.970	19422.43	435.91	50.26



Signal VWD1A, Wavelength=254 nm

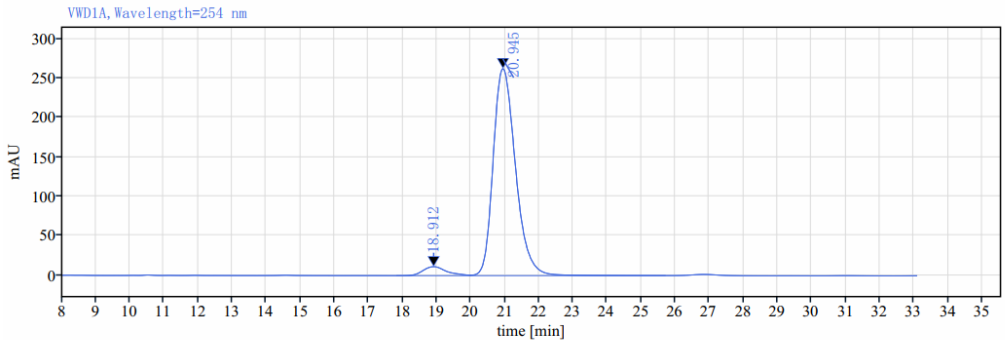
Ret. time [min]	Area	Height	Area%
13.844	145649.75	3521.93	98.09
18.101	2843.38	69.91	1.91

HPLC spectra for racemic and chiral product **8d** (91% *ee*).



Signal VWD1A, Wavelength=254 nm

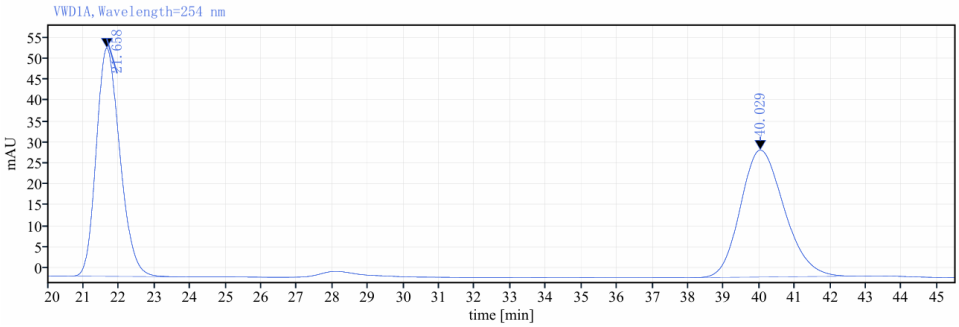
Ret. time [min]	Area	Height	Area%
18.930	7497.11	172.58	50.34
21.007	7395.43	162.59	49.66



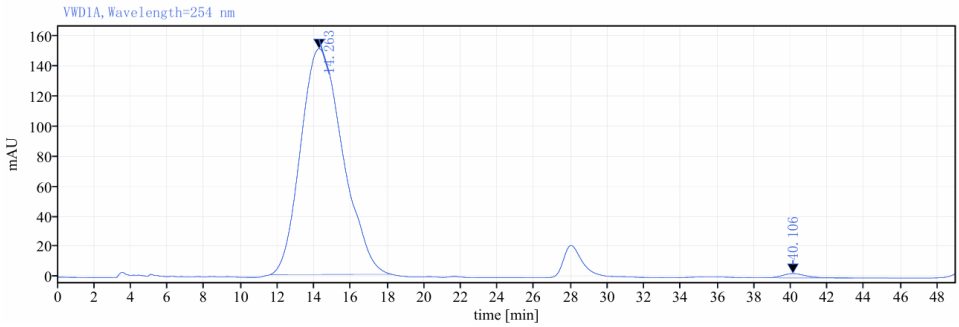
Signal VWD1A, Wavelength=254 nm

Ret. time [min]	Area	Height	Area%
18.912	549.25	11.41	4.39
20.945	11968.15	262.60	95.61

HPLC spectra for racemic and chiral product **11a** (98% *ee*).

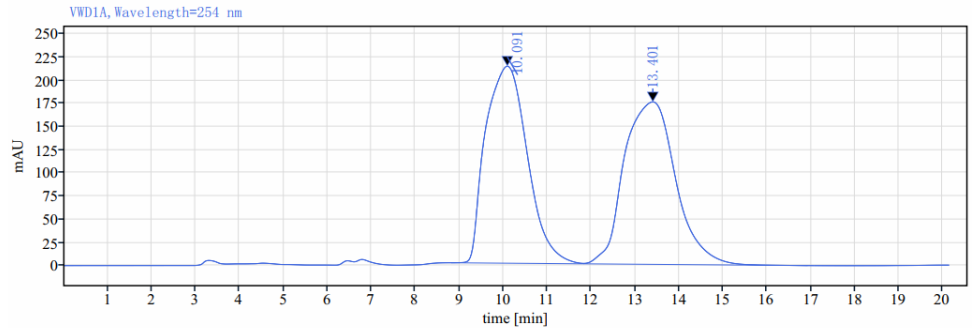


Signal	VWD1A, Wavelength=254 nm			
Ret. time [min]		Area	Height	Area%
21.658		2514.88	54.47	49.31
40.029		2584.79	30.29	50.69

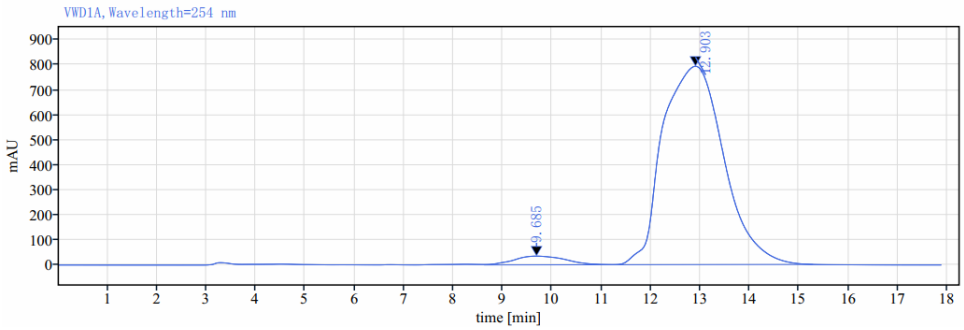


Signal	VWD1A, Wavelength=254 nm			
Ret. time [min]		Area	Height	Area%
14.263		23931.98	150.02	98.94
40.106		256.21	2.88	1.06

HPLC spectra for racemic and chiral product **13a** (93% *ee*).

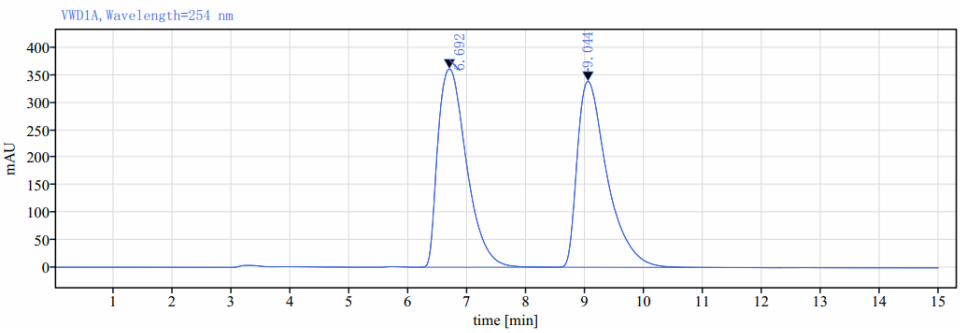


Signal	VWD1A, Wavelength=254 nm			
Ret. time [min]		Area	Height	Area%
10.091		14063.46	212.99	49.58
13.401		14300.99	175.64	50.42

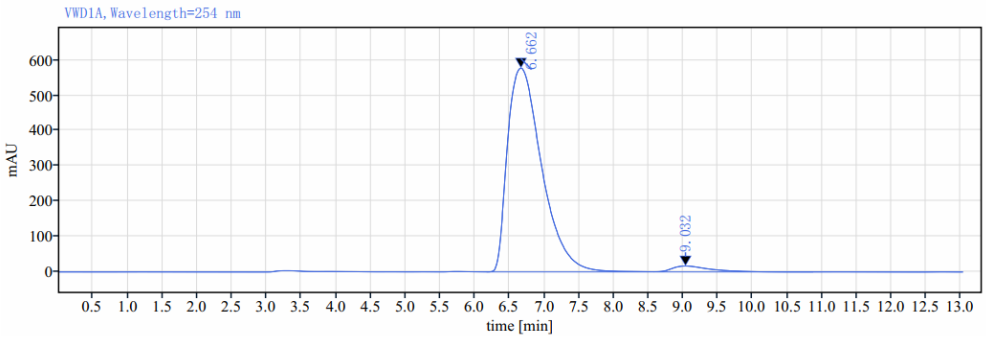


Signal	VWD1A, Wavelength=254 nm		
Ret. time [min]	Area	Height	Area%
9.685	2535.43	34.96	3.57
12.903	68436.40	793.85	96.43

HPLC spectra for racemic and chiral product **16a** (94% *ee*).



Signal	VWD1A, Wavelength=254 nm		
Ret. time [min]	Area	Height	Area%
6.692	12264.46	362.18	50.54
9.044	12000.72	339.72	49.46



Signal	VWD1A, Wavelength=254 nm		
Ret. time [min]	Area	Height	Area%
6.662	19800.12	577.56	96.91
9.032	631.65	16.75	3.09