Supporting Information

Synthesis of Aza-eight-membered Ring-fused Indolines Initiated by Zn-catalyzed C2 Alkylation of Indoles and Subsequent Base-promoted Ring-expansion

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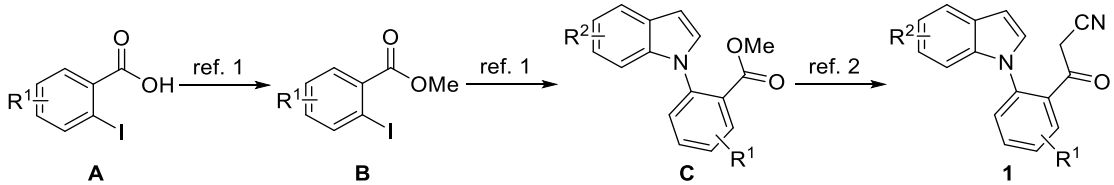
1. General Methods

All reactions were carried out under air. Toluene was prepared by distillation from sodium using benzophenone as indicator. Unless noted, all commercial reagents were used without further purification. Reactions were monitored by thin layer chromatography. Preparation of ynones were using reported method. Purification of reaction products was carried out by flash chromatography on silica gel (200~300 mesh). ^{1}H NMR spectra were recorded at 400 MHz or 500 MHz, ^{13}C NMR spectra were recorded at 100 MHz or 125 MHz, and in $CDCl_3$ (containing 0.03% TMS) solutions. ^{1}H NMR spectra were recorded with tetramethylsilane (δ= 0.00 ppm) as internal reference; ^{13}C NMR spectra were recorded with $CDCl_3$ (δ= 77.00 ppm) as internal reference. High-resolution mass spectra were performed on a mass spectrometer with a TOF (for EI or ESI) or FT-ICR (for MALDI) analyzer.

The crystal preparation and measurement methods of **3a**, **3k** and **4a** as follows: Place 50 mg of **3a** (**3k** or **4a**) in a 50 ml round bottom flask, dissolve **3a** (**3k** or **4a**) with 2 ml of dichloromethane, then add 6 ml of petroleum ether and shake well, and let it stand still at room temperature until crystals precipitate out. The crystals were carefully picked out for single crystal X-ray diffraction. Single crystal X-ray diffraction data was collected in Bruker SMARTAPEX diffractiometers with molybdenum cathodes.

2. Synthesis of 1.

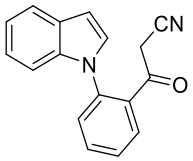


The intermediates **B** and **C** were prepared according to reference 1.

The ortho indole substituted benzoylacetonitrile **1** were synthesized according to reference 2.

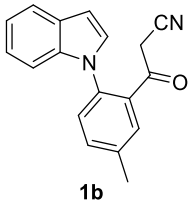
To a solution of $^{n}BuLi$ (1.3 equiv, 0.677 mmol, 270 μL, 2.5 M solution in hexane) in THF (1.5 M, 0.3 mL) in a two-neck round bottom flask was added dropwise a solution of acetonitrile (2.0 equiv, 1.04 mmol, 60 μL) in THF (0.8 M, 0.7 mL) at -78 °C. After being stirred for 1 h, a solution of methyl 2-(1H-indol-1-yl)benzoate **C1** (130.9 mg, 0.521 mmol) in THF (3.6 M, 0.2 ml) was added slowly. After 0.5 h, the

resulting mixture was warmed to -45 °C. After 30 min, cold 2 N HCl was added to the reaction mixture to neutralize it. The resulting mixture was diluted with EtOAc and the organic layer was separated. The water layer was extracted with CH_2Cl_2, washed with brine, dried over Na_2SO_4, and concentrated in vacuo. The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1) to give the **1a** (115.3 mg, 85 %) as a yellow oil.



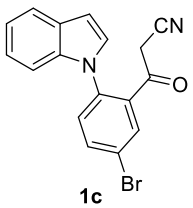
1a

3-(2-(1H-indol-1-yl)phenyl)-3-oxopropanenitrile **(1a)**. Yellow oil, purified by chromatography on silica gel (petroleum ether/ethyl acetate = 10:1); yield: 85%, 115.3 mg. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.84 (d, *J* = 8.0 Hz, 1H), 7.79-7.69 (m, 2H), 7.62-7.56 (m, 1H), 7.53 (d, *J* = 7.6 Hz, 1H), 7.27-7.15 (m, 4H), 6.82 (d, *J* = 7.6 Hz, 1H), 2.80 (s, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 190.8, 137.9, 137.1, 134.6, 134.4, 130.8, 128.9, 128.7, 128.5, 128.3, 123.9, 121.8, 121.7, 113.6, 109.9, 105.8, 30.2. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{17}H_{13}N_2O$ 261.1022; found 261.1024.



1b

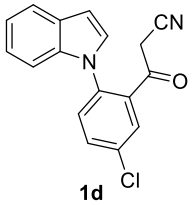
3-(2-(1H-indol-1-yl)-5-methylphenyl)-3-oxopropanenitrile (**1b)**. White solid, purified by chromatography on silica gel (petroleum ether/ethyl acetate = 10:1); yield: 61%, 87.3 mg, m.p. 144-146 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.71 (d, *J* = 7.2 Hz, 1H), 7.64 (s, 1H), 7.54 (d, *J* = 8.4 Hz, 1H), 7.39 (d, *J* = 8.0 Hz, 1H), 7.29-7.11 (m, 4H), 6.79 (d, *J* = 4.0 Hz, 1H), 2.78 (s, 2H), 2.50 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 190.9, 139.2, 137.2, 135.4, 135.1, 134.4, 131.1, 128.8, 128.6, 128.3, 123.8, 121.8, 121.6, 113.7, 110.0, 105.5, 30.2, 20.7. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{18}H_{15}N_2O$ 275.1179; found 275.1178.



1c

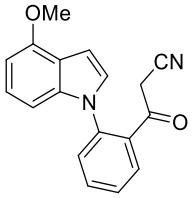
3-(5-bromo-2-(1H-indol-1-yl)phenyl)-3-oxopropanenitrile (**1c)**. Yellow solid, purified by chromatography on silica gel (petroleum ether/ethyl acetate = 10:1); yield: 83%, 146.9 mg, m.p. 101-103 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95 (d, *J* = 1.2 Hz,

1H), 7.90-7.82 (m, 1H), 7.76-7.67 (m, 1H), 7.41 (d, *J* = 8.4 Hz, 1H), 7.29-7.22 (m, 2H), 7.19-7.10 (m, 2H), 6.83 (d, *J* = 2.8 Hz, 1H), 2.79 (s, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 189.5, 137.3, 136.9, 136.8, 135.7, 133.5, 129.9, 128.9, 128.3, 124.2, 122.4, 121.9, 121.9, 113.2, 109.7, 106.3, 30.2. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{17}H_{12}BrN_2O$ 339.0128; found 339.0133.



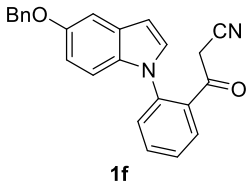
1d

3-(5-chloro-2-(1H-indol-1-yl)phenyl)-3-oxopropanenitrile (**1d)**. Yellow oil, purified by chromatography on silica gel (petroleum ether/ethyl acetate = 10:1); yield: 78%, 119.6 mg. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.81 (s, 1H), 7.76-7.67 (m, 2H), 7.48 (d, *J* = 8.8 Hz, 1H), 7.29-7.22 (m, 2H), 7.18-7.09 (m, 2H), 6.83 (s, 1H), 2.79 (s, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 189.6, 137.0, 136.4, 135.6, 134.9, 134.3, 130.7, 129.8, 128.9, 128.4, 124.2, 122.0, 122.0, 113.2, 109.7, 106.3, 30.2. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{17}H_{12}ClN_2O$ 295.0633; found 295.0632.



1e

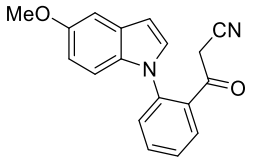
3-(2-(4-methoxy-1H-indol-1-yl)phenyl)-3-oxopropanenitrile (**1e)**. Yellow oil, purified by chromatography on silica gel (petroleum ether/ethyl acetate = 5:1); yield: 84%, 127.2 mg. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.84 (d, *J* = 7.6 Hz, 1H), 7.78-7.69 (m, 1H), 7.63-7.54 (m, 1H), 7.51 (d, *J* = 7.6 Hz, 1H), 7.21-7.13 (m, 1H), 7.09 (s, 1H), 6.91 (s, 1H), 6.75 (d, *J* = 1.0 Hz, 1H), 6.63 (d, *J* = 1.0 Hz, 1H), 4.00 (s, 3H), 2.81 (s, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 190.7, 153.9, 138.5, 138.1, 134.6, 134.4, 130.9, 128.8, 128.4, 126.9, 125.0, 119.5, 113.6, 103.1, 102.9, 101.2, 55.3, 30.2. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{18}H_{15}N_2O_2$ 291.1128; found 291.1128.



1f

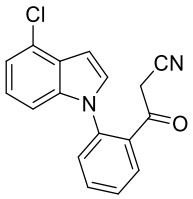
3-(2-(5-(benzyloxy)-1H-indol-1-yl)phenyl)-3-oxopropanenitrile (**1f)**. Yellow solid, purified by chromatography on silica gel (petroleum ether/ethyl acetate = 5:1); yield: 88%, 168.2 mg, m.p. 124-126 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.82 (d, *J* = 8.0 Hz, 1H), 7.78-7.70 (m, 1H), 7.60-7.32 (m, 7H), 7.23 (d, *J* = 1.2 Hz, 1H), 7.17-7.06 (m,

2H), 7.03-6.93 (m, 1H), 6.72 (d, *J* = 3.2 Hz, 1H), 6.13 (s, 2H), 2.82 (s, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 190.9, 154.8, 138.1, 137.5, 134.6, 134.4, 132.4, 130.9, 129.6, 129.1, 128.8, 128.7, 128.2, 128.2, 127.8, 114.8, 113.7, 110.9, 105.6, 104.6, 70.7, 30.3. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{24}H_{19}N_2O_2$ 367.1441; found 367.1441.



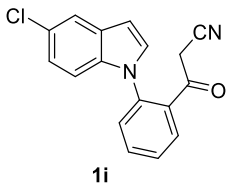
1g

3-(2-(5-methoxy-1H-indol-1-yl)phenyl)-3-oxopropanenitrile (**1g)**. Yellow oil, purified by chromatography on silica gel (petroleum ether/ethyl acetate = 5:1); yield: 75%, 113.6 mg. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.85-7.78 (m, 1H), 7.77-7.69 (m, 1H), 7.61-7.47 (m, 2H), 7.18-7.10 (m, 2H), 7.07 (d, *J* = 8.8 Hz, 1H), 6.93-6.85 (m, 1H), 6.73 (d, *J* = 3.2 Hz, 1H), 3.87 (s, 3H), 2.82 (s, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 190.9, 155.6, 138.1, 134.6, 134.4, 132.2, 130.8, 129.6, 129.1, 128.6, 128.1, 114.1, 113.7, 110.8, 105.5, 103.1, 55.6, 30.2. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{18}H_{15}N_2O_2$ 291.1128; found 291.1131.



1h

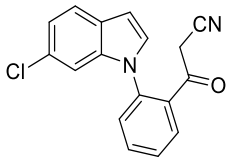
3-(2-(4-chloro-1H-indol-1-yl)phenyl)-3-oxopropanenitrile (**1h)**. Yellow oil, purified by chromatography on silica gel (petroleum ether/ethyl acetate = 10:1); yield: 82%, 125.8 mg. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.84 (d, *J* = 7.6 Hz, 1H), 7.80-7.72 (m, 1H), 7.66-7.57 (m, 1H), 7.50 (d, *J* = 8.0 Hz, 1H), 7.28-7.20 (m, 2H), 7.20-7.13 (m, 1H), 7.06 (d, *J* = 8.0 Hz, 1H), 7.06 (d, *J* = 3.2 Hz, 1H), 2.86 (s, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 190.4, 137.7, 137.4, 134.5, 130.9, 129.2, 129.2, 128.4, 127.7, 127.0, 124.5, 121.4, 113.4, 108.7, 104.2, 30.4. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{17}H_{12}ClN_2O$ 295.0633; found 295.0633.



1i

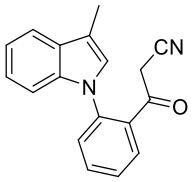
3-(2-(5-chloro-1H-indol-1-yl)phenyl)-3-oxopropanenitrile (**1i)**. Yellow oil, purified by chromatography on silica gel (petroleum ether/ethyl acetate = 10:1); yield: 80%, 123.9 mg. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.83 (d, *J* = 7.6 Hz, 1H), 7.80-7.74 (m, 1H), 7.70 (s, 1H), 7.66-7.58 (m, 1H), 7.52 (d, *J* = 8.0 Hz, 1H), 7.27-7.16 (m, 2H), 7.10 (d, *J* = 8.8 Hz, 1H), 6.76 (d, *J* = 3.2 Hz, 1H), 2.84 (s, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ

190.6, 137.4, 135.5, 134.6, 134.5, 130.9, 130.0, 129.9, 129.1, 128.3, 127.5, 124.3, 121.3, 113.4, 111.1, 105.3, 30.4. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{17}H_{12}ClN_2O$ 295.0633; found 295.0635.



1j

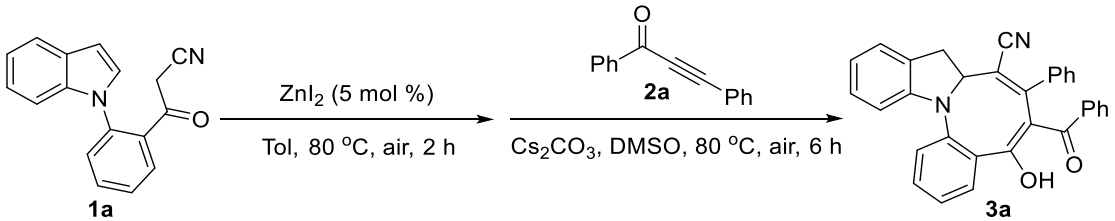
3-(2-(6-chloro-1H-indol-1-yl)phenyl)-3-oxopropanenitrile (**1j)**. Yellow oil, purified by chromatography on silica gel (petroleum ether/ethyl acetate = 10:1); yield: 85%, 130.8 mg. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.84 (d, *J* = 8.0 Hz, 1H), 7.80-7.73 (m, 1H), 7.66-7.58 (m, 2H), 7.51 (d, *J* = 8.0 Hz, 1H), 7.22-7.11 (m, 3H), 6.78 (d, *J* = 3.2 Hz, 1H), 2.88 (d, *J* = 14.4 Hz, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 190.3, 137.4, 137.2, 134.6, 134.5, 130.9, 129.9, 129.4, 129.2, 128.4, 127.3, 122.8, 122.5, 113.4, 110.0, 105.7, 30.4. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{17}H_{12}ClN_2O$ 295.0633; found 295.0636.



1k

3-(2-(3-methyl-1H-indol-1-yl)phenyl)-3-oxopropanenitrile (**1k)**. Yellow oil, purified by chromatography on silica gel (petroleum ether/ethyl acetate = 10:1); yield: 65%, 93.0 mg. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.81 (d, *J* = 8.0 Hz, 1H), 7.76-7.63 (m, 2H), 7.59-7.44 (m, 2H), 7.29-7.19 (m, 2H), 7.19-7.10 (m, 1H), 6.97 (s, 1H), 2.85 (s, 2H), 2.41 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 191.0, 138.3, 137.3, 134.5, 134.3, 130.8, 129.6, 128.3, 128.1, 126.0, 123.9, 121.1, 120.0, 115.5, 113.7, 109.8, 30.3, 9.2. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{18}H_{15}N_2O$ 275.1179; found 275.1179.

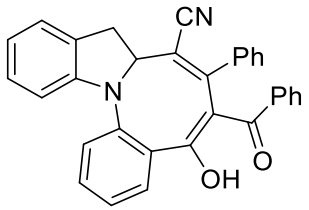
2. Synthesis of 3.



1a **3a**

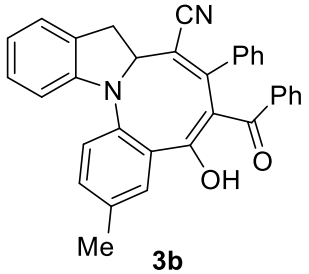
In a schlenk tube, 3-(2-(1H-indol-1-yl)phenyl)-3-oxopropanenitrile **1a** (0.2 mmol, 52.1 mg), ZnI_2 (0.01 mmol, 3.2 mg) and toluene (0.2 mL) were stirred at 80 °C (oil bath) under air . After 2 h, then 1,3-diphenylprop-2-yn-1-one **2a** (0.2 mmol, 41.2 mg),

Cs_2CO_3 (0.4 mmol, 130.3 mg) and DMSO (2.0 mL) were added. After the completion of the addition, the reaction mixture was allowed to react at 80 °C for 6 h. Then, the reaction mixture was cooled to room temperature and was treated with H_2O, then extracted with EA and dried over anhydrous Na_2SO_4. After removal of the EA, the residue was purified by chromatography on basic silica gel (PE: EA = 10: 1) to afford **3a** (yellow solid, 72.2 mg, 77%).



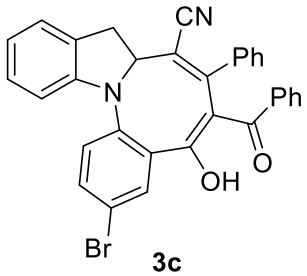
3a

(5Z,7E)-6-benzoyl-5-hydroxy-7-phenyl-8a,9-dihydrobenzo[7,8]azocino[1,2-a]indole-8-carbonitrile (**3a)**. Yellow solid, obtained in 8 h and purified by chromatography on silica gel (petroleum ether/ethyl acetate = 10:1); yield: 77%, 72.2 mg, m.p. 246-248 ^oC. ^1H NMR (400 MHz, $CDCl_3$) δ 17.67 (s, 1H), 7.50 (d, *J* = 8.0 Hz, 1H), 7.42 (d, *J* = 8.0 Hz, 1H), 7.37-7.19 (m, 7H), 7.16-7.03 (m, 7H), 6.98 (d, *J* = 7.6 Hz, 1H), 6.87-6.79 (m, 1H), 5.84 (dd, *J* = 11.2, 9.2 Hz, 1H), 3.82 (dd, *J* = 15.2, 11.2 Hz, 1H), 3.46 (dd, *J* = 15.2, 9.2 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 185.4, 181.7, 153.4, 139.4, 132.0, 130.2, 129.2, 124.9, 124.8, 124.3, 123.6, 123.2, 122.2, 122.0, 121.3, 121.2, 120.9, 120.8, 118.2, 116.0, 115.5, 113.3, 110.3, 106.3, 104.8, 102.3, 57.5, 28.2. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{32}H_{23}N_2O_2$ 467.1754; found 467.1755.



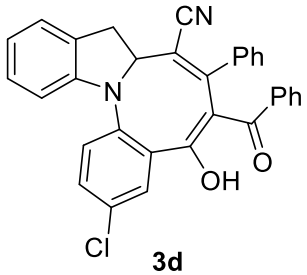
3b

(5Z,7E)-6-benzoyl-5-hydroxy-3-methyl-7-phenyl-8a,9-dihydrobenzo[7,8]azocino[1,2-a]indole-8-carbonitrile (**3b)**. Brown solid, obtained in 10 h and purified by chromatography on silica gel (petroleum ether/ethyl acetate = 10:1); yield: 83%, 79.5 mg, m.p. 234-236 ^oC. ^1H NMR (400 MHz, $CDCl_3$) δ 17.70 (s, 1H), 7.38 (d, *J* = 8.4 Hz, 1H), 7.30-7.02 (m, 14H), 6.92 (d, *J* = 8.0 Hz, 1H), 6.84-6.76 (m, 1H), 5.79 (dd, J_1 = J_2 = 10.0 Hz, 1H), 3.79 (dd, J_1 = J_2 = 13.2 Hz, 1H), 3.43 (dd, *J* = 15.6, 8.8 Hz, 1H), 2.32 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 192.5, 188.8, 160.3, 146.6, 137.3, 136.4, 136.3, 132.7, 132.7, 131.8, 131.1, 130.6, 130.1, 129.1, 128.3, 128.2, 127.9, 127.8, 125.2, 122.5, 120.0, 117.4, 113.3, 111.9, 109.0, 64.5, 35.2, 20.3. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{33}H_{25}N_2O_2$ 481.1911; found 481.1915.



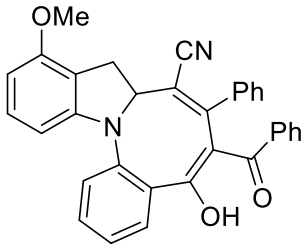
3c

(5Z,7E)-6-benzoyl-3-bromo-5-hydroxy-7-phenyl-8a,9-dihydrobenzo[7,8]azocino[1,2-a]indole-8-carbonitrile (**3c)**. Yellow solid, obtained in 10 h and purified by chromatography on silica gel (petroleum ether/ethyl acetate = 10:1); yield: 66%, 71.8 mg, m.p. 236-238 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 17.70 (s, 1H), 7.54 (s, 1H), 7.46-7.34 (m, 2H), 7.32-7.04 (m, 12H), 6.94 (d, J = 8.0 Hz, 1H), 6.88-6.80 (m, 1H), 5.79 (dd, J_1 = J_2 = 9.6 Hz, 1H), 3.82 (dd, J = 15.6, 10.8 Hz, 1H), 3.46 (dd, J_1 = 15.2, 9.2 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 190.9, 188.6, 160.3, 145.8, 138.2, 136.9, 135.8, 134.7, 133.0, 132.9, 132.1, 130.4, 129.2, 129.1, 128.4, 128.3, 128.0, 127.9, 125.4, 123.9, 120.8, 117.2, 115.1, 113.1, 111.5, 109.3, 64.5, 35.2. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{32}H_{22}BrN_2O_2$ 545.0859; found 545.0857.



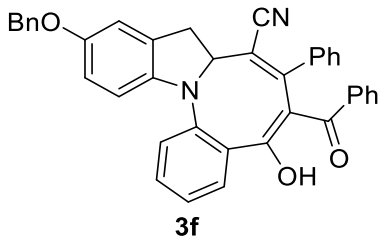
3d

(5Z,7E)-6-benzoyl-3-chloro-5-hydroxy-7-phenyl-8a,9-dihydrobenzo[7,8]azocino[1,2-a]indole-8-carbonitrile (**3d)**. Yellow solid, obtained in 10 h and purified by chromatography on silica gel (petroleum ether/ethyl acetate = 10:1); yield: 54%, 54.4 mg, m.p. 238-240 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 17.57 (s, 1H), 7.45 (d, J = 8.8 Hz, 1H), 7.40 (d, J = 1.2 Hz, 1H), 7.33-7.18 (m, 7H), 7.18-7.03 (m, 6H), 6.94 (d, J = 8.4 Hz, 1H), 6.88-6.81 (m, 1H), 5.81 (dd, J_1 = J_2 = 10.0 Hz, 1H), 3.82 (dd, J = 15.2, 10.8 Hz, 1H), 3.47 (dd, J = 15.2, 8.8 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 191.0, 188.6, 160.3, 146.0, 137.8, 136.9, 135.8, 132.5, 132.1, 131.8, 130.4, 130.2, 129.2, 129.1, 128.4, 128.4, 128.0, 127.9, 127.9, 125.4, 123.7, 120.8, 117.2, 113.1, 111.5, 109.3, 64.6, 35.2. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{32}H_{22}ClN_2O_2$ 501.1364; found 501.1365.



3e

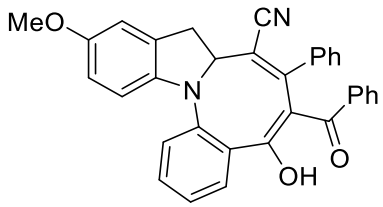
(5Z,7E)-6-benzoyl-5-hydroxy-10-methoxy-7-phenyl-8a,9-dihydrobenzo[7,8]azocino[1,2-a]indole-8-carbonitrile (**3e)**. Yellow solid, obtained in 10 h and purified by chromatography on silica gel (petroleum ether/ethyl acetate = 5:1); yield: 61%, 60.1 mg, m.p. 250-252 ºC. ^{1}H NMR (400 MHz, $CDCl_3$) δ 17.63 (s, 1H), 7.49 (d, *J* = 8.4 Hz, 1H), 7.40 (d, *J* = 7.6 Hz, 1H), 7.36-7.24 (m, 4H), 7.24-7.17 (m, 2H), 7.16-7.97 (m, 7H), 6.63 (d, *J* = 8.4 Hz, 1H), 6.42 (d, *J* = 8.4 Hz, 1H), 5.85 (dd, J_1 = J_2 = 10.0 Hz, 1H), 3.87 (s, 1H), 3.67 (dd, *J* = 15.2, 10.4 Hz, 1H), 3.51 (dd, *J* = 15.6, 9.6 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 192.4, 188.7, 160.2, 156.8, 147.7, 139.2, 137.2, 136.2, 131.9, 131.7, 131.2, 130.5, 130.1, 129.1, 129.0, 128.3, 128.2, 127.9, 122.9, 122.5, 117.3, 115.8, 113.3, 111.9, 103.2, 103.1, 64.9, 55.3, 32.2. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{33}H_{25}N_2O_3$ 497.1860; found 497.1870.



3f

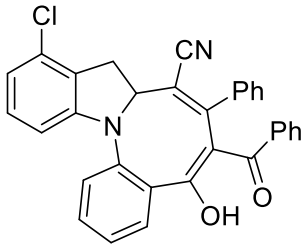
(5Z,7E)-6-benzoyl-11-(benzyloxy)-5-hydroxy-7-phenyl-8a,9-dihydrobenzo[7,8]azocino[1,2-a]indole-8-carbonitrile (**3f)**. Brown solid, obtained in 10 h and purified by chromatography on silica gel (petroleum ether/ethyl acetate = 5:1); yield: 76%, 87.0 mg, m.p. 208-210 ºC. ^{1}H NMR (400 MHz, $CDCl_3$) δ 17.68 (s, 1H), 7.48-7.35 (m, 6H), 7.34-7.24 (m, 5H), 7.22-7.16 (m, 2H), 7.14-7.00 (m, 6H), 6.95-6.82 (m, 2H), 6.70 (d, *J* = 7.6 Hz, 1H), 5.79 (dd, J_1 = J_2 = 10.0 Hz, 1H), 5.03 (s, 1H), 3.80 (dd, *J* = 15.6, 10.8 Hz, 1H), 3.41 (dd, *J* = 16.0, 9.2 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 192.5, 188.6, 160.4, 153.5, 140.4, 139.7, 137.5, 137.2, 136.2, 131.9, 131.7, 131.1, 130.6, 130.5, 130.1, 129.0, 128.8, 128.3, 128.2, 128.1, 127.9, 127.6, 122.5, 122.0, 117.4,

113.6, 113.3, 113.2, 111.8, 109.6, 70.8, 64.5, 35.4. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{39}H_{29}N_2O_3$ 573.2173; found 573.2173.



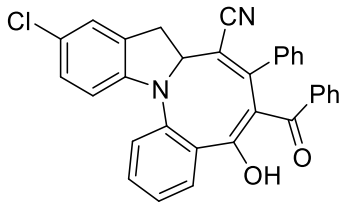
3g

(5Z,7E)-6-benzoyl-5-hydroxy-11-methoxy-7-phenyl-8a,9-dihydrobenzo[7,8]azocino[1,2-a]indole-8-carbonitrile (**3g)**. Brown solid, obtained in 10 h and purified by chromatography on silica gel (petroleum ether/ethyl acetate = 5:1); yield: 60%, 59.7 mg, m.p. 218-220 ºC. ^{1}H NMR (400 MHz, $CDCl_3$) δ 17.67 (s, 1H), 7.47 (d, *J* = 8.0 Hz, 1H), 7.39 (d, *J* = 8.0 Hz, 1H), 7.35-7.18 (m, 6H), 7.17-6.98 (m, 6H), 6.90 (d, *J* = 8.8 Hz, 1H), 6.86 (s, 1H), 6.72-6.55 (m, 1H), 5.82 (dd, *J* = 10.8, 9.2 Hz, 1H), 3.85-3.75 (m, 1H), 3.79 (s, 3H), 3.44 (dd, *J* = 15.6, 8.8 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 192.6, 188.6, 160.4, 154.4, 140.1, 139.8, 137.2, 136.2, 131.9, 131.8, 131.1, 130.7, 130.1, 129.1, 128.3, 128.2, 128.0, 122.5, 122.0, 117.4, 113.3, 112.2, 112.1, 111.9, 109.7, 64.5, 55.9, 35.5. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{33}H_{25}N_2O_3$ 497.1860; found 497.1858.



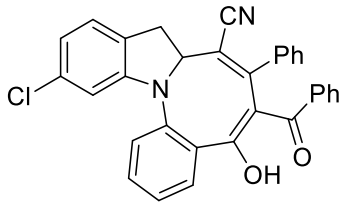
3h

(5Z,7E)-6-benzoyl-10-chloro-5-hydroxy-7-phenyl-8a,9-dihydrobenzo[7,8]azocino[1,2-a]indole-8-carbonitrile (**3h)**. Yellow solid, obtained in 10 h and purified by chromatography on silica gel (petroleum ether/ethyl acetate = 10:1); yield: 64%, 63.6 mg, m.p. 258-260 ºC. ^{1}H NMR (400 MHz, $CDCl_3$) δ 17.67 (s, 1H), 7.48-7.40 (m, 2H), 7.37-7.19 (m, 6H), 7.16-6.98 (m, 7H), 6.90-6.73 (m, 2H), 5.86 (dd, J_1 = J_2 = 10.4 Hz, 1H), 3.78 (dd, *J* = 16.0, 10.8 Hz, 1H), 3.58 (dd, *J* = 16.0, 9.2 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 192.1, 189.0, 160.8, 147.6, 138.6, 137.0, 136.1, 132.0, 131.8, 131.4, 131.2, 130.6, 130.3, 129.3, 129.0, 128.4, 128.3, 127.9, 127.6, 123.6, 122.3, 120.3, 117.2, 113.2, 111.2, 107.5, 64.3, 34.4. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{32}H_{22}ClN_2O_2$ 501.1364; found 501.1365.



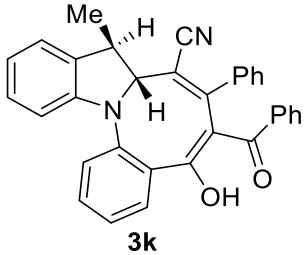
3i

(5Z,7E)-6-benzoyl-11-chloro-5-hydroxy-7-phenyl-8a,9-dihydrobenzo[7,8]azocino[1, 2-a]indole-8-carbonitrile (**3i)**. Yellow solid, obtained in 10 h and purified by chromatography on silica gel (petroleum ether/ethyl acetate = 10:1); yield: 71%, 70.9 mg, m.p. 235-237 ºC. ^{1}H NMR (400 MHz, $CDCl_3$) δ 17.68 (s, 1H), 7.48-7.38 (m, 2H), 7.37-7.24 (m, 4H), 7.23-7.16 (m, 3H), 7.14-6.98 (m, 7H), 6.86 (d, *J* = 8.0 Hz, 1H), 5.82 (dd, $J_1 = J_2$ = 10.0 Hz, 1H), 3.79 (dd, *J* = 14.8, 11.6 Hz, 1H), 3.43 (dd, *J* = 16.0, 9.2 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 192.2, 188.9, 160.7, 145.0, 138.7, 137.1, 136.1, 132.0, 131.9, 131.4, 131.1, 130.6, 130.3, 129.0, 128.3, 128.2, 127.9, 127.6, 125.4, 124.7, 123.4, 122.1, 117.2, 113.2, 111.3, 110.0, 64.6, 34.9. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{32}H_{22}ClN_2O_2$ 501.1364; found 501.1365.



3j

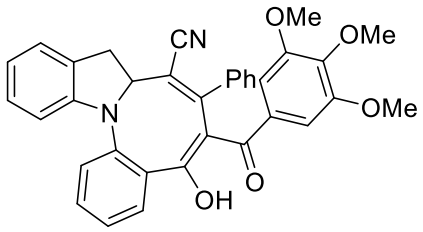
(5Z,7E)-6-benzoyl-12-chloro-5-hydroxy-7-phenyl-8a,9-dihydrobenzo[7,8]azocino[1, 2-a]indole-8-carbonitrile (**3j)**. Yellow solid, obtained in 10 h and purified by chromatography on silica gel (petroleum ether/ethyl acetate = 10:1); yield: 53%, 53.4 mg, m.p. 242-244 ºC. ^{1}H NMR (400 MHz, $CDCl_3$) δ 17.67 (s, 1H), 7.48-7.36 (m, 3H), 7.33-7.24 (m, 3H), 7.23-7.17 (m, 2H), 7.16-7.03 (m, 7H), 6.93 (s, 1H), 6.78 (d, *J* = 8.0 Hz, 1H), 5.86 (dd, *J* = 11.2, 9.6 Hz, 1H), 3.75 (dd, *J* = 15.2, 10.8 Hz, 1H), 3.42 (dd, *J* = 15.2, 8.8 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 192.0, 189.0, 160.7, 147.6, 138.2, 137.1, 136.1, 133.6, 132.0, 132.0, 131.4, 130.7, 130.3, 129.0, 128.4, 128.3, 127.9, 127.7, 125.8, 123.7, 122.4, 120.0, 117.2, 113.1, 111.2, 109.5, 65.1, 34.6. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{32}H_{22}ClN_2O_2$ 501.1364; found 501.1364.



3k

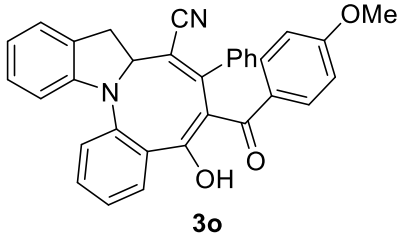
(5Z,7E,8aR,9R)-6-benzoyl-5-hydroxy-9-methyl-7-phenyl-8a,9-dihydrobenzo[7,8]azo cino[1,2-a]indole-8-carbonitrile (**3k)**. Yellow solid, obtained in 10 h and purified by

chromatography on silica gel (petroleum ether/ethyl acetate = 10:1); yield: 70%, 67.0 mg, m.p. 244-246 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 17.61 (s, 1H), 7.49 (d, *J* = 8.4 Hz, 1H), 7.43 (d, *J* = 7.6 Hz, 1H), 7.38-7.17 (m, 8H), 7.15-7.02 (m, 7H), 6.97 (d, *J* = 7.6 Hz, 1H), 6.92-6.82 (m, 1H), 5.38 (d, *J* = 11.2 Hz, 1H), 4.20-4.00 (m, 1H), 1.64 (d, *J* = 6.8 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 191.5, 189.3, 161.8, 146.2, 138.9, 137.4, 136.6, 133.8, 131.8, 131.1, 130.8, 130.2, 129.0, 128.3, 128.2, 128.0, 127.7, 123.6, 123.2, 122.9, 120.4, 117.3, 113.5, 111.1, 108.8, 73.0, 41.9, 16.2. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{33}H_{25}N_2O_2$ 481.1911; found 481.1910.



3n

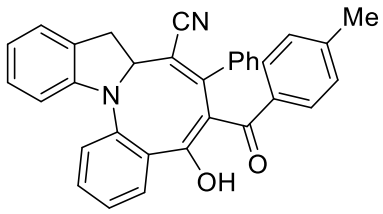
(5Z,7E)-5-hydroxy-7-phenyl-6-(3,4,5-trimethoxybenzoyl)-8a,9-dihydrobenzo[7,8]azocino[1,2-a]indole-8-carbonitrile (**3n)**. Brown solid, obtained in 12 h and purified by chromatography on silica gel (petroleum ether/ethyl acetate = 3:1); yield: 66%, 72.9 mg, m.p. 184-186 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 17.55 (s, 1H), 7.50 (d, *J* = 8.4 Hz, 1H), 7.42 (d, *J* = 7.6 Hz, 1H), 7.39-7.32 (m, 1H), 7.23-7.06 (m, 8H), 6.97 (d, *J* = 8.4 Hz, 1H), 6.86-6.78 (m, 1H), 6.54 (s, 1H), 5.90 (dd, *J* = 11.2, 8.8 Hz, 1H), 3.90 -3.80 (m, 1H), 3.80 (s, 3H), 3.78 (s, 6H), 3.36 (dd, *J* = 15.2, 8.8 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 190.7, 189.1, 161.1, 153.0, 146.3, 141.4, 139.2, 137.2, 131.9, 131.6, 131.0, 130.8, 130.3, 128.9, 128.4, 127.9, 125.2, 123.1, 122.5, 120.4, 117.2, 113.1, 111.1, 109.4, 105.6, 64.8, 60.8, 56.0, 35.2. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{35}H_{29}N_2O_5$ 557.2071; found 557.2070.



3o

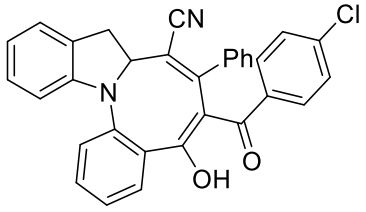
(5Z,7E)-5-hydroxy-6-(4-methoxybenzoyl)-7-phenyl-8a,9-dihydrobenzo[7,8]azocino[1,2-a]indole-8-carbonitrile (**3o)**. Yellow solid, obtained in 12 h and purified by chromatography on silica gel (petroleum ether/ethyl acetate = 5:1); yield: 62%, 61.6 mg, m.p. 216-218 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 17.94 (s, 1H), 7.49 (d, *J* = 8.4 Hz, 1H), 7.45-7.38 (m, 3H), 7.38-7.29 (m, 1H), 7.28-7.19 (m, 3H), 7.18-7.03 (m, 5H), 6.97 (d, *J* = 7.6 Hz, 1H), 6.86-6.78 (m, 1H), 6.72 (d, *J* = 8.4 Hz, 1H), 5.82 (dd, $J_1 = J_2$ = 10.0 Hz, 1H), 3.85-3.77 (m, 1H), 3.75 (s, 3H), 3.43 (dd, *J* = 15.6, 9.2 Hz, 1H). ^{13}C

NMR (100 MHz, $CDCl_3$) δ 192.1, 187.3, 163.0, 160.9, 146.3, 139.0, 137.1, 131.6, 130.7, 130.6, 130.3, 129.2, 129.0, 128.3, 128.3, 127.8, 125.2, 123.0, 122.2, 120.2, 117.5, 113.7, 112.4, 111.5, 109.4, 64.6, 55.3, 35.2. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{33}H_{25}N_2O_3$ 497.1860; found 497.1859.



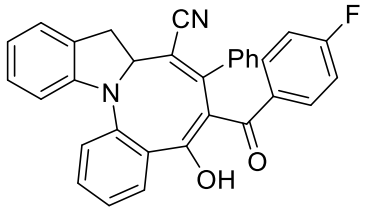
3p

(5Z,7E)-5-hydroxy-6-(4-methylbenzoyl)-7-phenyl-8a,9-dihydrobenzo[7,8]azocino[1, 2-a]indole-8-carbonitrile (**3p)**. Yellow solid, obtained in 10 h and purified by chromatography on silica gel (petroleum ether/ethyl acetate = 10:1); yield: 79%, 75.6 mg, m.p. 228-230 ºC. ^{1}H NMR (400 MHz, $CDCl_3$) δ 17.78 (s, 1H), 7.49 (d, *J* = 8.0 Hz, 1H), 7.40 (d, *J* = 8.0 Hz, 1H), 7.37-7.29 (m, 1H), 7.28-7.13 (m, 5H), 7.13-7.03 (m, 5H), 7.03-6.93 (m, 3H), 6.86-6.76 (m, 1H), 5.76 (dd, J_1 = J_2 = 10.0 Hz, 1H), 3.81 (dd, *J* = 15.2, 10.8 Hz, 1H), 3.43 (dd, *J* = 15.6, 9.2 Hz, 1H), 2.25 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 192.2, 188.4, 160.7, 146.3, 142.9, 139.0, 137.2, 133.3, 131.6, 131.5, 130.6, 130.2, 129.2, 129.0, 129.0, 128.2, 128.1, 127.7, 125.2, 123.0, 122.3, 120.3, 117.4, 112.9, 111.6, 109.3, 64.5, 35.2, 21.2. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{33}H_{25}N_2O_2$ 481.1911; found 481.1910.



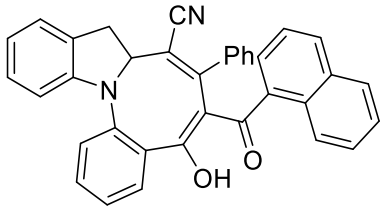
3q

(5Z,7E)-6-(4-chlorobenzoyl)-5-hydroxy-7-phenyl-8a,9-dihydrobenzo[7,8]azocino[1, 2-a]indole-8-carbonitrile (**3q)**. Yellow solid, obtained in 10 h and purified by chromatography on silica gel (petroleum ether/ethyl acetate = 10:1); yield: 75%, 74.4 mg, m.p. 202-204 ºC. ^{1}H NMR (400 MHz, $CDCl_3$) δ 17.64 (s, 1H), 7.51 (d, *J* = 8.4 Hz, 1H), 7.43-7.33 (m, 2H), 7.28-7.07 (m, 12H), 6.97 (d, *J* = 8.0 Hz, 1H), 6.89-6.79 (m, 1H), 5.81 (dd, J_1 = J_2 = 10.0 Hz, 1H), 3.82 (dd, *J* = 14.4, 12.0 Hz, 1H), 3.36 (dd, *J* = 15.2, 9.2 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 192.7, 187.2, 159.9, 146.3, 139.0, 138.3, 137.0, 134.5, 131.9, 131.2, 130.6, 130.5, 129.4, 129.1, 129.0, 128.7, 128.4, 127.8, 125.2, 123.1, 122.5, 120.4, 117.2, 113.2, 112.1, 109.3, 64.5, 35.3. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{32}H_{22}ClN_2O_2$ 501.1364; found 501.1364.



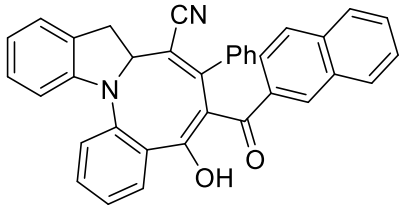
3r

(5Z,7E)-6-(4-fluorobenzoyl)-5-hydroxy-7-phenyl-8a,9-dihydrobenzo[7,8]azocino[1,2-a]indole-8-carbonitrile (**3r)**. Yellow solid, obtained in 10 h and purified by chromatography on silica gel (petroleum ether/ethyl acetate = 10:1); yield: 51%, 49.6 mg, m.p. 238-240 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 17.70 (s, 1H), 7.51 (d, *J* = 8.4 Hz, 1H), 7.44-7.30 (m, 4H), 7.28-7.22 (m, 1H), 7.21-7.03 (m, 7H), 7.01-6.80 (m, 4H), 5.82 (dd, J_1 = J_2 = 10.0 Hz, 1H), 3.82 (dd, *J* = 15.6, 11.2 Hz, 1H), 3.45 (dd, *J* = 15.6, 9.2 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 192.5, 187.3, 164.9 (*J* = 127.2 Hz), 160.2, 146.3, 139.1, 137.1, 132.4 (*J* = 3.3 Hz), 131.8, 130.9 (*J* = 57.8 Hz), 130.6, 130.6, 130.4, 129.1, 129.0, 128.4, 127.8, 125.2, 123.1, 122.5, 120.4, 117.3, 115.7, 115.5, 112.5 (*J* = 51.7 Hz), 109.3, 64.5, 35.3. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{32}H_{22}FN_2O_2$ 485.1660; found 485.1657.



3s

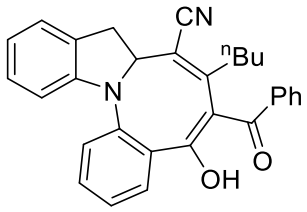
(5Z,7E)-6-(1-naphthoyl)-5-hydroxy-7-phenyl-8a,9-dihydrobenzo[7,8]azocino[1,2-a]indole-8-carbonitrile (**3s)**. Brown solid, obtained in 12 h and purified by chromatography on silica gel (petroleum ether/ethyl acetate = 10:1); yield: 58%, 59.4 mg, m.p. 184-186 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 17.54 (s, 1H), 7.78-7.66 (m, 2H), 7.61-7.34 (m, 6H), 7.25 (d, *J* = 7.6 Hz, 1H), 7.19-7.05 (m, 3H), 7.01-6.74 (m, 6H), 6.58 (d, *J* = 7.6 Hz, 1H), 5.84 (dd, J_1 = J_2 = 10.0 Hz, 1H), 3.73 (dd, *J* = 15.2, 10.8 Hz, 1H), 3.45 (dd, *J* = 15.6, 9.2 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 192.2, 190.6, 159.7, 146.5, 138.6, 137.4, 134.0, 133.1, 131.7, 131.2, 131.0, 130.7, 129.4, 129.3, 129.0, 128.5, 128.0, 127.9, 126.9, 126.6, 126.0, 125.2, 124.6, 124.5, 123.0, 122.8, 120.3, 117.0, 115.6, 111.6, 108.8, 64.0, 35.3. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{36}H_{25}N_2O_2$ 517.1911; found 517.1910.



3t

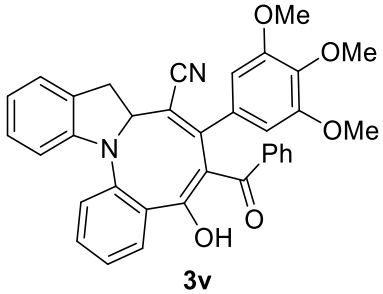
(5Z,7E)-6-(2-naphthoyl)-5-hydroxy-7-phenyl-8a,9-dihydrobenzo[7,8]azocino[1,2-a]indole-8-carbonitrile (**3t)**. Brown solid, obtained in 12 h and purified by chromatography on silica gel (petroleum ether/ethyl acetate = 10:1); yield: 59%, 60.7

mg, m.p. 232-234 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 17.82 (s, 1H), 7.83 (s, 1H), 7.79-7.70 (m, 2H), 7.65 (d, *J* = 8.8 Hz, 1H), 7.58-7.47 (m, 3H), 7.46-7.30 (m, 3H), 7.25 (d, *J* = 6.8 Hz, 1H), 7.19-7.04 (m, 4H), 7.03-6.89 (m, 4H), 6.87-6.78 (m, 1H), 5.90 (dd, J_1 = J_2 = 10.0 Hz, 1H), 3.87 (dd, *J* = 15.2, 10.8 Hz, 1H), 3.50 (dd, *J* = 15.2, 9.2 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 192.6, 188.2, 160.6, 146.3, 139.0, 137.2, 134.6, 133.3, 132.0, 131.7, 131.4, 130.6, 130.2, 129.7, 129.2, 129.1, 128.9, 128.5, 128.3, 128.1, 127.9, 127.8, 127.1, 125.2, 123.9, 123.0, 122.4, 120.3, 117.4, 113.4, 111.8, 109.3, 64.6, 35.3. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{36}H_{25}N_2O_2$ 517.1911; found 517.1914.



3u

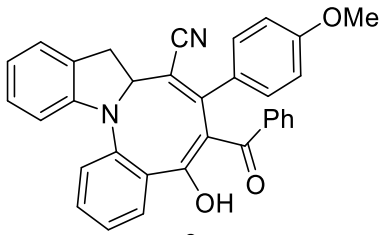
(5Z,7E)-6-benzoyl-7-butyl-5-hydroxy-8a,9-dihydrobenzo[7,8]azocino[1,2-a]indole-8-carbonitrile (**3u)**. Yellow solid, obtained in 8 h and purified by chromatography on silica gel (petroleum ether/ethyl acetate = 20:1); yield: 53%, 47.6 mg, m.p. 250-252 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 18.16 (s, 1H), 7.59-7.52 (m, 2H), 7.48-7.37 (m, 4H), 7.33 (d, *J* = 7.6 Hz, 1H), 7.28-7.23 (m, 1H), 7.20 (d, *J* = 7.2 Hz, 1H), 7.12-6.99 (m, 2H), 6.94 (d, *J* = 8.0 Hz, 1H), 6.84-6.77 (m, 1H), 5.63 (dd, *J* = 11.6, 8.8 Hz, 1H), 3.74 (dd, *J* = 15.2, 11.2 Hz, 1H), 3.29 (dd, *J* = 15.2, 8.8 Hz, 1H), 0,92 (s, 9H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 204.2, 189.2, 160.1, 146.2, 139.5, 138.0, 131.4, 131.1, 131.0, 130.0, 129.5, 129.4, 129.0, 127.8, 125.2, 123.1, 121.9, 120.4, 117.4, 112.2, 111.7, 110.2, 65.2, 42.8, 34.9, 27.1. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{30}H_{27}N_2O_2$ 447.2067; found 447.2068.



3v

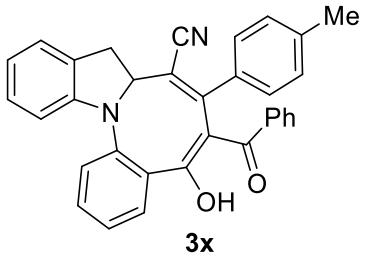
(5Z,7E)-6-benzoyl-5-hydroxy-7-(3,4,5-trimethoxyphenyl)-8a,9-dihydrobenzo[7,8]azocino[1,2-a]indole-8-carbonitrile (**3v)**. Yellow solid, obtained in 10 h and purified by chromatography on silica gel (petroleum ether/ethyl acetate = 3:1); yield: 71%, 79.1 mg, m.p. 212-214 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 17.60 (s, 1H), 7.52 (d, *J* = 8.8 Hz, 1H), 7.38-7.22 (m, 8H), 7.14-7.03 (m, 2H), 6.97 (d, *J* = 8.0 Hz, 1H), 6.88-6.78 (m, 1H), 6.32 (s, 1H), 5.83 (dd, *J* = 11.6, 8.8 Hz, 1H), 3.81 (dd, *J* = 15.2, 11.2 Hz, 1H), 3.71 (s, 3H), 3.70 (s, 6H), 3.46 (dd, *J* = 15.2, 8.8 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 191.7, 189.2, 160.2, 152.8, 146.3, 139.8, 139.2, 136.4, 132.5, 131.9, 131.8, 131.2, 130.2, 129.1, 128.3, 127.9, 127.8, 125.2, 123.0, 122.7, 120.4, 117.5, 113.2,

111.3, 109.3, 106.7, 64.5, 60.7, 56.0, 35.2. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{35}H_{29}N_2O_5$ 557.2071; found 557.2071.



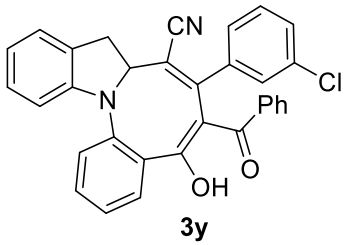
3w

(5Z,7E)-6-benzoyl-5-hydroxy-7-(4-methoxyphenyl)-8a,9-dihydrobenzo[7,8]azocino[1,2-a]indole-8-carbonitrile (**3w)**. Brown solid, obtained in 12 h and purified by chromatography on silica gel (petroleum ether/ethyl acetate = 5:1); yield: 63%, 62.6 mg, m.p. 234-236 ºC. ^{1}H NMR (400 MHz, $CDCl_3$) δ 17.70 (s, 1H), 7.50 (d, *J* = 8.4 Hz, 1H), 7.41-7.28 (m, 5H), 7.27-7.18 (m, 3H), 7.17-7.03 (m, 4H), 6.97 (d, *J* = 8.0 Hz, 1H), 6.86-6.78 (m, 1H), 6.59 (d, *J* = 8.4 Hz, 1H), 5.82 (dd, J_1 = J_2 = 10.0 Hz, 1H), 3.81 (dd, *J* = 15.2, 10.8 Hz, 1H), 3.66 (s, 3H), 3.44 (dd, *J* = 15.2, 9.2 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 192.2, 188.7, 161,2, 160.0, 146.4, 139.2, 136.2, 132.0, 131.7, 131.4, 130.7, 130.4, 129.6, 129.3, 128.3, 128.0, 127.8, 125.2, 123.0, 122.4, 120.3, 117.9, 113.6, 113.1, 109.8, 109.3, 64.6, 55.1, 35.3. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{33}H_{25}N_2O_3$ 497.1860; found 497.1859.



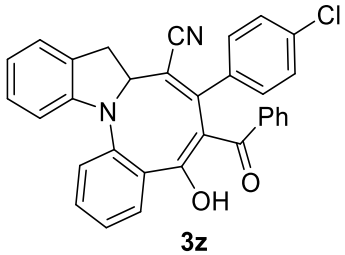
3x

(5Z,7E)-6-benzoyl-5-hydroxy-7-(p-tolyl)-8a,9-dihydrobenzo[7,8]azocino[1,2-a]indole-8-carbonitrile (**3x)**. Yellow solid, obtained in 12 h and purified by chromatography on silica gel (petroleum ether/ethyl acetate = 10:1); yield: 75%, 71.8 mg, m.p. 250-252 ºC. ^{1}H NMR (400 MHz, $CDCl_3$) δ 17.69 (s, 1H), 7.49 (d, *J* = 8.4 Hz, 1H), 7.39 (d, *J* = 7.6 Hz, 1H), 7.37-7.27 (m, 4H), 7.26-7.18 (m, 3H), 7.14-7.01 (m, 4H), 6.97 (d, *J* = 8.0 Hz, 1H), 6.91-6.77 (m, 3H), 5.82 (dd, *J* = 11.6, 9.2 Hz, 1H), 3.81 (dd, *J* = 15.6, 11.2 Hz, 1H), 3.44 (dd, *J* = 15.6, 9.2 Hz, 1H), 2.16 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 192.3, 188.6, 160.4, 146.4, 140.7, 139.1, 136.2, 134.3, 132.0, 131.7, 131.4, 130.5, 129.2, 129.0, 128.3, 128.0, 127.8, 125.2, 123.0, 122.4, 120.3, 117.6, 113.1, 111.0, 109.3, 64.5, 35.2, 20.9. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{33}H_{25}N_2O_2$ 481.1911; found 481.1913.



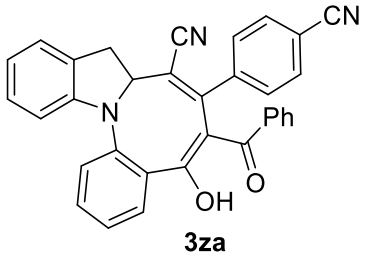
3y

(5Z,7E)-6-benzoyl-7-(3-chlorophenyl)-5-hydroxy-8a,9-dihydrobenzo[7,8]azocino[1, 2-a]indole-8-carbonitrile (**3y)**. Brown solid, obtained in 8 h and purified by chromatography on silica gel (petroleum ether/ethyl acetate = 10:1); yield: 80%, 80.1 mg, m.p. 230-232 ºC. ^{1}H NMR (400 MHz, $CDCl_3$) δ 17.61 (s, 1H), 7.51 (d, *J* = 8.0 Hz, 1H), 7.45-7.30 (m, 3H), 7.27-7.20 (m, 5H), 7.15-6.93 (m, 7H), 6.88-6.78 (m, 1H), 5.81 (dd, *J* = 10.8, 9.2 Hz, 1H), 3.80 (dd, *J* = 15.2, 11.2 Hz, 1H), 3.46 (dd, *J* = 15.2, 9.2 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 192.6, 188.6, 158.8, 146.3, 139.1, 138.9, 136.1, 134.2, 132.0, 131.9, 131.2, 130.6, 130.0, 129.5, 129.0, 128.9, 128.5, 127.9, 127.2, 125.3, 123.2, 122.6, 120.5, 116.8, 113.1, 113.0, 109.3, 64.3, 35.2. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{32}H_{22}ClN_2O_2$ 501.1364; found 501.1366.



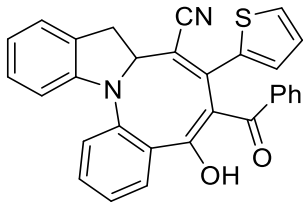
3z

(5Z,7E)-6-benzoyl-7-(4-chlorophenyl)-5-hydroxy-8a,9-dihydrobenzo[7,8]azocino[1, 2-a]indole-8-carbonitrile (**3z)**. Yellow solid, obtained in 10 h and purified by chromatography on silica gel (petroleum ether/ethyl acetate = 10:1); yield: 53%, 53.1 mg, m.p. 215-217 ºC. ^{1}H NMR (400 MHz, $CDCl_3$) δ 17.66 (s, 1H), 7.51 (d, *J* = 8.0 Hz, 1H), 7.40-7.22 (m, 8H), 7.13-7.01 (m, 6H), 6.97 (d, *J* = 7.6 Hz, 1H), 6.88-6.77 (m, 1H), 5.81 (dd, *J* = 10.8, 9.2 Hz, 1H), 3.80 (dd, *J* = 15.2, 10.8 Hz, 1H), 3.46 (dd, *J* = 15.6, 9.2 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 192.7, 188.4, 159.1, 146.3, 139.0, 136.3, 136.0, 135.7, 132.2, 131.9, 131.2, 130.5, 130.2, 129.1, 128.5, 128.5, 127.9, 127.9, 125.2, 123.1, 122.5, 120.4, 117.1, 112.9, 112.4, 109.3, 64.4, 35.2. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{32}H_{22}ClN_2O_2$ 501.1364; found 501.1354.



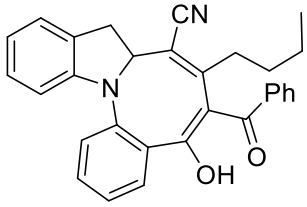
3za

(5Z,7E)-6-benzoyl-7-(4-cyanophenyl)-5-hydroxy-8a,9-dihydrobenzo[7,8]azocino[1,2 -a]indole-8-carbonitrile (**3za)**. Brown solid, obtained in 10 h and purified by chromatography on silica gel (petroleum ether/ethyl acetate = 4:1); yield: 53%, 52.4 mg, m.p. 186-188 ºC. ^{1}H NMR (400 MHz, $CDCl_3$) δ 17.60 (s, 1H), 7.52 (d, *J* = 8.4 Hz, 1H), 7.44-7.30 (m, 5H), 7.28-7.17 (m, 7H), 7.14-7.07 (m, 2H), 6.98 (d, *J* = 8.0 Hz, 1H), 6.89-6.80 (m, 1H), 5.83 (dd, J_1 = J_2 = 10.0 Hz, 1H), 3.80 (dd, *J* = 15.2, 11.2 Hz, 1H), 3.49 (dd, *J* = 15.2, 8.8 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 193.3, 188.1, 158.3, 146.1, 141.7, 138.8, 135.9, 132.3, 132.1, 131.9, 131.1, 130.5, 129.5, 128.9, 128.6, 127.9, 125.3, 123.2, 122.6, 120.6, 118.1, 116.5, 114.5, 113.3, 112.7, 109.3, 64.2, 35.2. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{33}H_{22}N_3O_2$ 492.1707; found 492.1707.



3zb

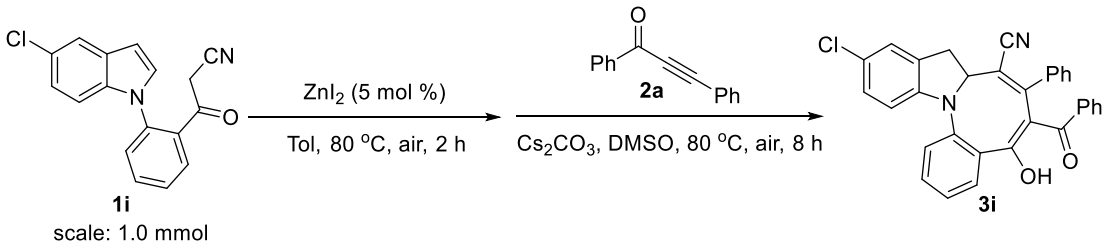
(5Z,7Z)-6-benzoyl-5-hydroxy-7-(thiophen-2-yl)-8a,9-dihydrobenzo[7,8]azocino[1,2-a]indole-8-carbonitrile (**3zb)**. Yellow solid, obtained in 10 h and purified by chromatography on silica gel (petroleum ether/ethyl acetate = 10:1); yield: 76%, 71.6 mg, m.p. 248-250 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 17.77 (s, 1H), 7.53-7.38 (m, 4H), 7.36-7.17 (m, H), 7.12-7.00 (m, 2H), 6.96 (d, *J* = 8.0 Hz, 1H), 6.86-6.72 (m, 1H), 5.80 (dd, *J* = 10.4, 9.6 Hz, 1H), 3.82 (dd, *J* = 15.6, 11.2 Hz, 1H), 3.43 (dd, *J* = 15.6, 9.2 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 192.7, 187.9, 151.5, 146.3, 141.0, 139.1, 136.0, 132.2, 131.7, 131.3, 130.7, 130.4, 130.3, 129.2, 128.4, 128.2, 128.1, 127.8, 125.2, 123.1, 122.4, 120.3, 117.8, 113.1, 109.5, 107.7, 64.6, 35.2. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{30}H_{21}N_2O_2S$ 473.1318; found 473.1319.



3zc

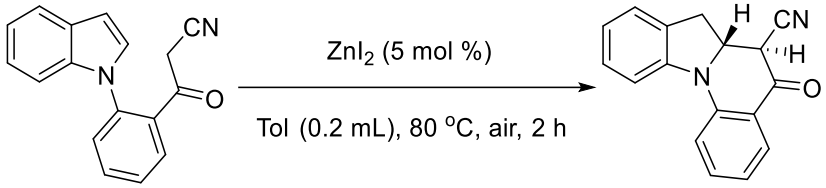
(5Z,7E)-6-benzoyl-7-butyl-5-hydroxy-8a,9-dihydrobenzo[7,8]azocino[1,2-a]indole-8-carbonitrile (**3zc)**. Yellow solid, obtained in 10 h and purified by chromatography on silica gel (petroleum ether/ethyl acetate = 20:1); yield: 56%, 50.4 mg, m.p. 75-77 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 17.75 (s, 1H), 7.61-7.53 (m, 3H), 7.50-7.44 (m, 3H), 7.41-7.35 (m, 1H), 7.26-7.17 (m, 2H), 7.12-7.01 (m, 2H), 6.94 (d, *J* = 8.0 Hz, 1H), 6.86-6.77 (m, 1H), 5.60 (dd, *J* = 10.8, 9.2 Hz, 1H), 3.70 (dd, *J* = 15.2, 11.2 Hz, 1H), 3.34 (dd, *J* = 15.6, 8.8 Hz, 1H), 2.60-2.45 (m, 2H), 1.75-1.65 (m, 1H), 1.28-1.21 (m, 1H), 1.13-1.03 (m, 1H), 0.94-0.84 (m, 1H), 0.78-0.68 (m, 1H), 0.60 (t, *J* = 6.4 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 193.6, 184.4, 163.9, 146.4, 138.4, 135.9, 132.6, 131.9, 131.5, 130.9, 129.1, 129.0, 128.3, 127.7, 125.2, 122.7, 122.6, 120.2, 116.2, 113.6, 111.0, 109.0, 62.6, 37.0, 34.3, 30.5, 21.8, 13.3. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{30}H_{27}N_2O_2$ 447.2067; found 447.2067.

4. 1.0 mmol scale reaction.



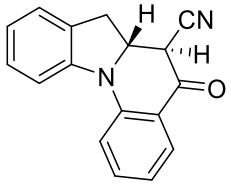
In a schlenk tube, 3-(2-(5-chloro-1H-indol-1-yl)phenyl)-3-oxopropanenitrile **1i** (1.0 mmol, 294.7 mg), ZnI_2 (0.05 mmol, 16.0 mg) and toluene (1.0 mL) were stirred at 80 °C (oil bath) under air. After 2 h, then 1,3-diphenylprop-2-yn-1-one **2a** (1.0 mmol, 206.2 mg), Cs_2CO_3 (2.0 mmol, 651.6mg) and DMSO (10.0 mL) were added. After the completion of the addition, the reaction mixture was allowed to react at 80 °C for 8 h. Then, the reaction mixture was cooled to room temperature and was treated with H_2O, then extracted with EA and dried over anhydrous Na_2SO_4. After removal of the EA, the residue was purified by chromatography on basic silica gel (PE: EA = 10: 1) to afford **3i** (yellow solid, 335.7 mg, 67%).

5. Synthesis of 4.



1a **4a**

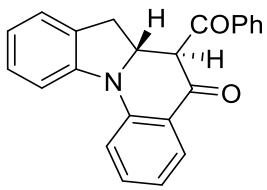
In a schlenk tube, 3-(2-(1H-indol-1-yl)phenyl)-3-oxopropanenitrile **1a** (0.2 mmol, 52.1 mg), ZnI_2 (0.01 mmol, 3.2 mg) and toluene (0.2 mL) were stirred at 80 °C (oil bath) under air. After the reaction was completed as monitored by thin-layer chromatography, the reaction mixture was then quenched by water, and the water layers were extracted with ethyl acetate (10 mL × 3). The combined organic layers were washed with brine, dried over anhydrous Na_2SO_4, filtered, and concentrated under reduced pressure. Purification by chromatography on silica gel (petroleum ether/ethyl acetate = 10/1) afforded desired compound **4a** (yellow solid, 51.6 mg, 99%).



4a

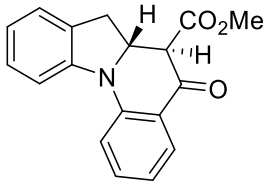
(6S,6aR)-5-oxo-5,6,6a,7-tetrahydroindolo[1,2-a]quinoline-6-carbonitrile (**4a**). Yellow solid, obtained in 2 h and purified by chromatography on silica gel (petroleum ether/ethyl acetate = 10:1); yield: 99%, 51.6 mg, m.p. 141-143 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.04 (d, *J* = 8.4 Hz, 1H), 7.67-7.49 (m, 2H), 7.33-7.15 (m, 3H), 7.13-7.03 (m, 1H), 6.99-6.87 (m, 1H), 4.86-4.70 (m, 1H), 3.98 (d, *J* = 12.8 Hz, 1H), 3.65 (dd, *J* = 16.8, 9.6 Hz, 1H), 3.21 (dd, *J* = 16.8, 4.8 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 184.1, 145.4, 143.9, 136.5, 129.5, 128.4, 128.3, 126.2, 122.2, 121.7, 121.0,

119.0, 114.7, 108.7, 62.0, 45.5, 33.1. HRMS (ESI) m/z: $[M+Na]^+$ calcd for $C_{17}H_{12}N_2NaO$ 283.0842; found 283.0842.



4b

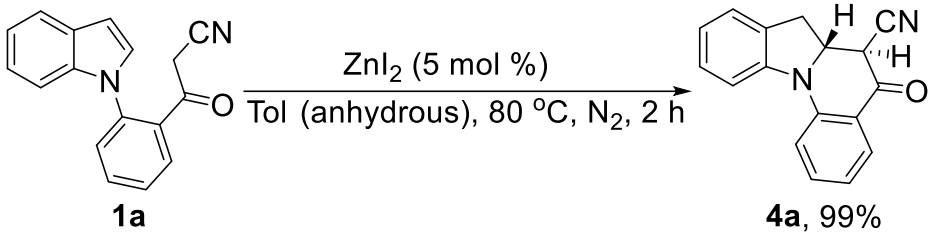
(6S,6aR)-6-benzoyl-6a,7-dihydroindolo[1,2-a]quinolin-5(6H)-one (**4b)**. Yellow solid, obtained in 2 h and purified by chromatography on silica gel (petroleum ether/ethyl acetate = 20:1); yield: 93%, 63.2 mg, m.p. 184-186 °C. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.05-7.91 (m, 3H), 7.68-7.55 (m, 3H), 7.53-7.45 (m, 2H), 7.36 (d, *J* = 8.0 Hz, 1H), 7.23-7.12 (m, 2H), 7.02-6.95 (m, 1H), 6.91-6.84 (m, 1H), 5.24-5.10 (m, 1H), 4.86 (d, *J* = 13.5 Hz, 1H), 3.58 (dd, *J* = 16.5, 9.5 Hz, 1H), 2.75 (dd, *J* = 17.0, 6.5 Hz, 1H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 197.0, 190.6, 145.5, 144.3, 137.9, 135.5, 133.7, 129.8, 129.0, 128.9, 128.7, 127.7, 125.7, 122.2, 120.7, 120.5, 117.1, 108.9, 61.7, 59.4, 33.8. HRMS (ESI) m/z: $[M+Na]^+$ calcd for $C_{23}H_{17}NNaO_2$ 362.1151; found 362.1151.



4c

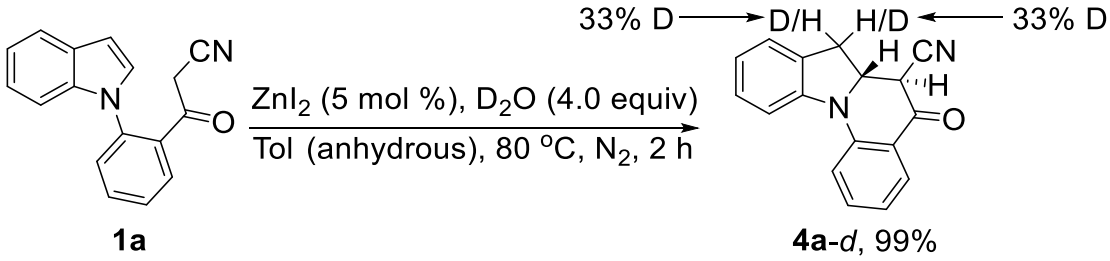
methyl (6R,6aR)-5-oxo-5,6,6a,7-tetrahydroindolo[1,2-a]quinoline-6-carboxylate (**4c)**. Yellow solid, obtained in 2 h and purified by chromatography on silica gel (petroleum ether/ethyl acetate = 20:1); yield: 97%, 56.9 mg, m.p. 146-148 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.02 (d, *J* = 7.6 Hz, 1H), 7.60-7.53 (m, 2H), 7.31 (d, *J* = 8.4 Hz, 1H), 7.23-7.16 (m, 2H), 7.04-6.96 (m, 1H), 6.92-6.85 (m, 1H), 4.93-4.82 (m, 1H), 3.87 (s, 3H), 3.85-3.80 (m, 1H), 3.52 (dd, *J* = 16.0, 9.2 Hz, 1H), 2.89 (dd, *J* = 16.0, 6.0 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 189.0, 169.1, 145.7, 144.4, 135.8, 129.5, 129.2, 128.0, 125.9, 121.6, 121.0, 120.9, 117.6, 109.0, 61.4, 59.0, 52.4, 33.2. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{18}H_{16}NO_3$ 294.1125, found 294.1127.

6. Mechanistic Studies



1a **4a**, 99%

In a schlenk tube, 3-(2-(1H-indol-1-yl)phenyl)-3-oxopropanenitrile **1a** (0.2 mmol, 52.1 mg), ZnI_2 (0.01 mmol, 3.2 mg) and anhydrous toluene (0.2 mL) were stirred at 80 °C (oil bath) under N_2. After the reaction was completed as monitored by thin-layer chromatography, the reaction mixture was then quenched by water, and the water layers were extracted with ethyl acetate (10 mL × 3). The combined organic layers were washed with brine, dried over anhydrous Na_2SO_4, filtered, and concentrated under reduced pressure. Purification by chromatography on silica gel (petroleum ether/ethyl acetate = 10/1) afforded desired compound **4a** (yellow solid, 51.8 mg, 99%).

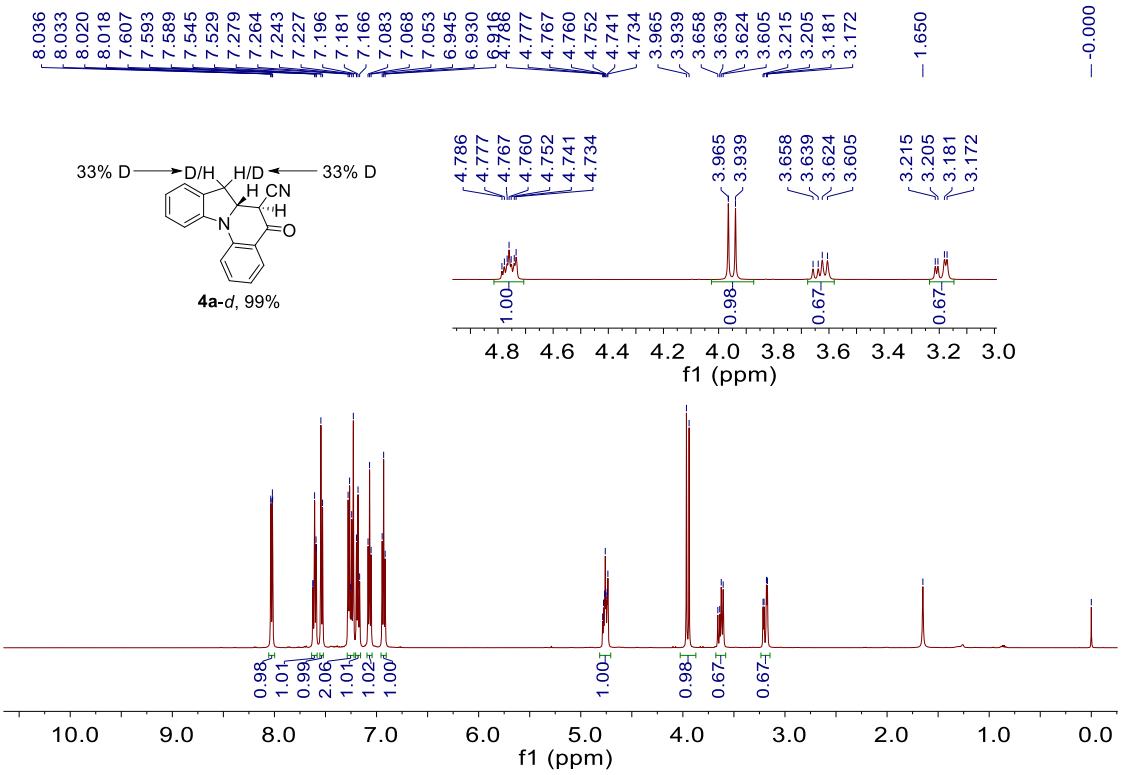


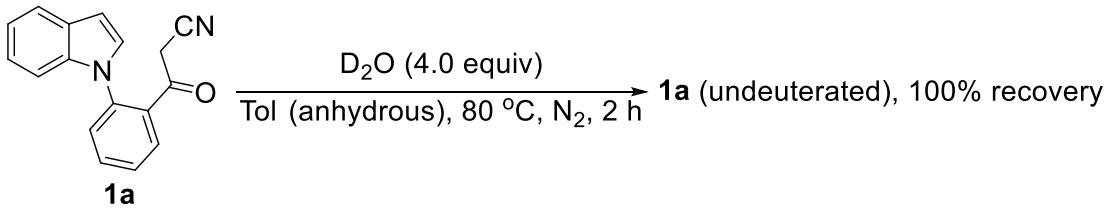
1a **4a**-*d*, 99%

In a schlenk tube, 3-(2-(1H-indol-1-yl)phenyl)-3-oxopropanenitrile **1a** (0.2 mmol, 52.1 mg), ZnI_2 (0.01 mmol, 3.2 mg), D_2O (0.8 mmol, 16 mg) and anhydrous toluene (0.2 mL) were stirred at 80 °C (oil bath) under N_2. After the reaction was completed as monitored by thin-layer chromatography, the reaction mixture was then quenched by water, and the water layers were extracted with ethyl acetate (10 mL × 3). The combined organic layers were washed with brine, dried over anhydrous Na_2SO_4, filtered, and concentrated under reduced pressure. Purification by chromatography on silica gel (petroleum ether/ethyl acetate = 10/1) afforded compound **4a**-*d* (yellow solid, 51.4 mg, 99%).

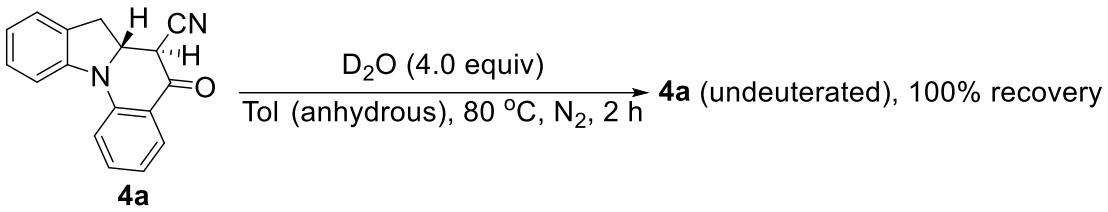
4a-*d*: ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.06-8.00 (m, 1H), 7.64-7.58 (m, 1H), 7.55-7.52 (m, 1H), 7.28-7.25 (m, 2H), 7.20-7.16 (m, 1H), 7.09-7.05 (m, 1H), 6.96-6.92 (m, 1H), 4.82-4.71 (m, 1H), 3.95 (d, *J* = 13.0 Hz, 1H), 3.63 (dd, *J* = 17.0, 9.5 Hz, 0.67H), 3.19 (dd, *J* = 17.0, 5.0 Hz, 0.67H).

^{1}H NMR (500 MHz, $CDCl_3$)

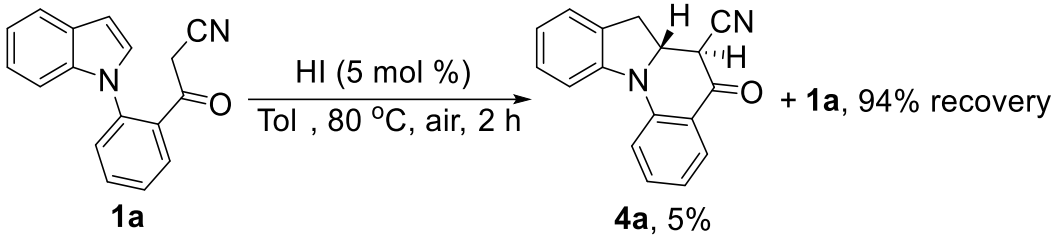




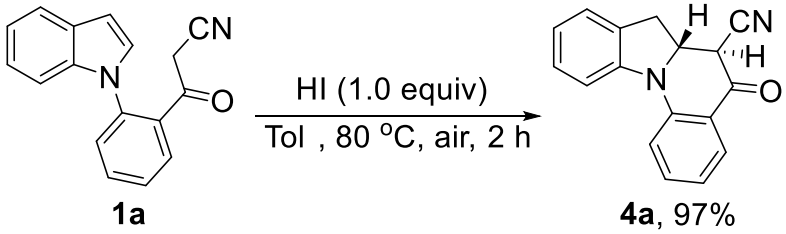
In a schlenk tube, 3-(2-(1H-indol-1-yl)phenyl)-3-oxopropanenitrile **1a** (0.2 mmol, 52.1 mg), D_2O (0.8 mmol, 16 mg) and anhydrous toluene (0.2 mL) were stirred at 80 °C (oil bath) under N_2. After 2 h, the reaction mixture was quenched by water, and the water layers were extracted with ethyl acetate (10 mL × 3). The combined organic layers were washed with brine, dried over anhydrous Na_2SO_4, filtered, and concentrated under reduced pressure. Purification by chromatography on silica gel (petroleum ether/ethyl acetate = 10/1) afforded undeuterated **1a** (yellow oil, 52.0 mg, 100%).



In a schlenk tube, (6S,6aR)-5-oxo-5,6,6a,7-tetrahydroindolo[1,2-a]quinoline-6-carbonitrile **4a** (0.2 mmol, 52.1 mg), D_2O (0.8 mmol, 16 mg) and anhydrous toluene (0.2 mL) were stirred at 80 °C (oil bath) under N_2. After 2 h, the reaction mixture was quenched by water, and the water layers were extracted with ethyl acetate (10 mL × 3). The combined organic layers were washed with brine, dried over anhydrous Na_2SO_4, filtered, and concentrated under reduced pressure. Purification by chromatography on silica gel (petroleum ether/ethyl acetate = 10/1) afforded undeuterated **4a** (yellow solid, 52.1 mg,100%).

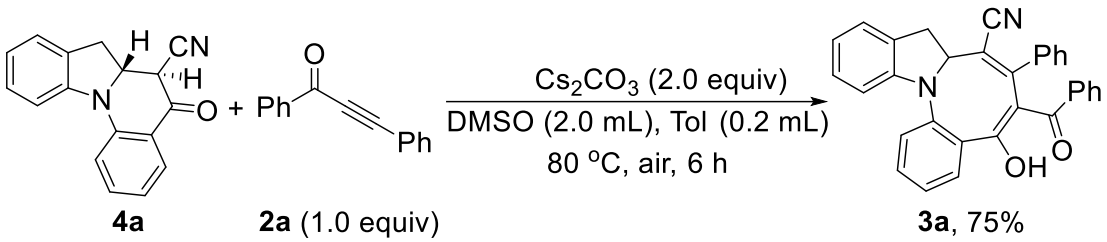


In a schlenk tube, 3-(2-(1H-indol-1-yl)phenyl)-3-oxopropanenitrile **1a** (0.2 mmol, 52.1 mg), HI (0.01 mmol) and toluene (0.2 mL) were stirred at 80 °C (oil bath) under air. After 2 h, the reaction mixture was quenched by water, and the water layers were extracted with ethyl acetate (10 mL × 3). The combined organic layers were washed with brine, dried over anhydrous Na_2SO_4, filtered, and concentrated under reduced pressure. Purification by chromatography on silica gel (petroleum ether/ethyl acetate = 10/1) afforded **4a** (yellow solid, 2.7 mg, 5%) and **1a** (yellow oil, 48.8 mg, 94%).



In a schlenk tube, 3-(2-(1H-indol-1-yl)phenyl)-3-oxopropanenitrile **1a** (0.2 mmol, 52.1 mg), HI (0.2 mmol) and anhydrous toluene (0.2 mL) were stirred at 80 °C (oil

bath) under air. After 2 h, the reaction mixture was quenched by water, and the water layers were extracted with ethyl acetate (10 mL × 3). The combined organic layers were washed with brine, dried over anhydrous Na_2SO_4, filtered, and concentrated under reduced pressure. Purification by chromatography on silica gel (petroleum ether/ethyl acetate = 10/1) afforded compound **4a** (yellow solid, 50.4 mg, 97%).



In a schlenk tube, (6S,6aR)-5-oxo-5,6,6a,7-tetrahydroindolo[1,2-a]quinoline-6-carbonitrile **4a** (0.2 mmol, 52.1 mg), 1,3-diphenylprop-2-yn-1-one **2a** (0.2 mmol, 41.2 mg), Cs_2CO_3 (0.4 mmol, 130.3 mg), DMSO (2.0 mL) and toluene (0.2 mL) were stirred at 80 °C (oil bath) under air. After the reaction was completed as monitored by thin-layer chromatography, the reaction mixture was then quenched by water, and the water layers were extracted with ethyl acetate (10 mL × 3). The combined organic layers were washed with brine, dried over anhydrous Na_2SO_4, filtered, and concentrated under reduced pressure. Purification by chromatography on silica gel (petroleum ether/ethyl acetate = 10/1) afforded **3a** (yellow solid, 70.2 mg, 75%).

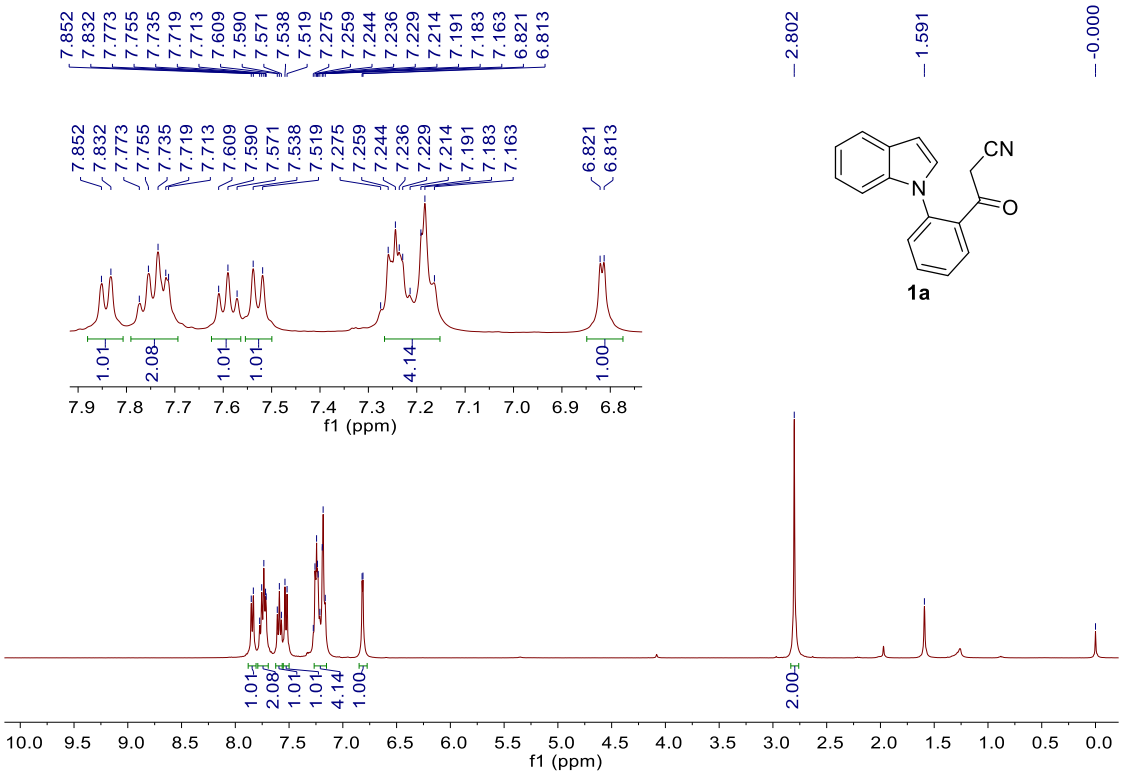
7. References

(1) Kiruthika, S. E.; Nandakumar, A.; Perumal, P. T. *Org. Lett*. **2014**, *16*, 4424.

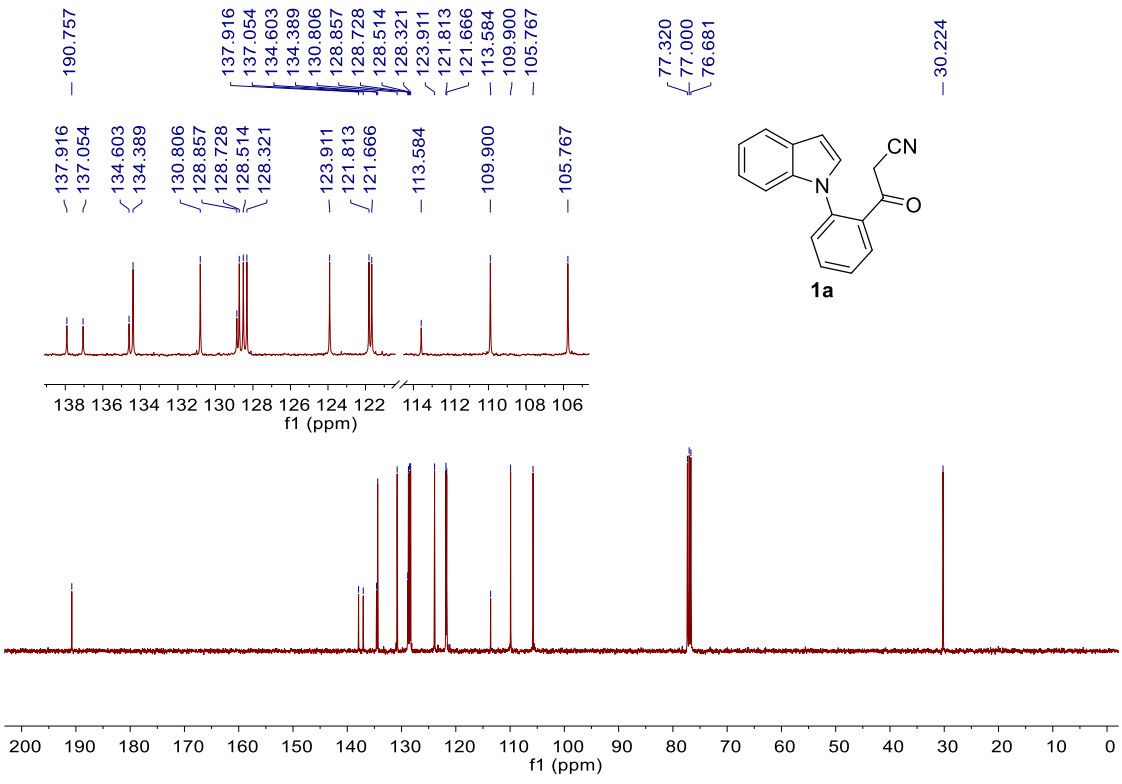
(2) Ko, T. Y.; Youn, S. W. *Adv. Synth. Catal.* **2016**, *358*, 1934.

8. Copies of Spectra of New Products

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



^{13}C NMR (100 MHz, $CDCl_3$)



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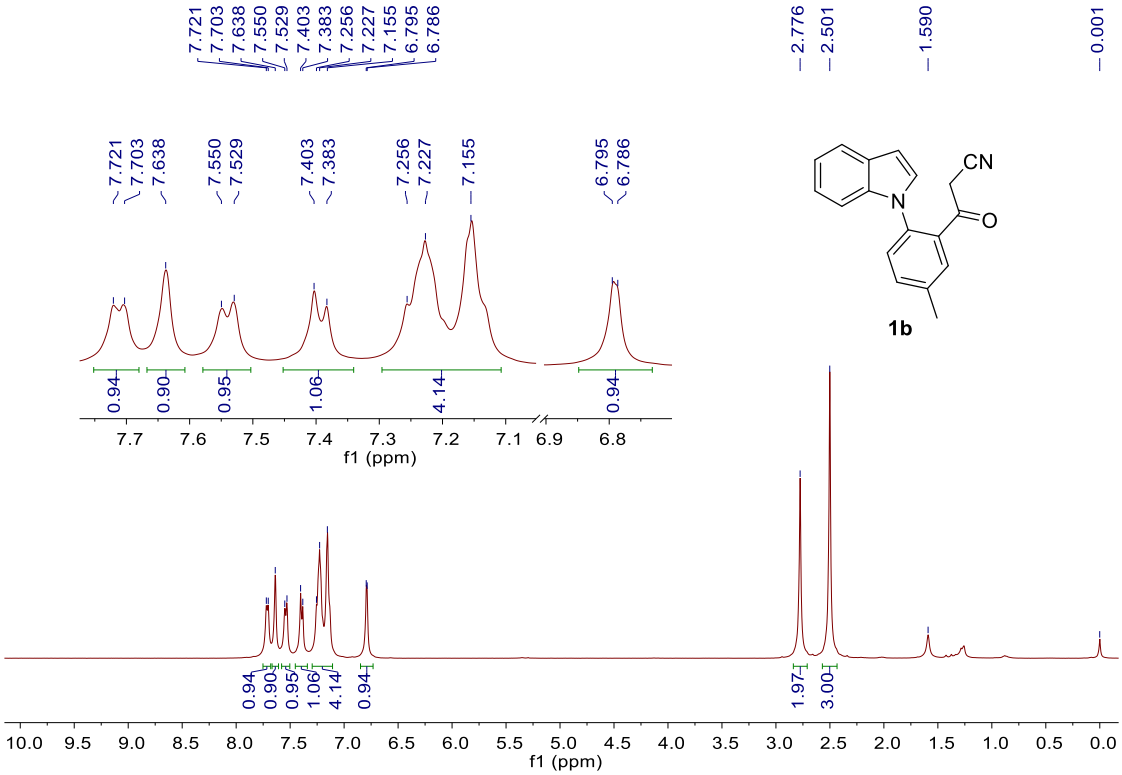

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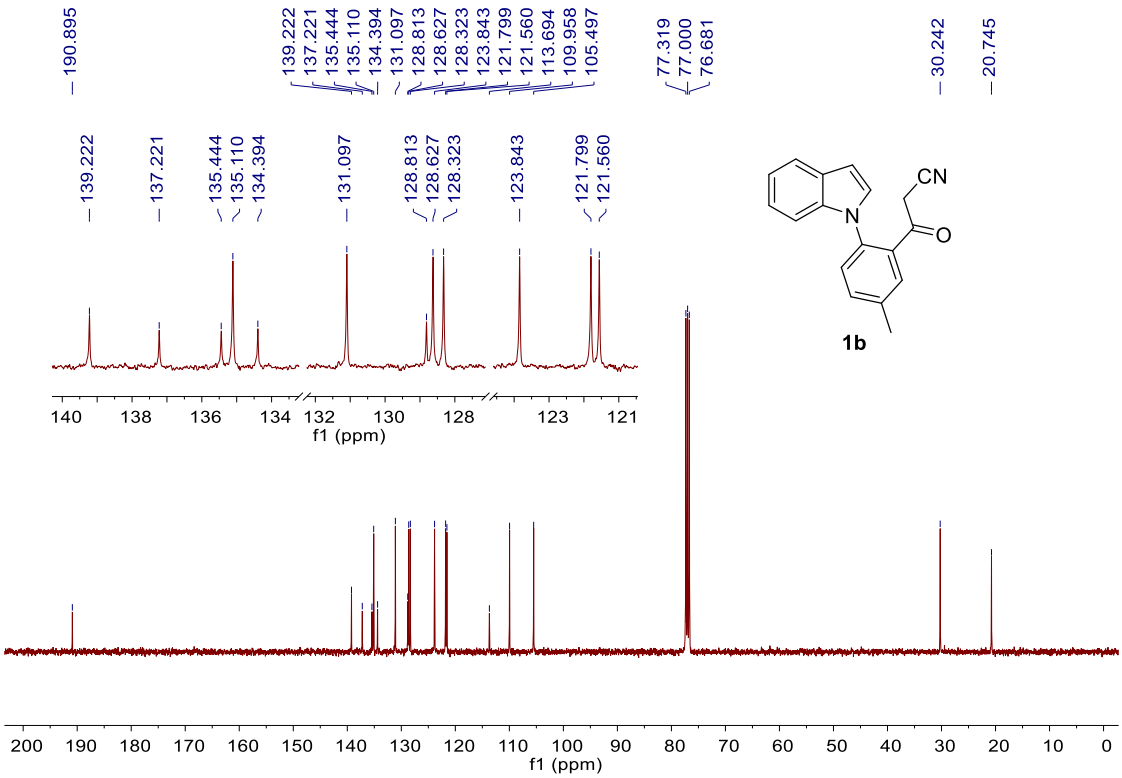

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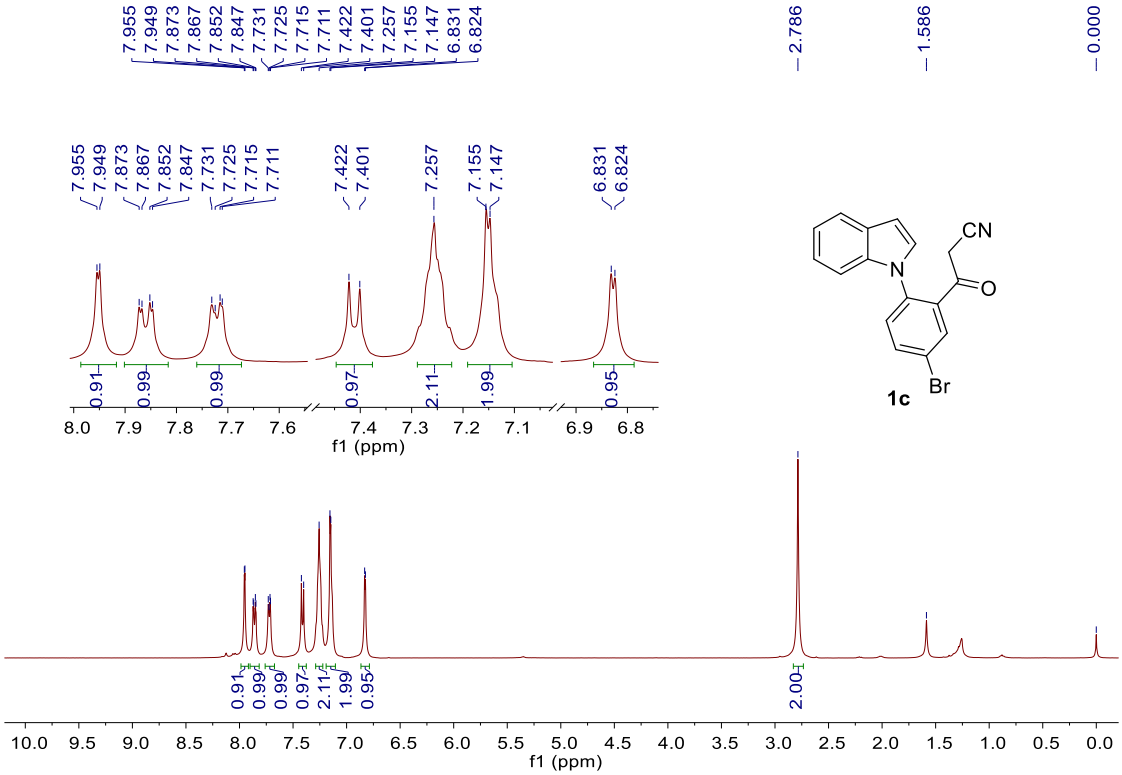

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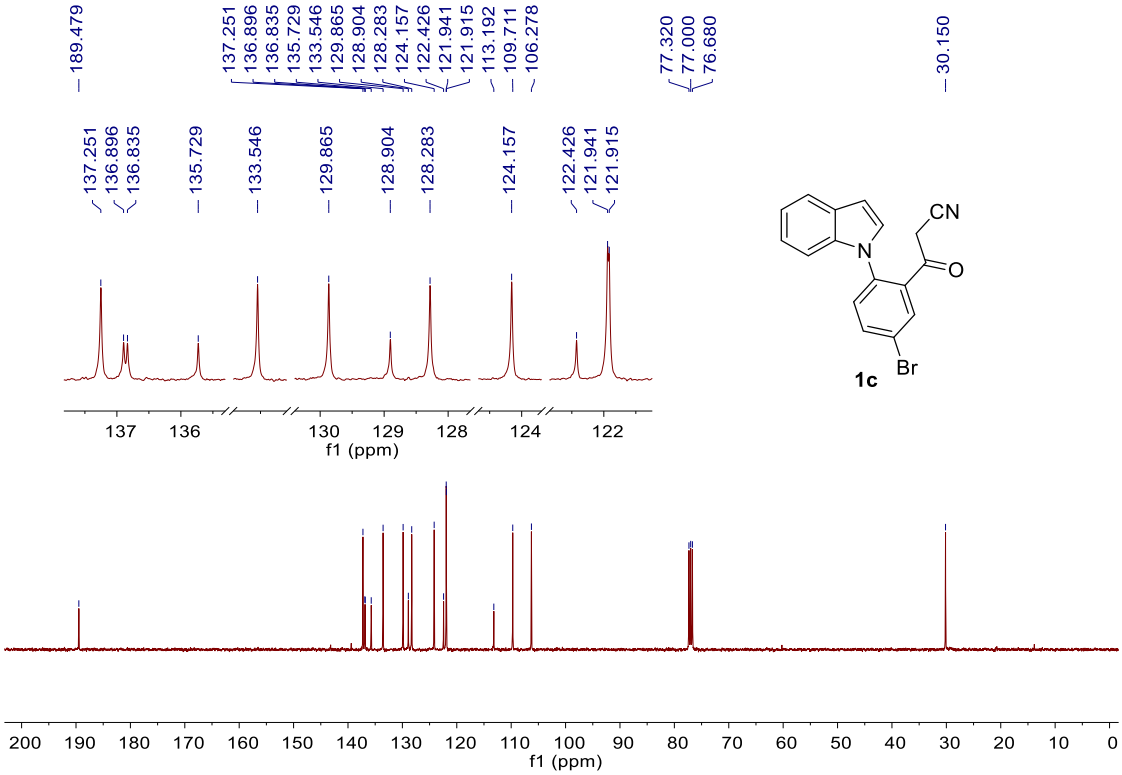

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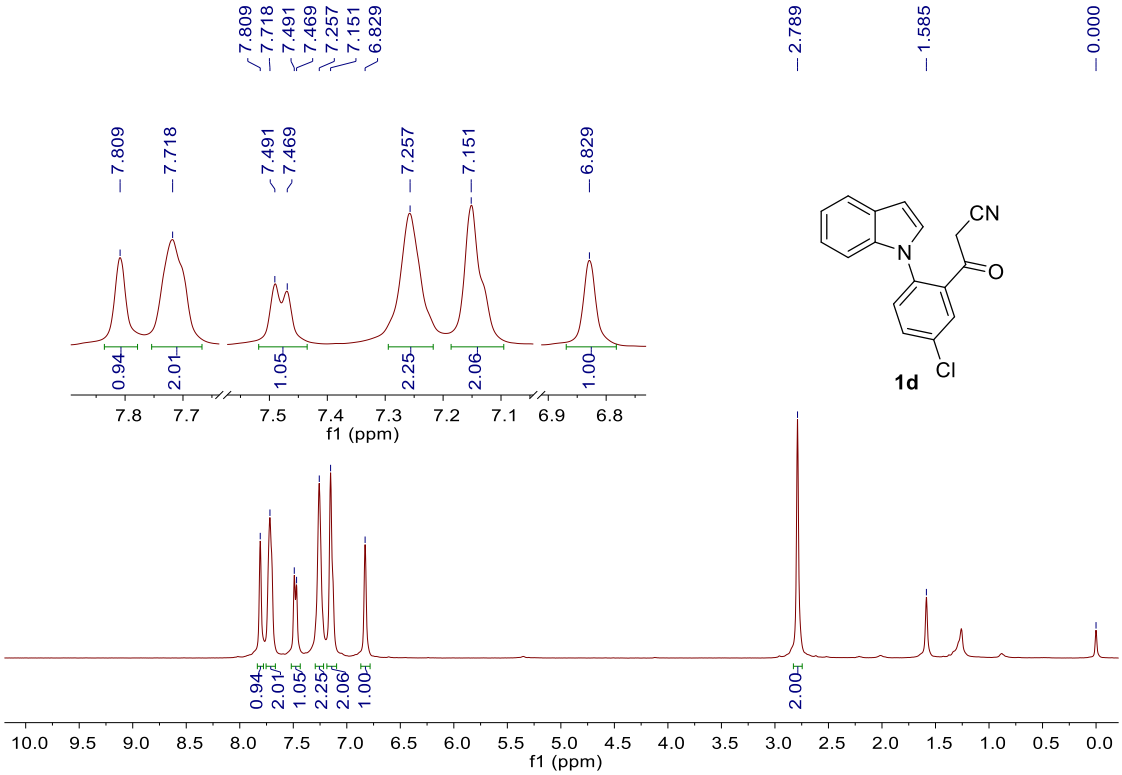

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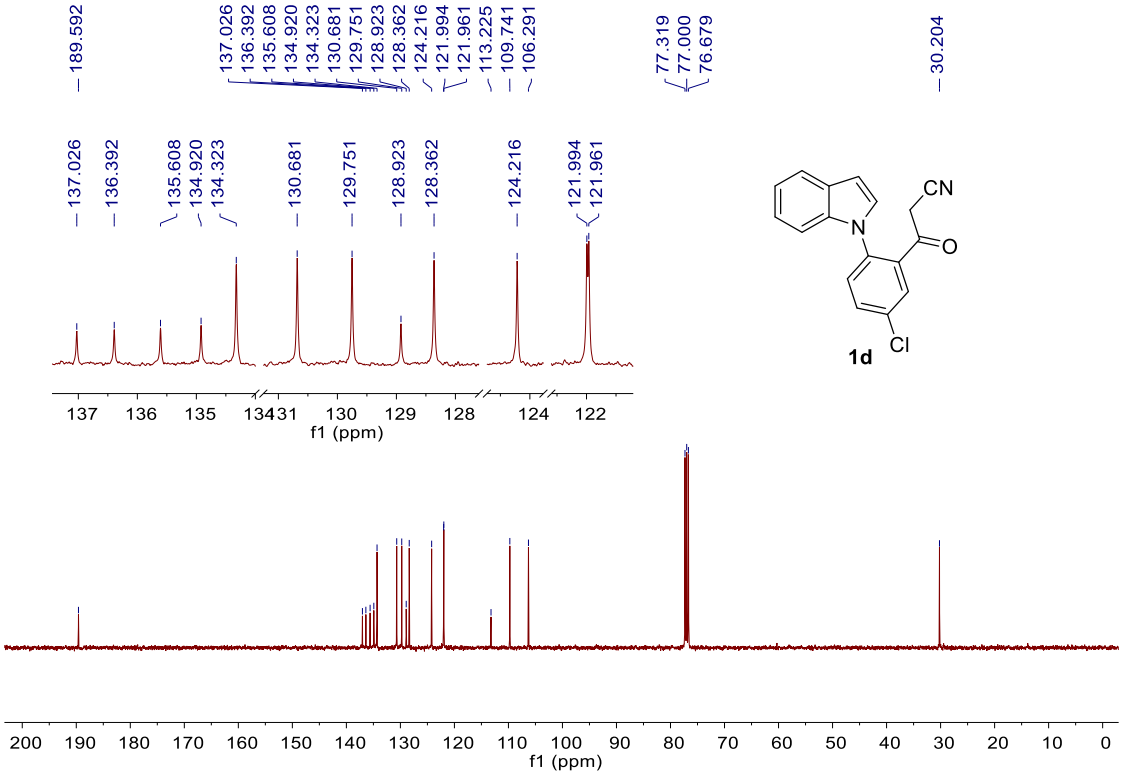

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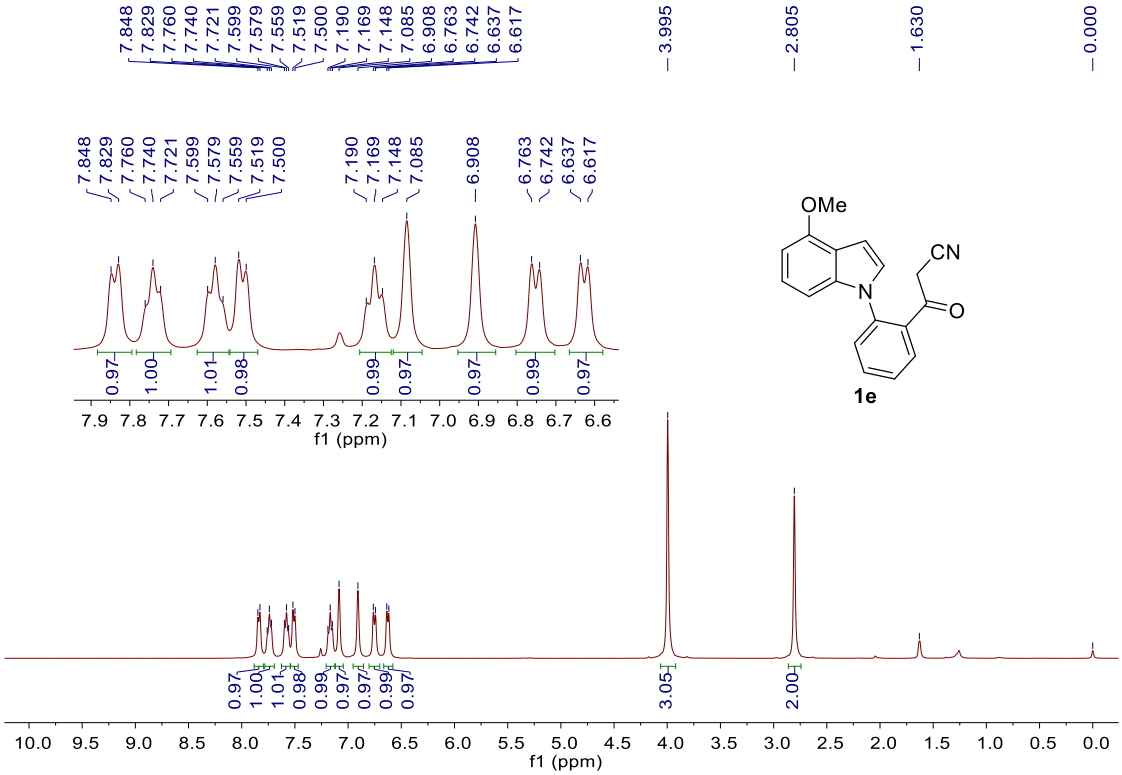

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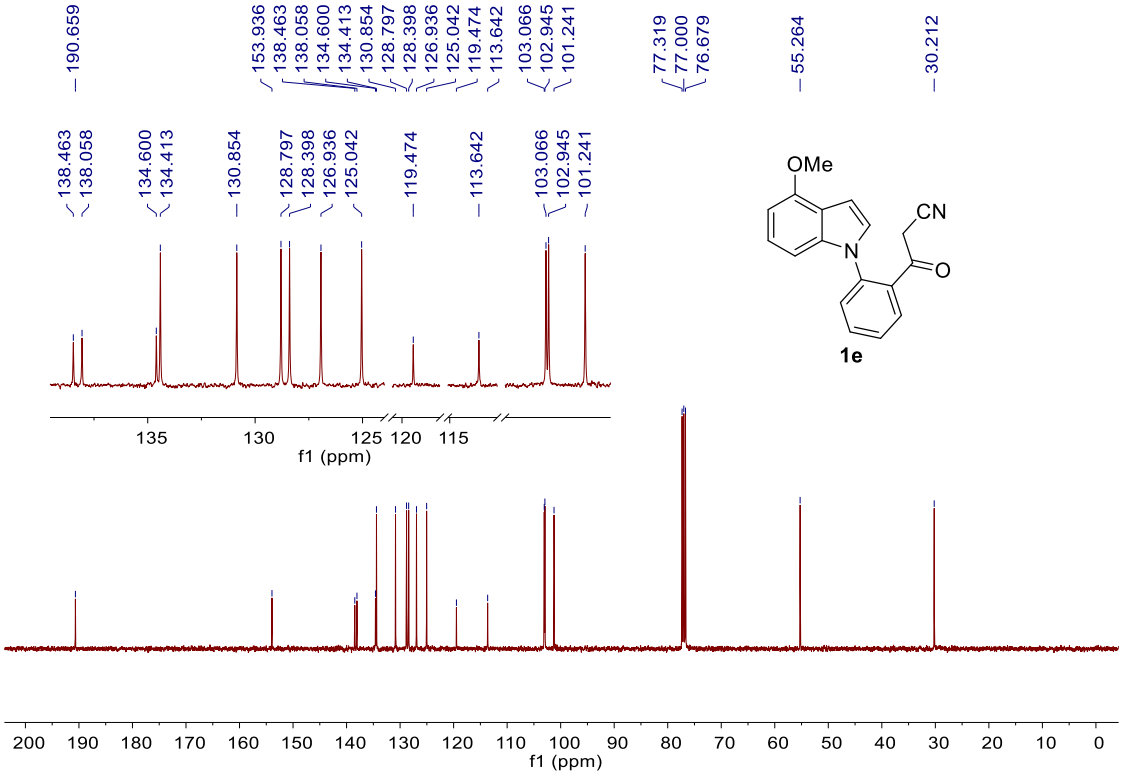

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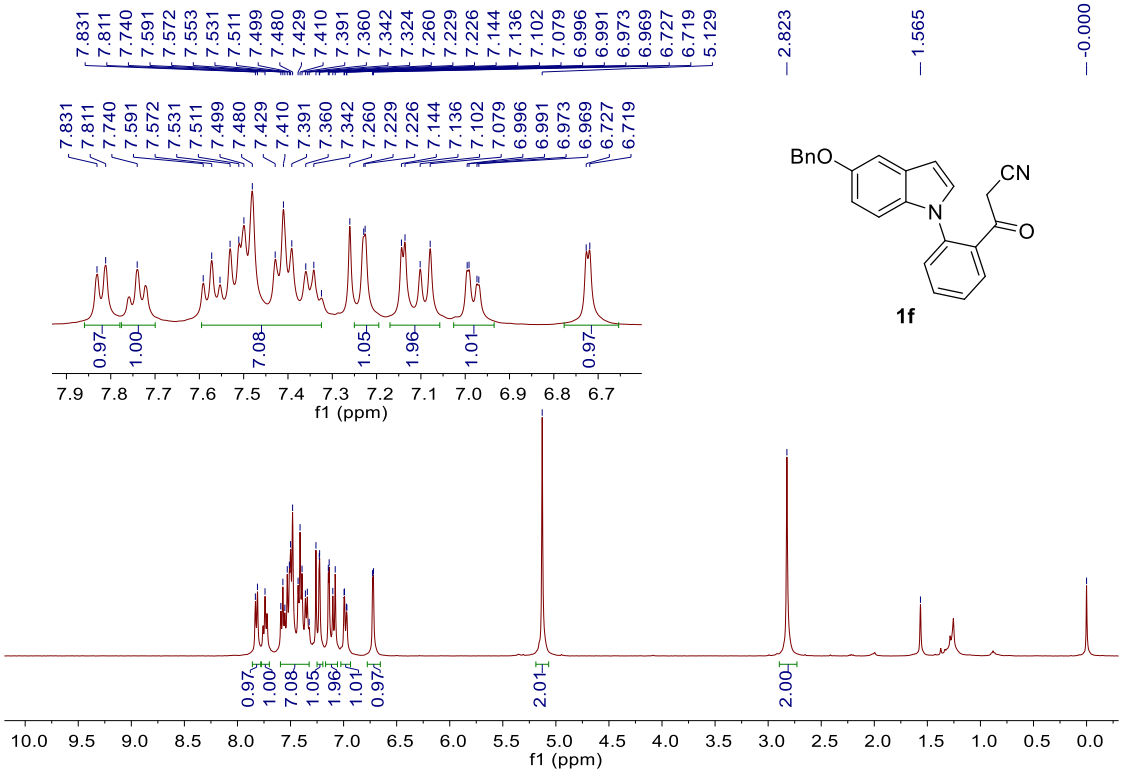

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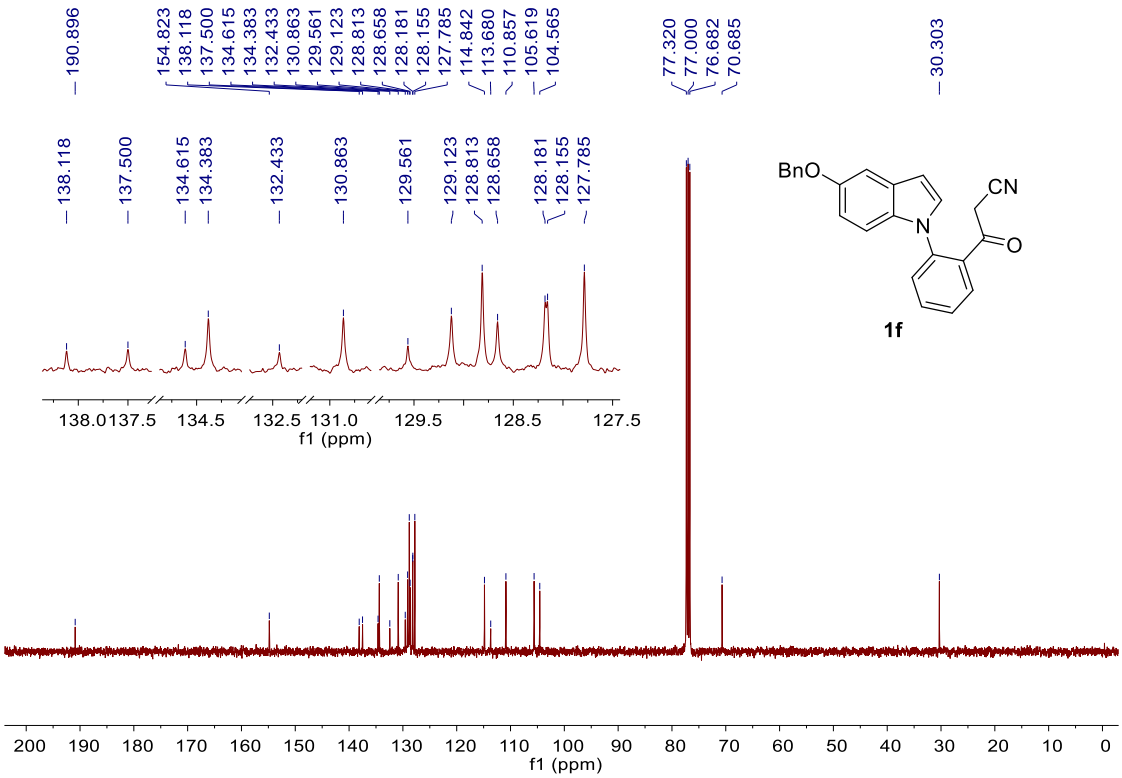

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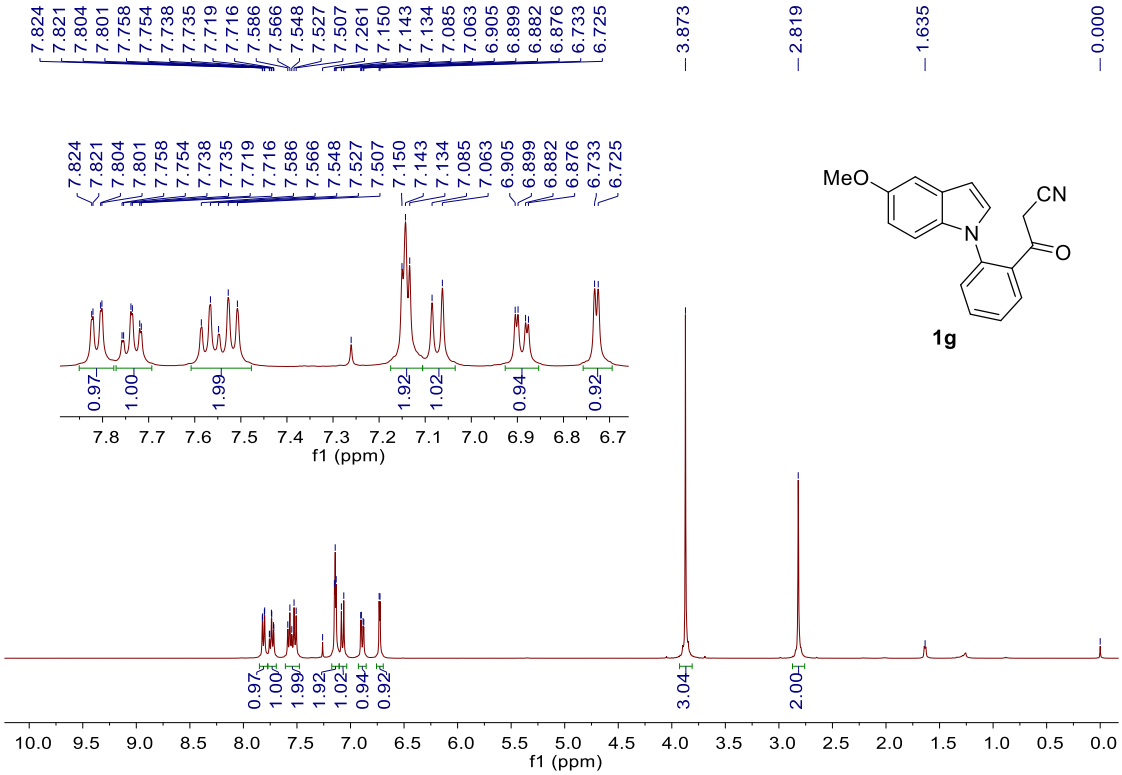

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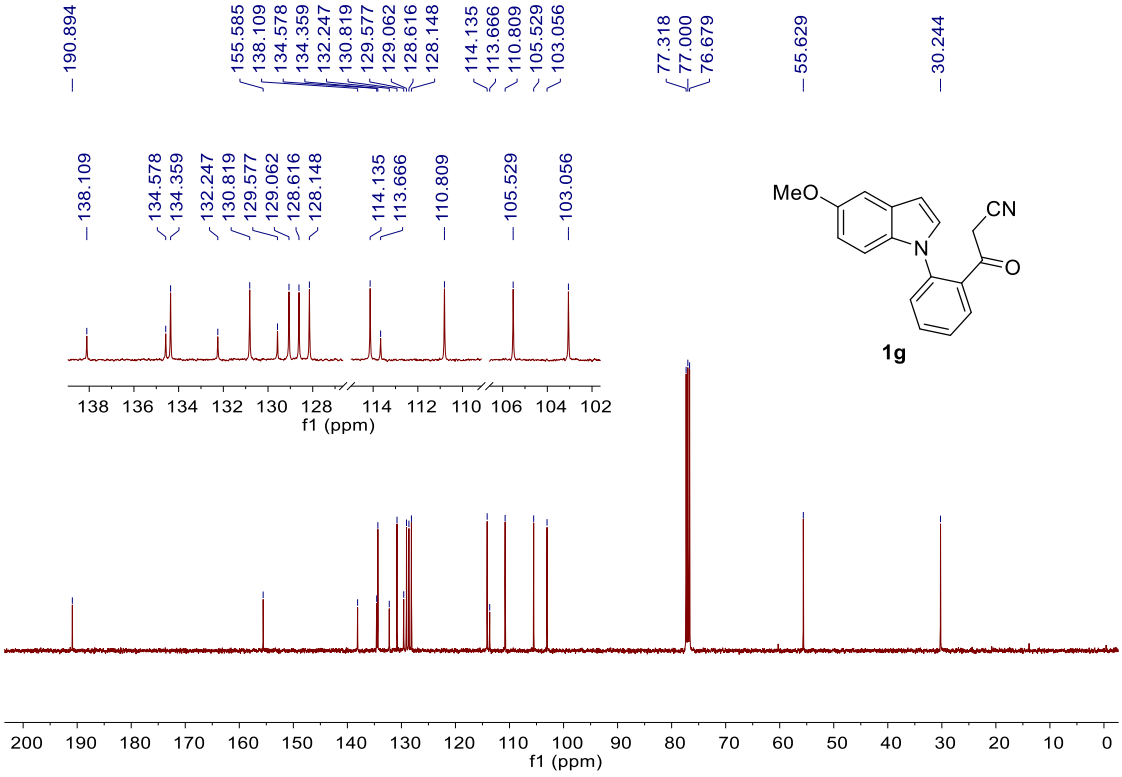

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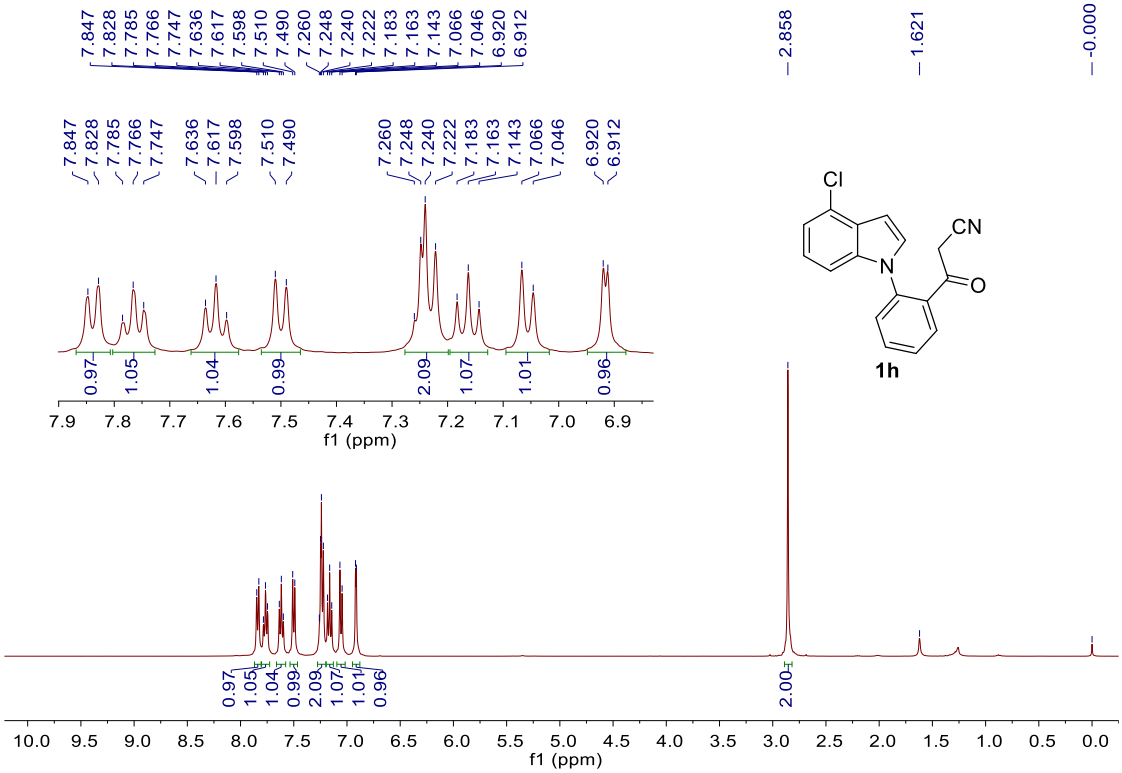

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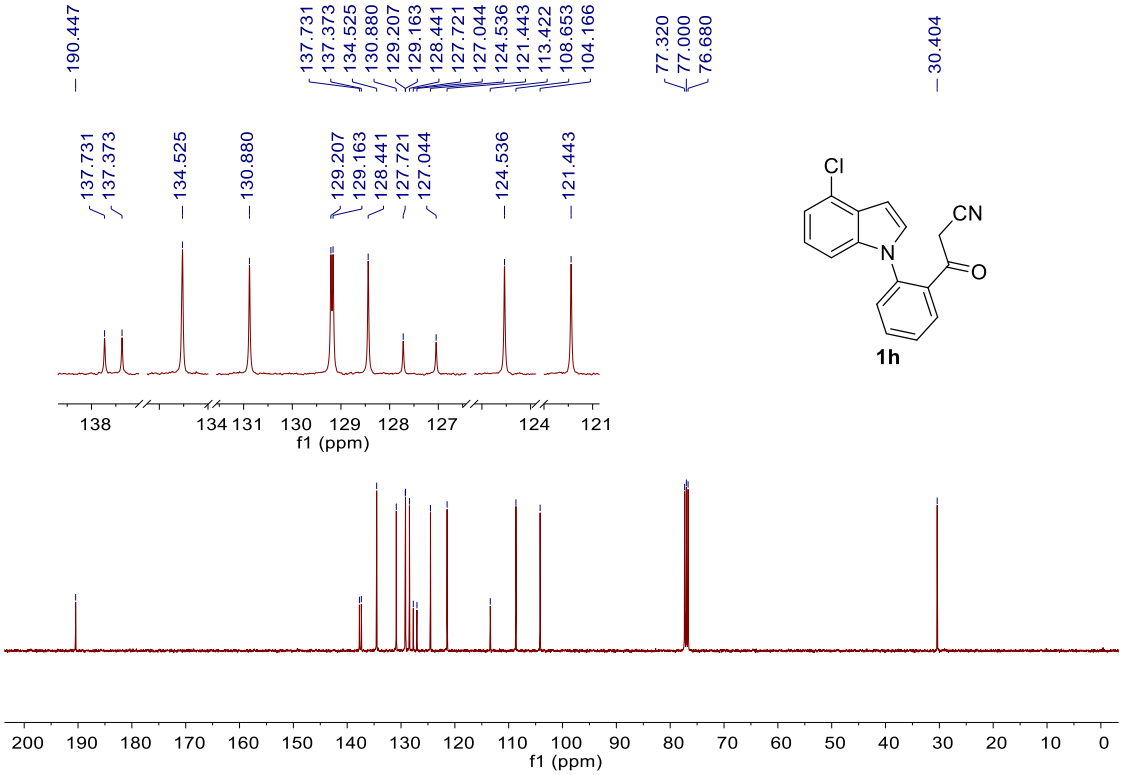

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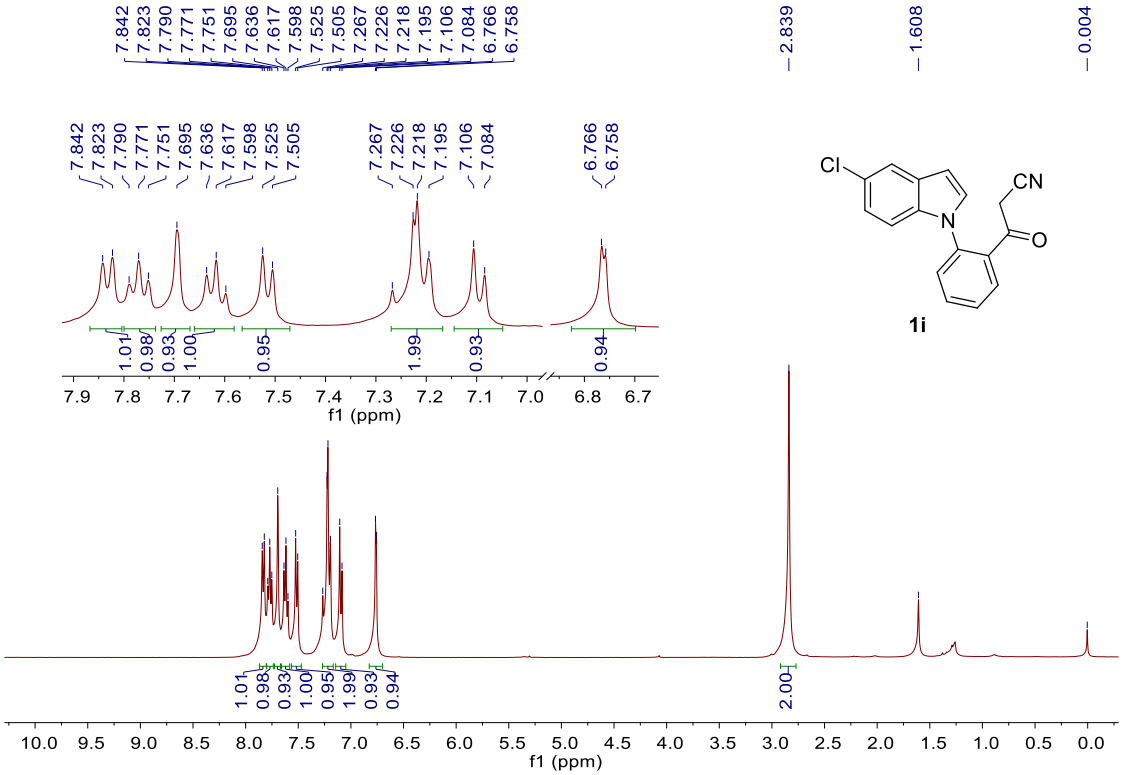

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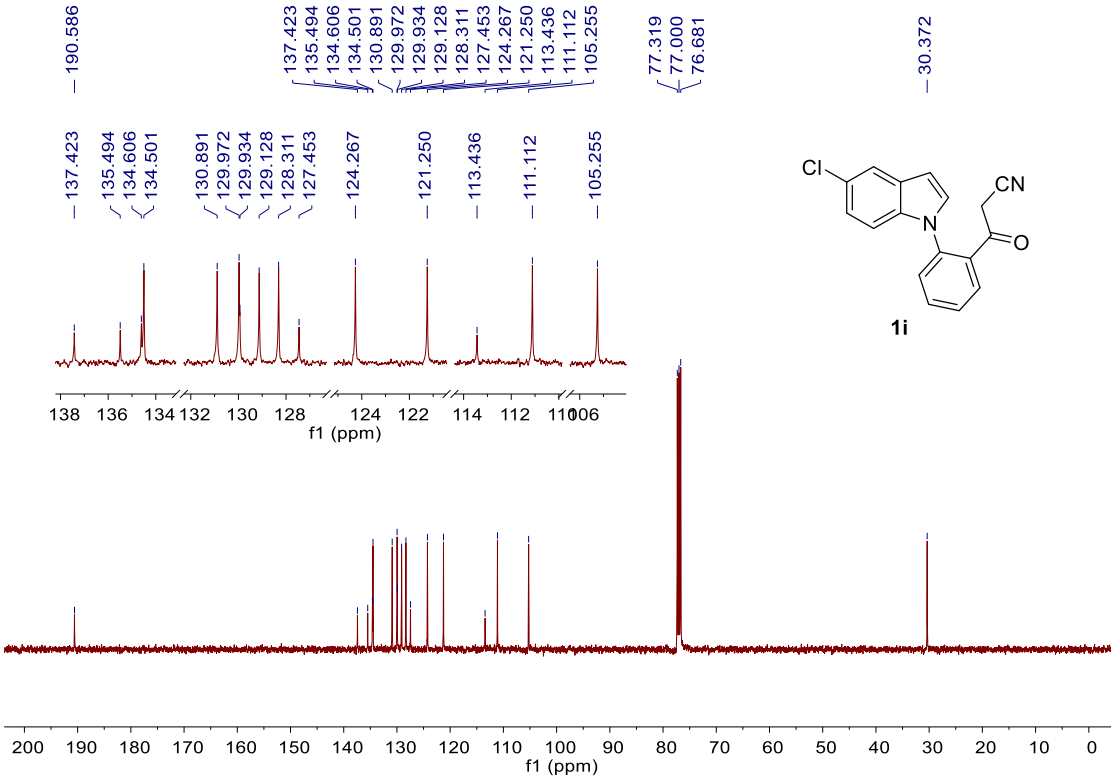

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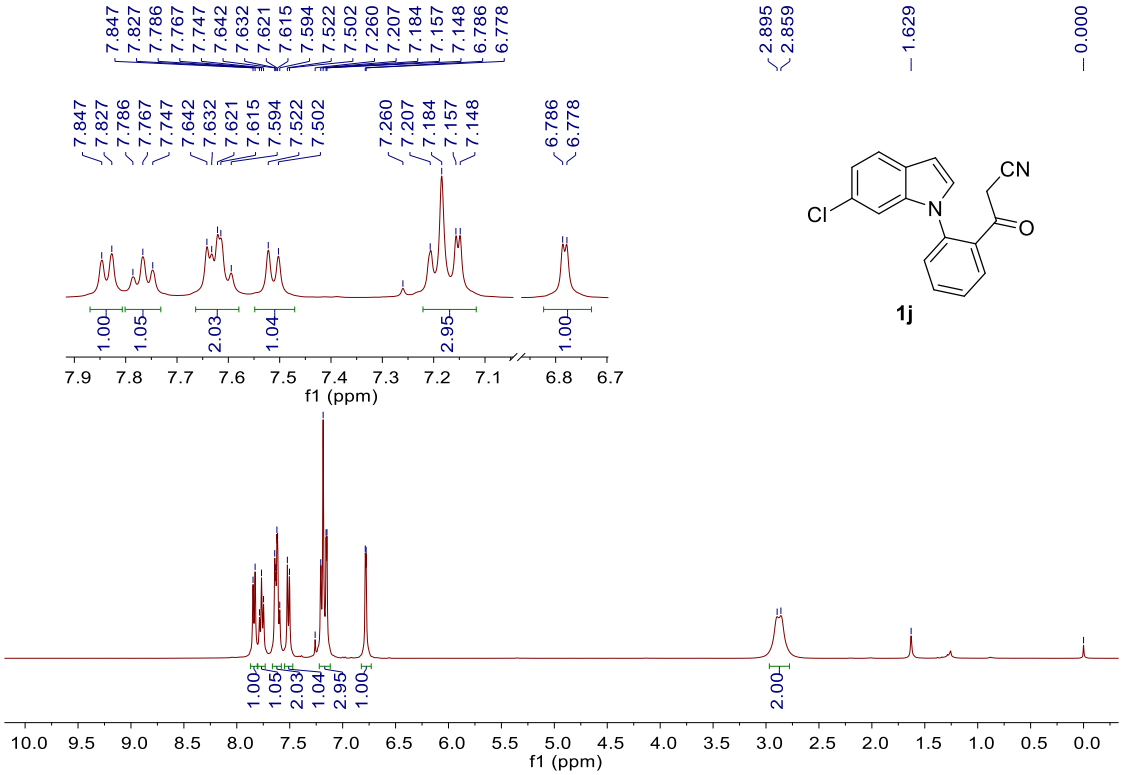

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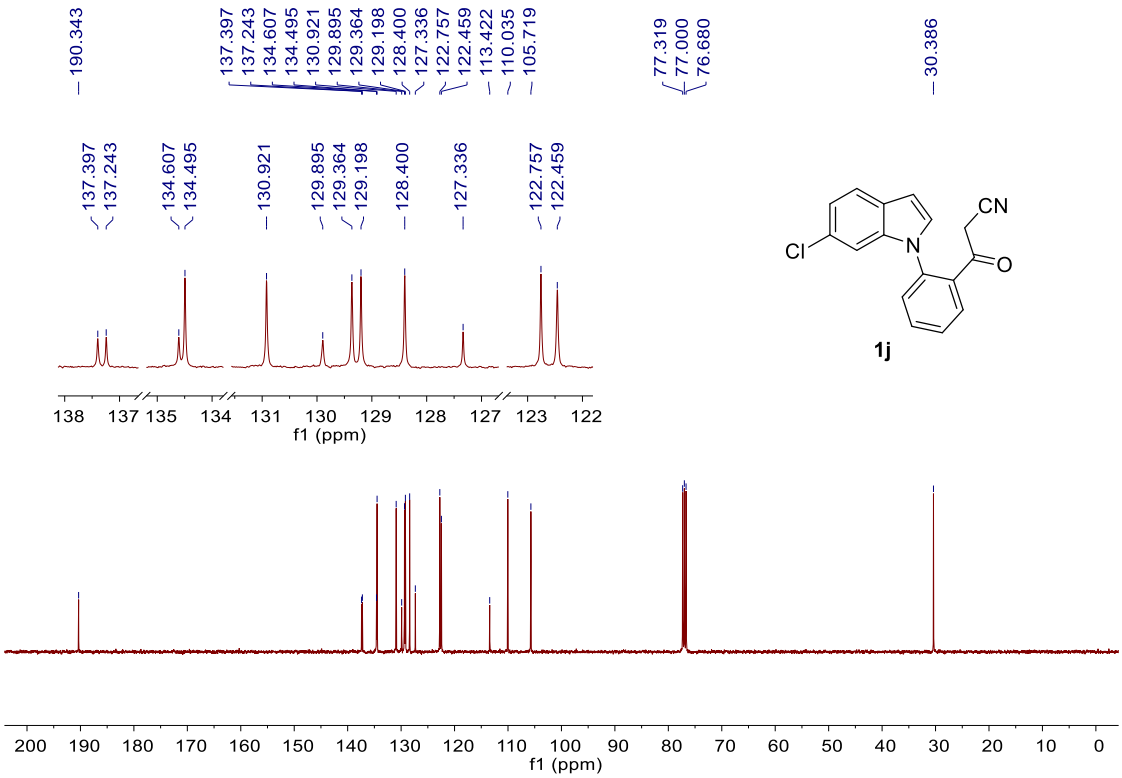

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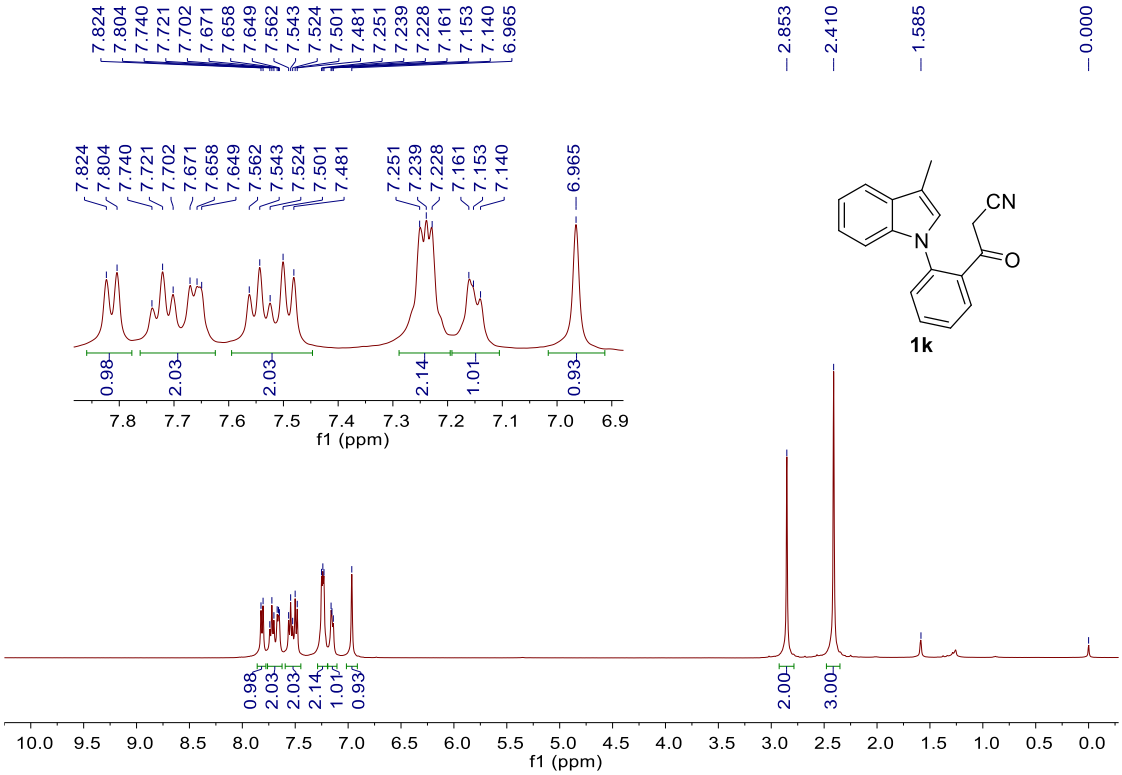

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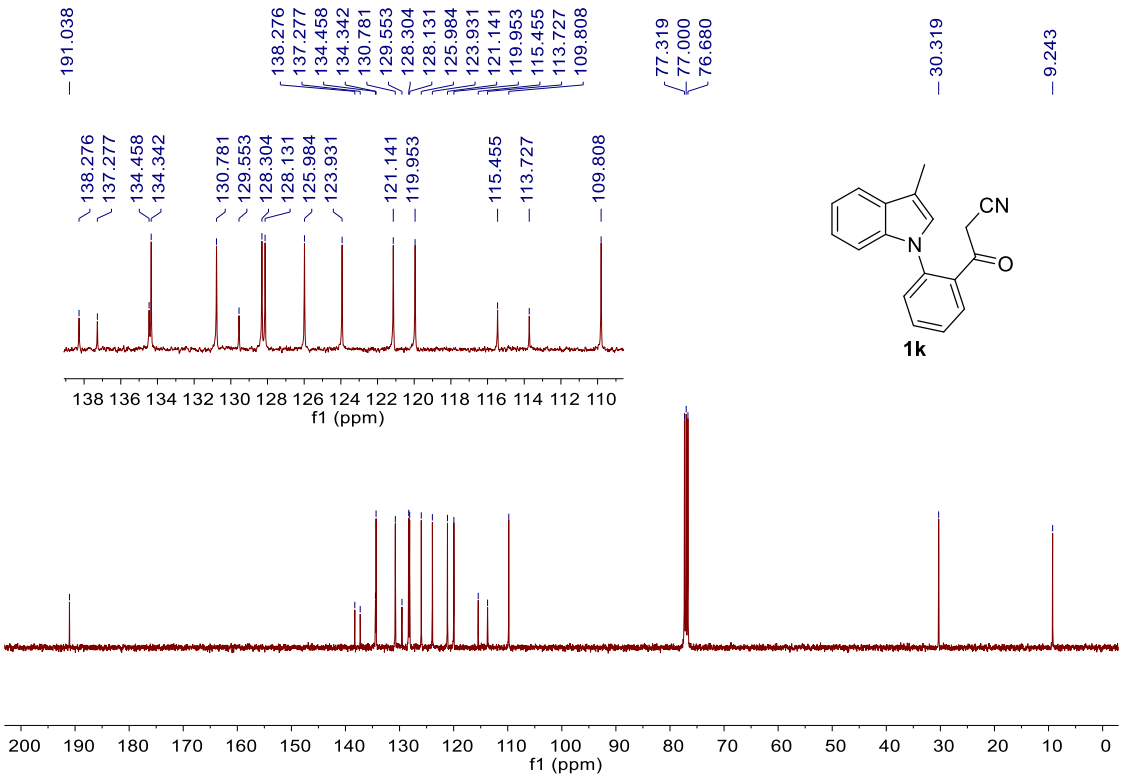

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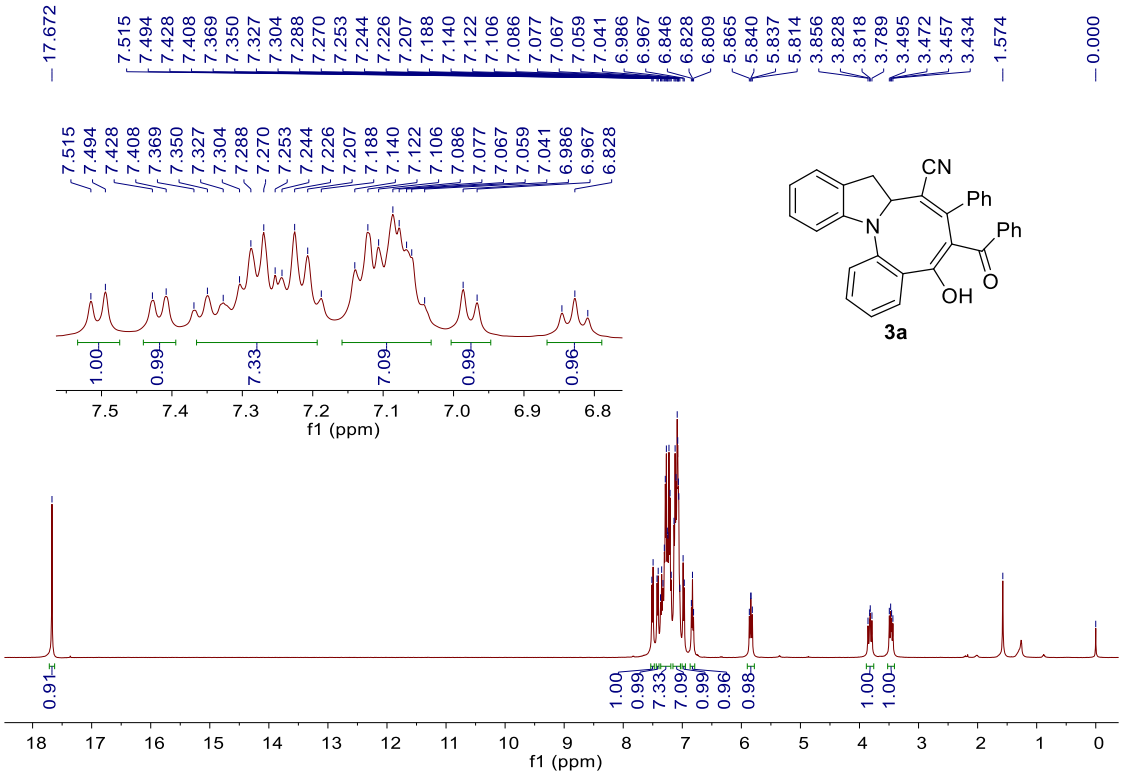
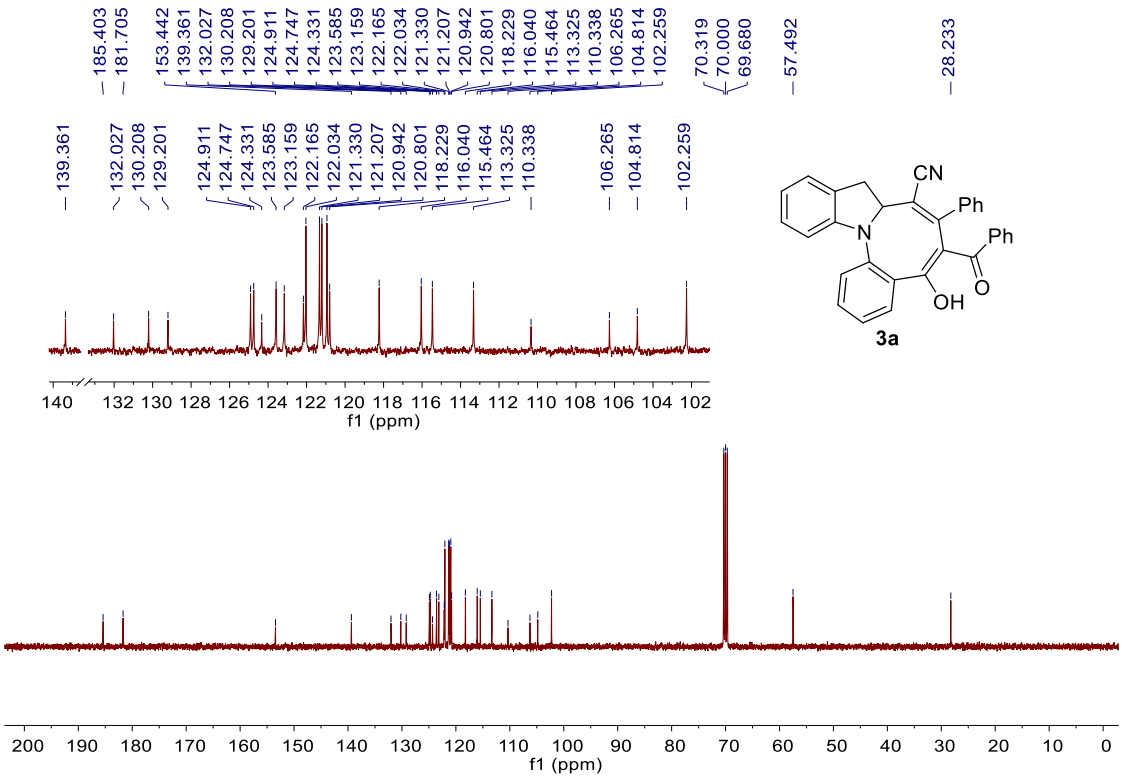
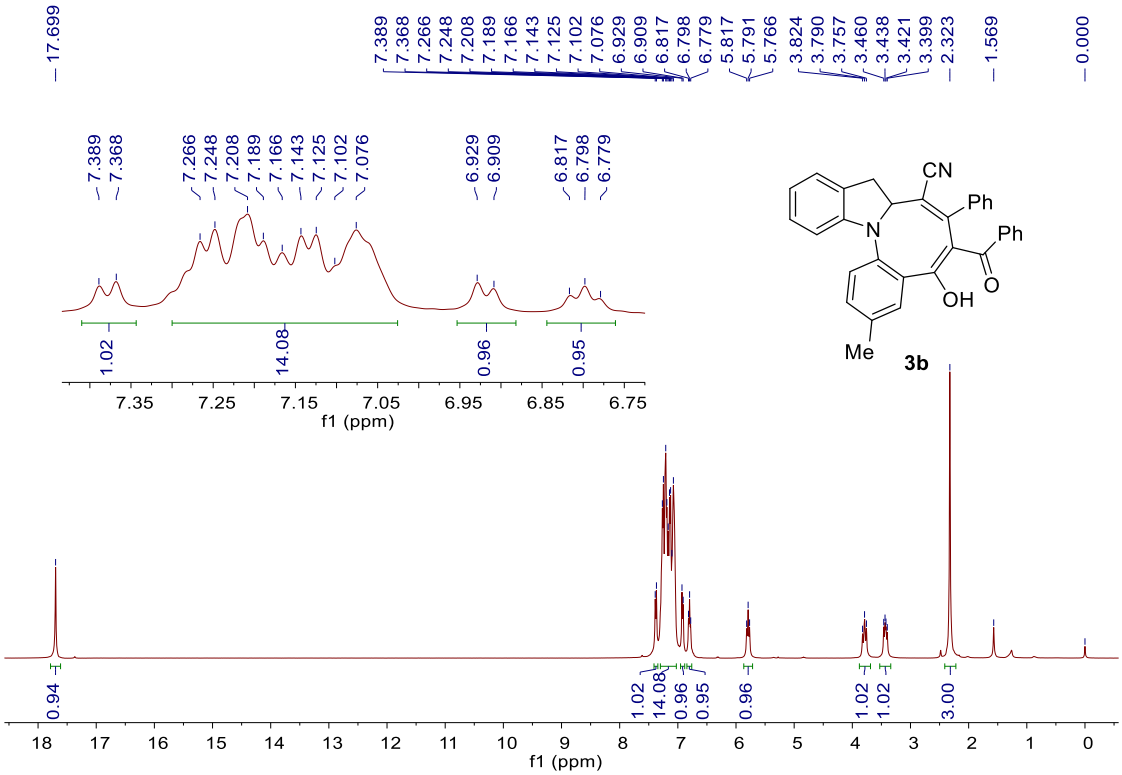


^{13}C NMR (100 MHz, $CDCl_3$)



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



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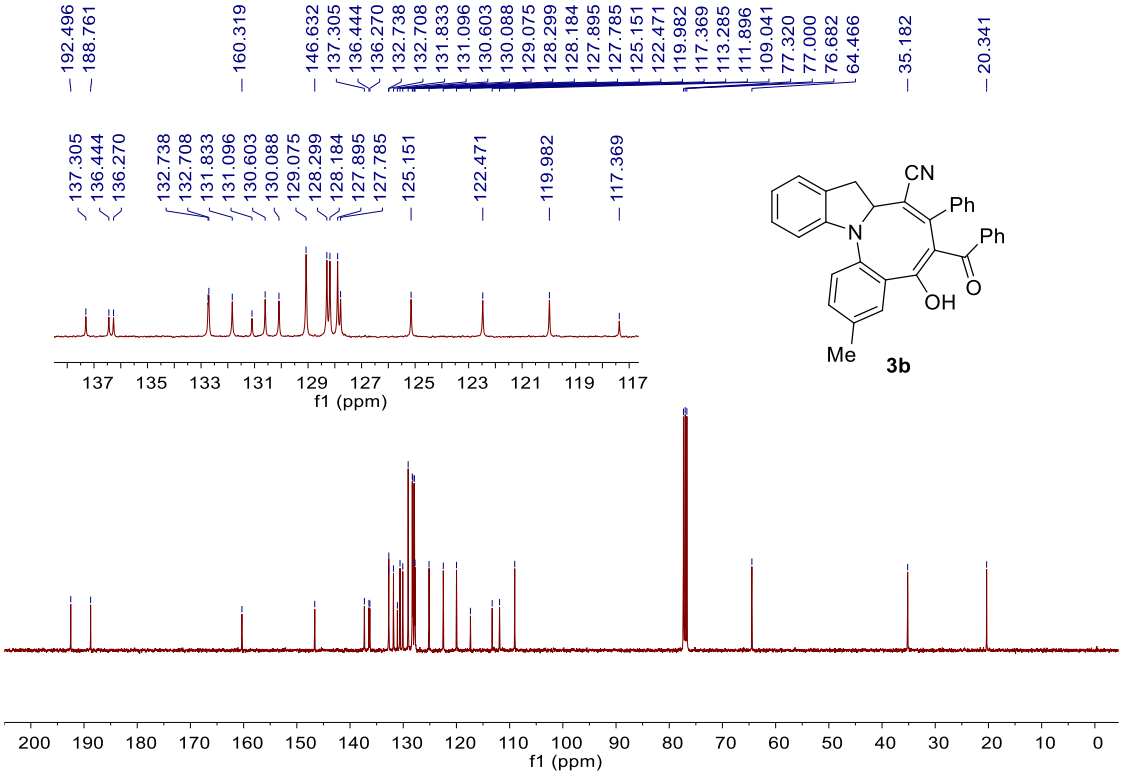

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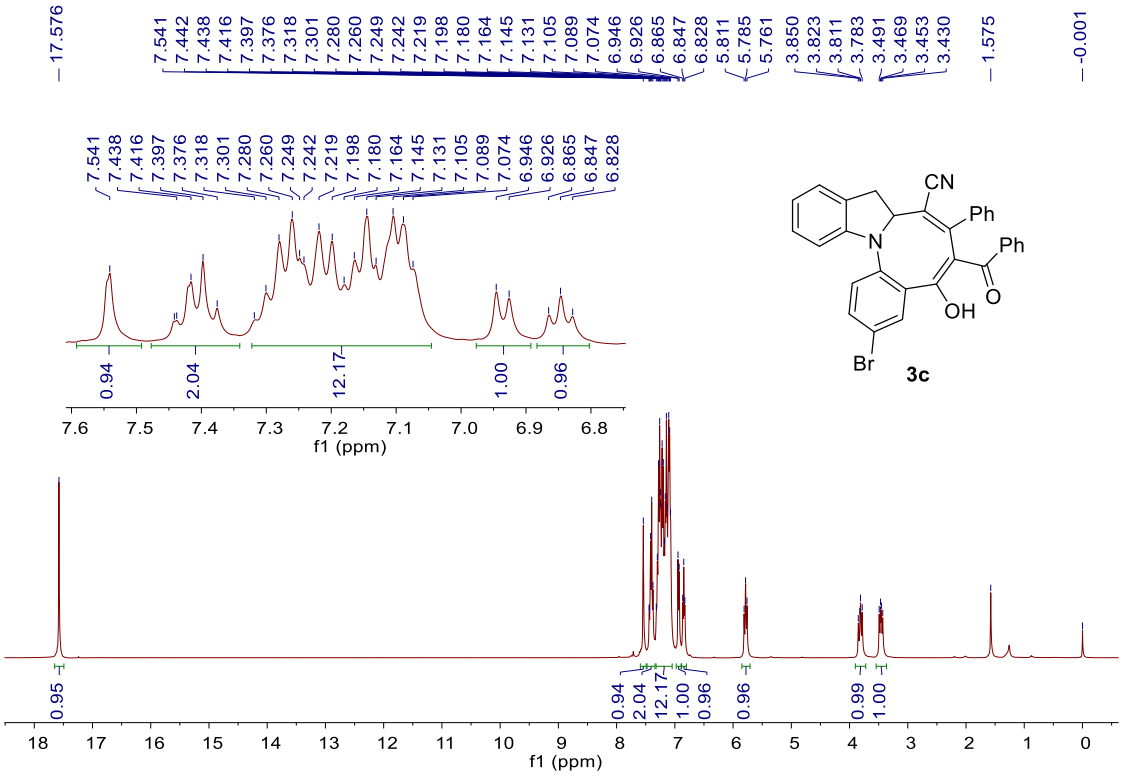

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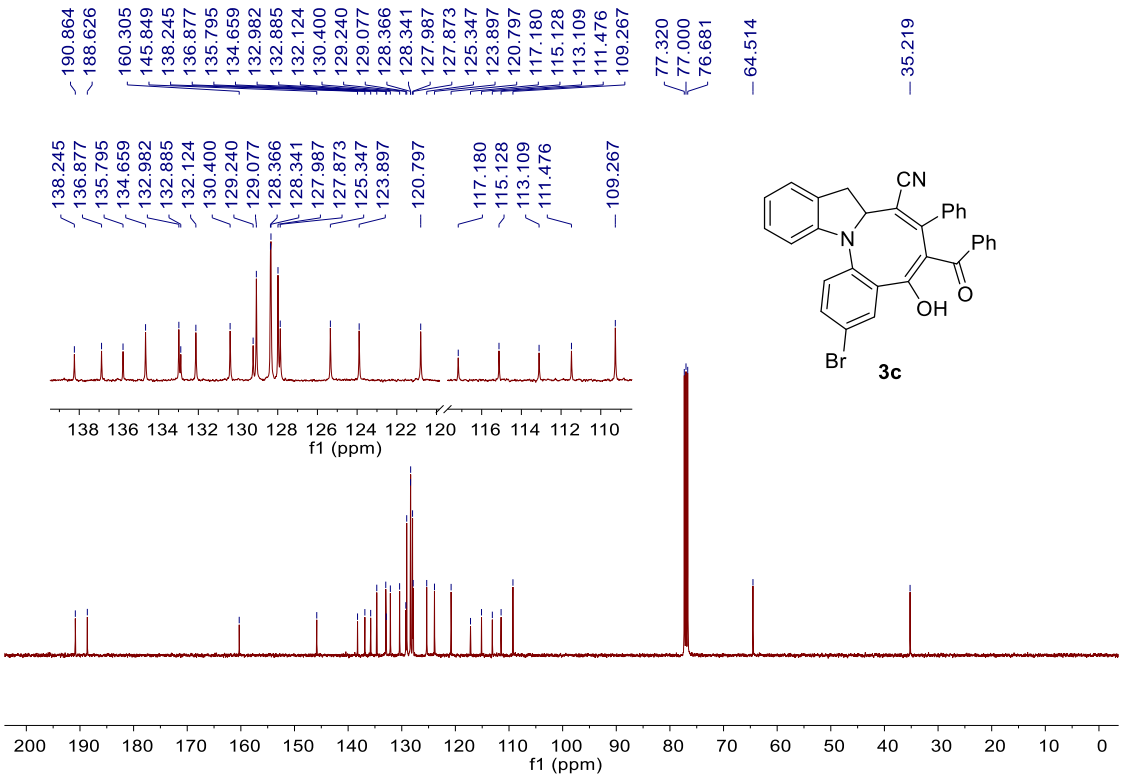

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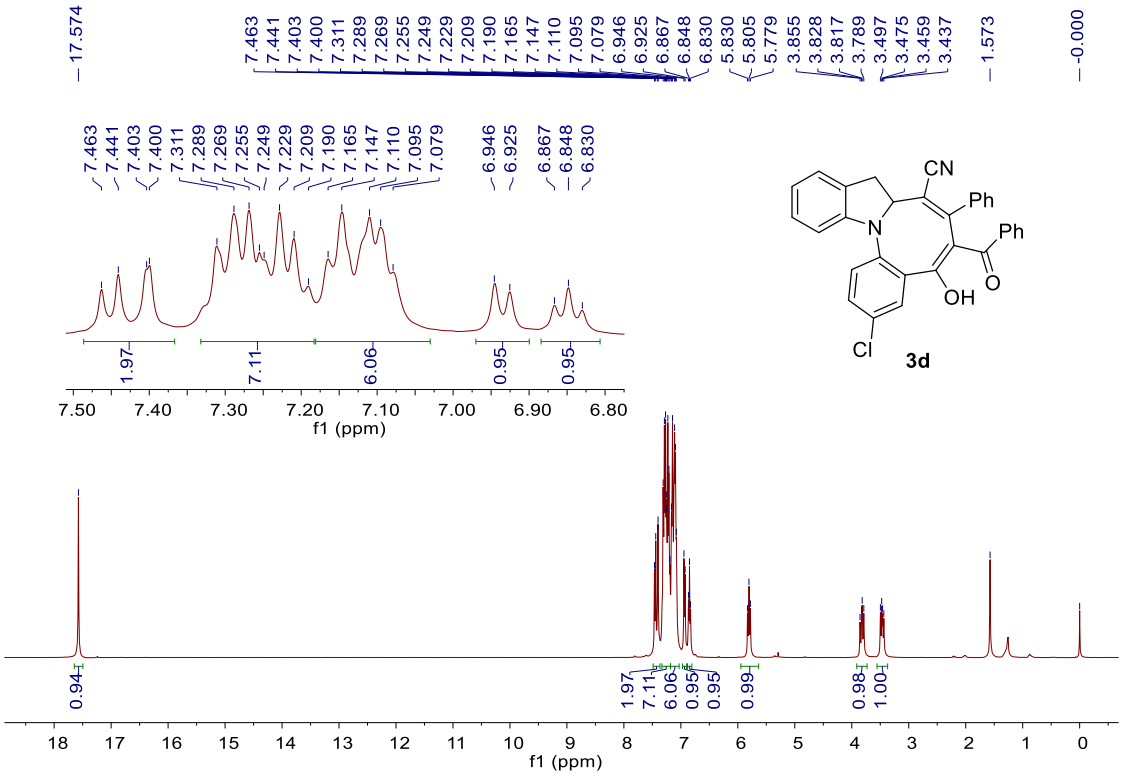

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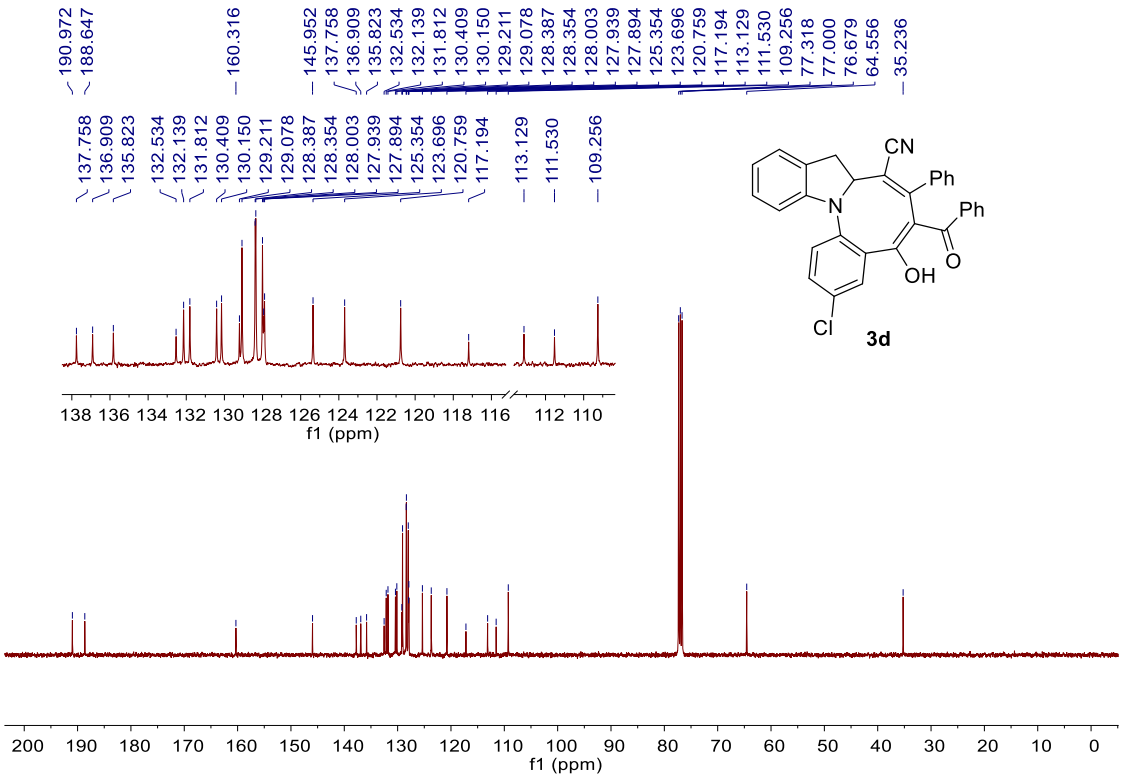

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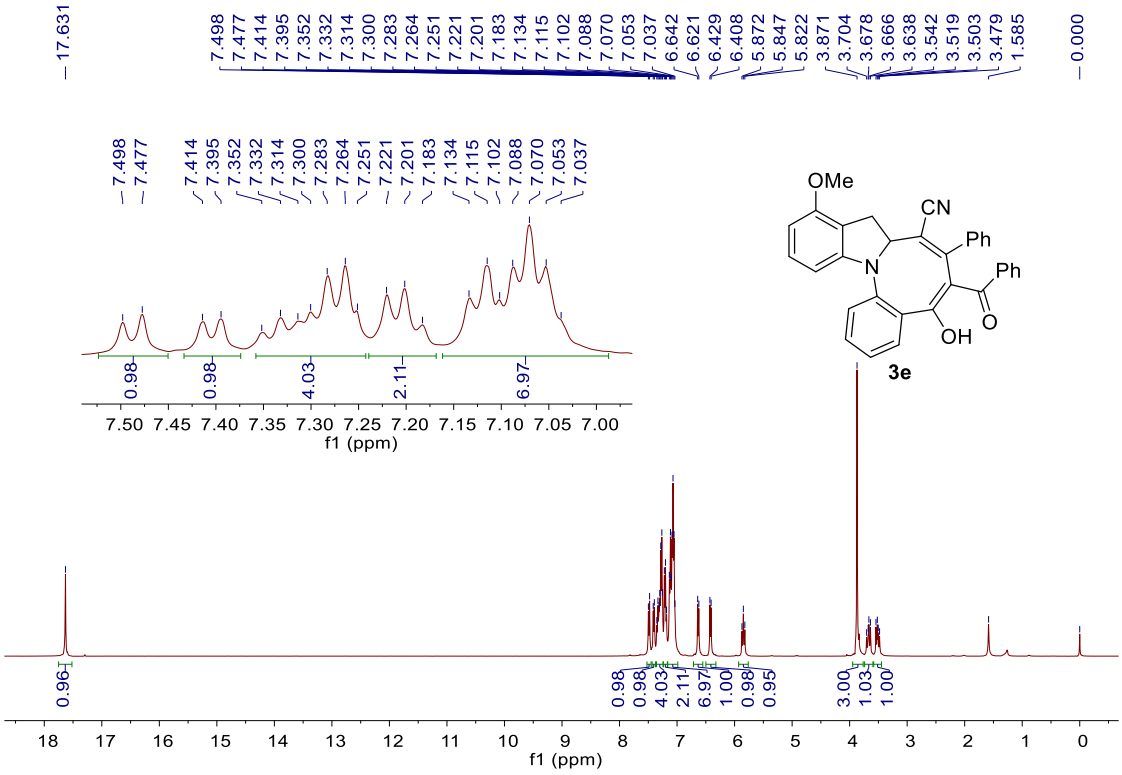

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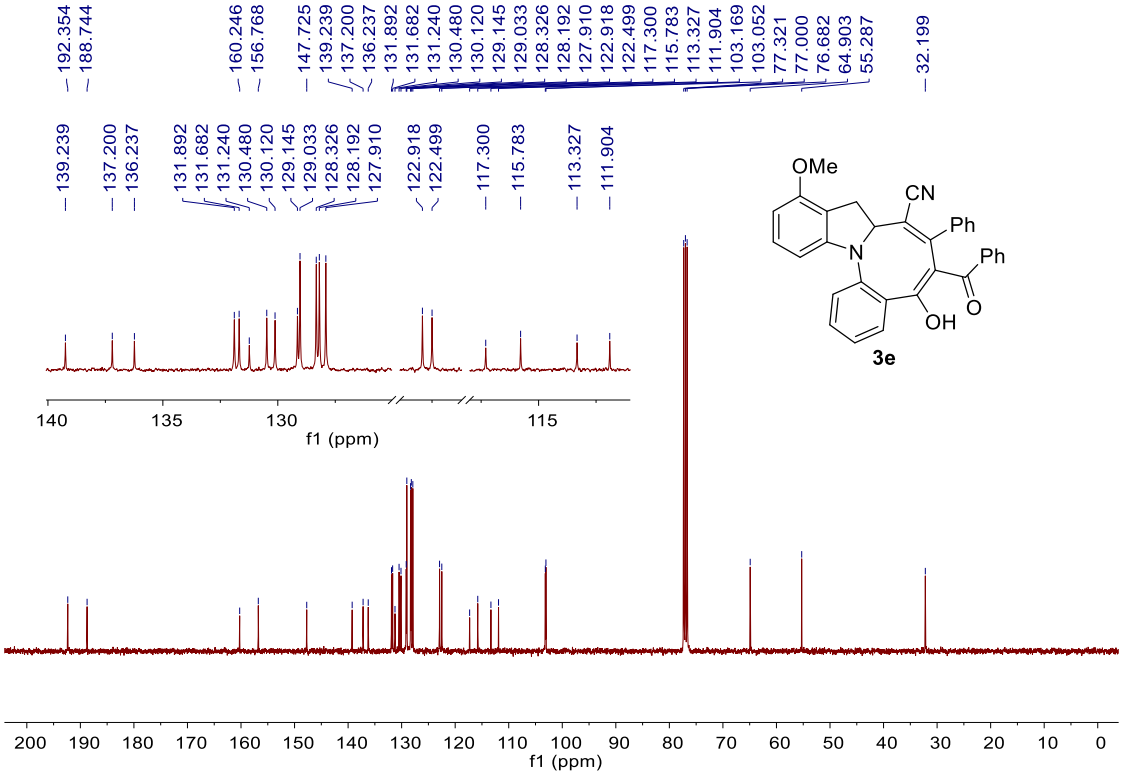

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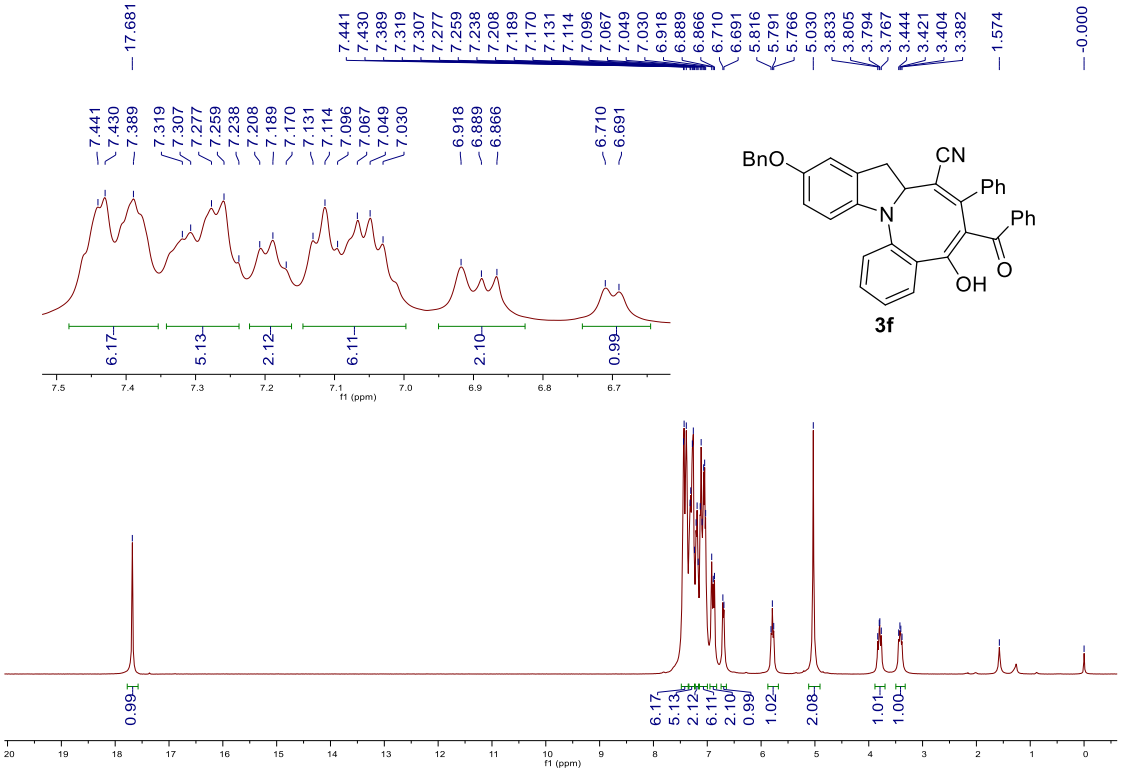

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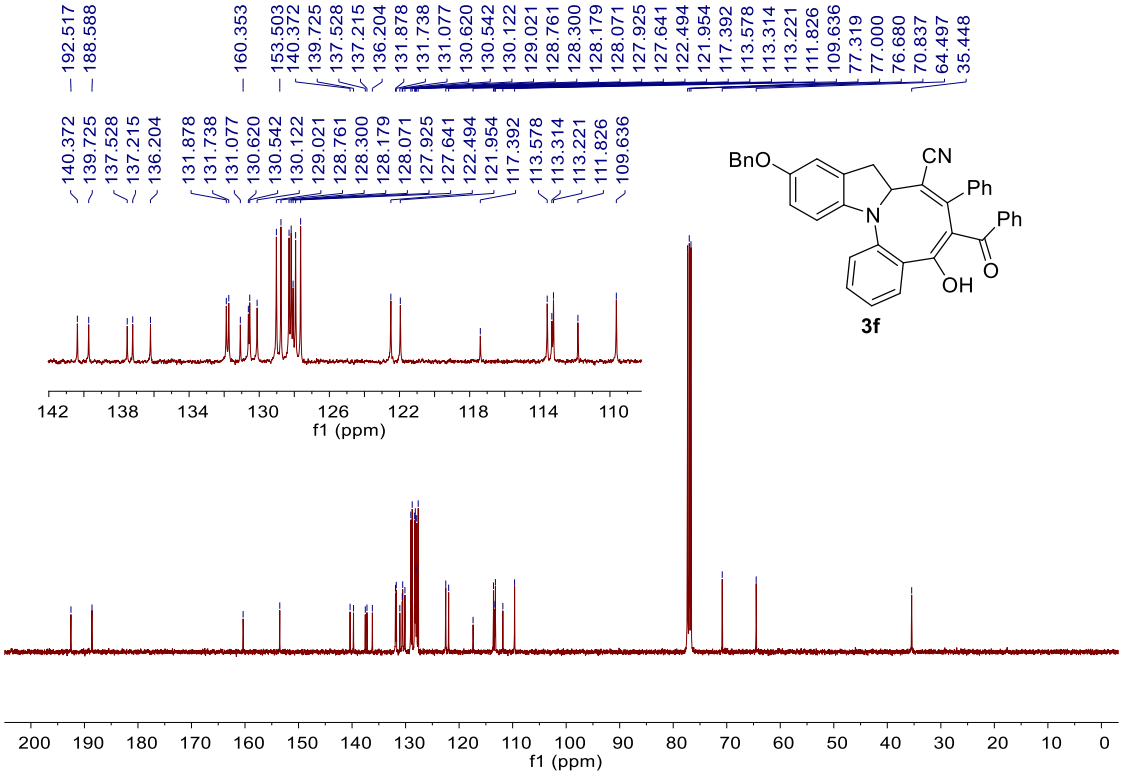

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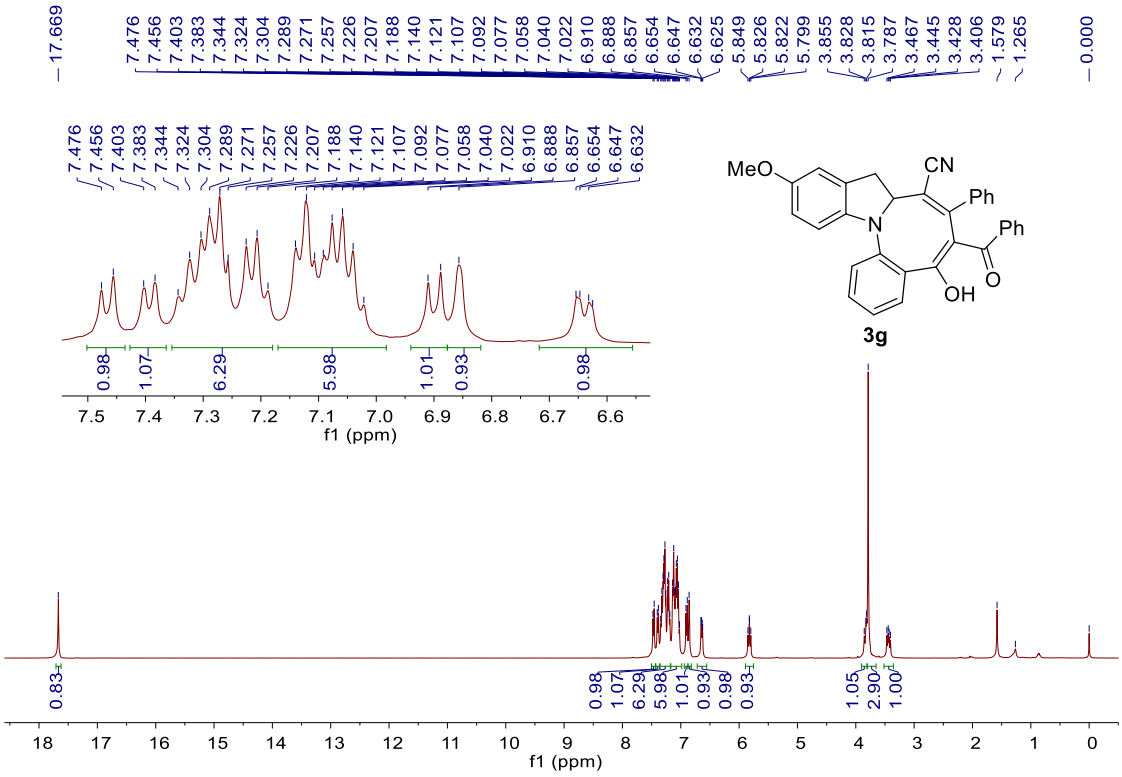

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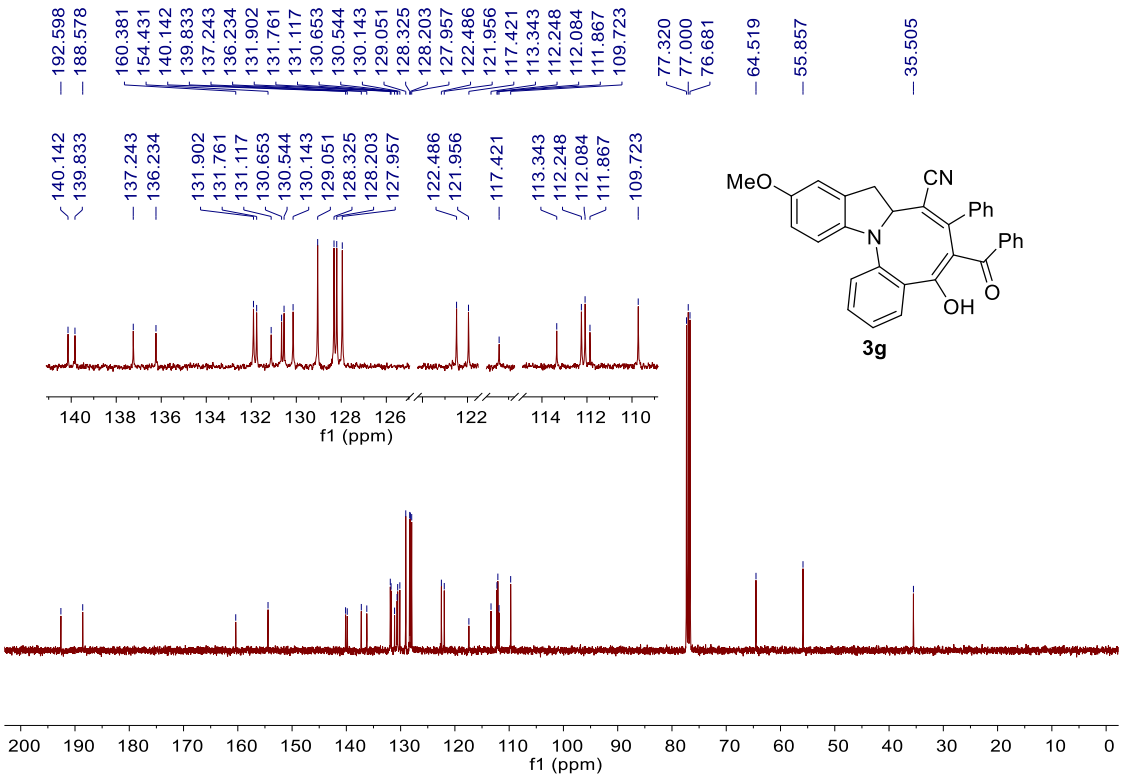

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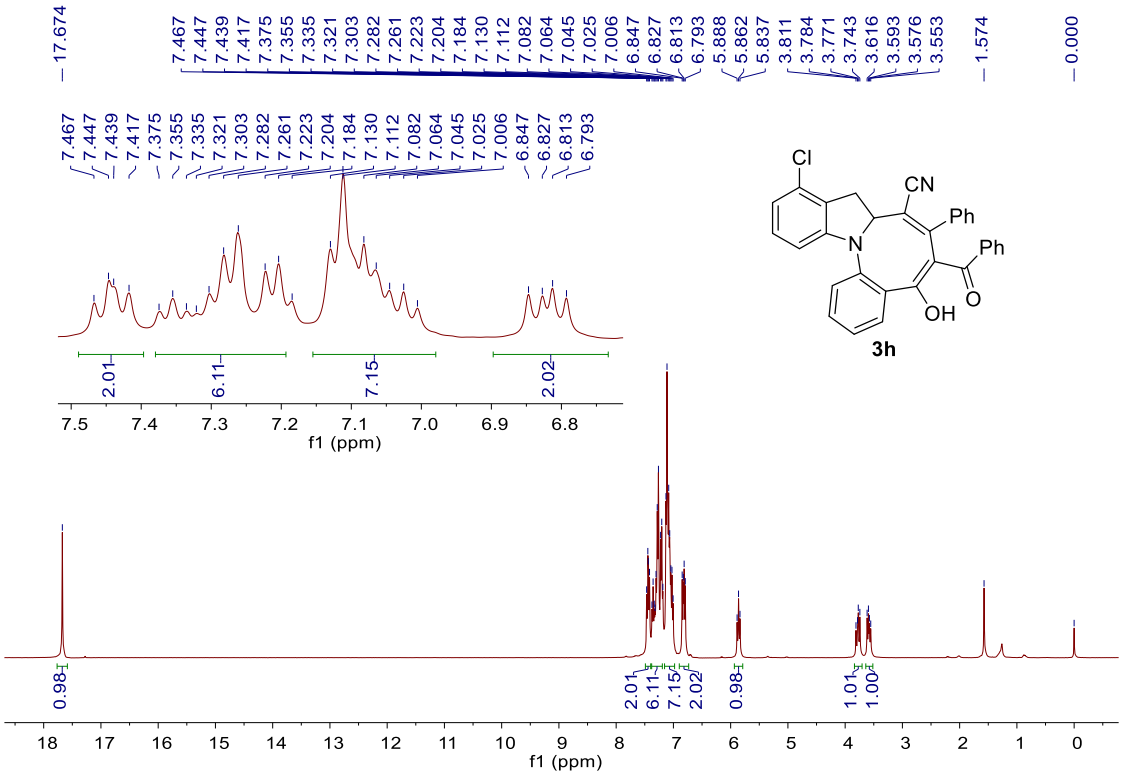

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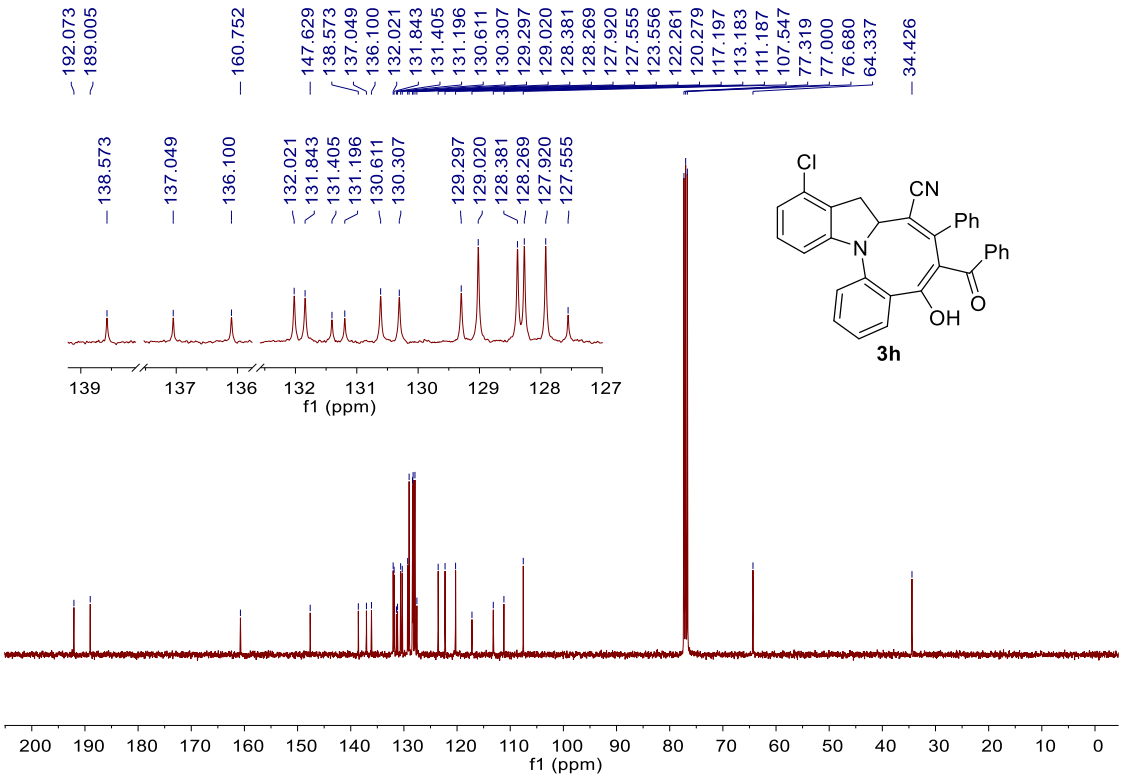

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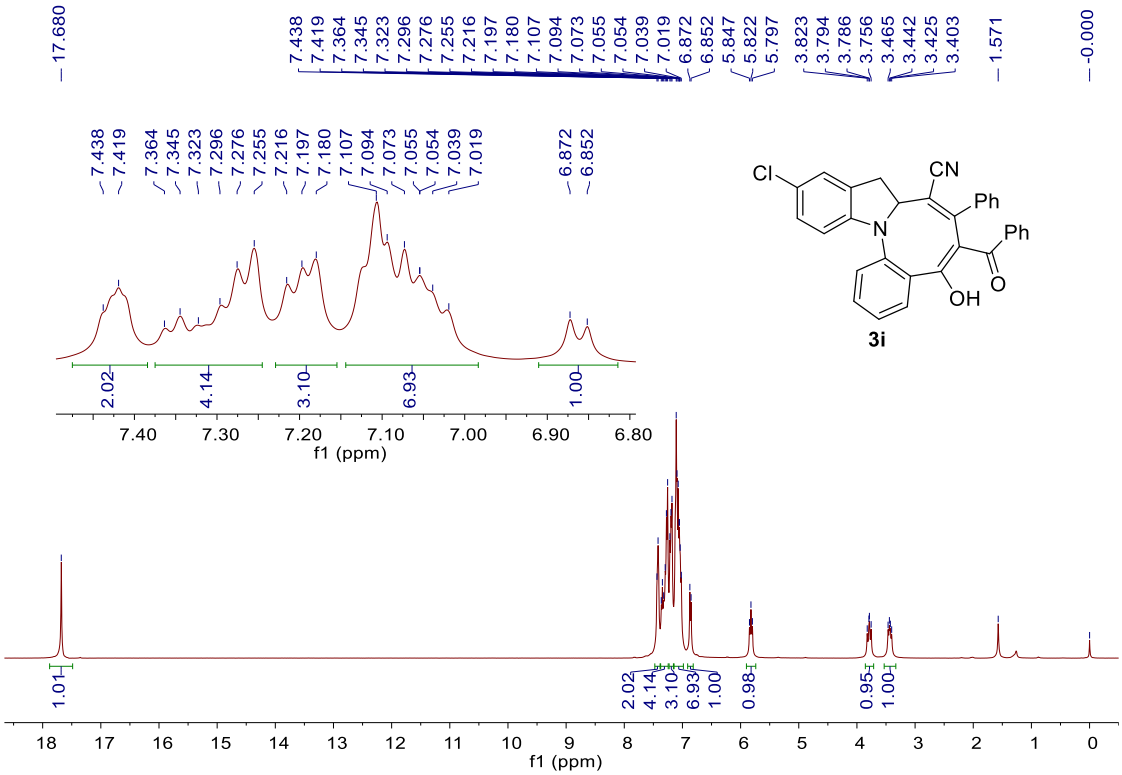

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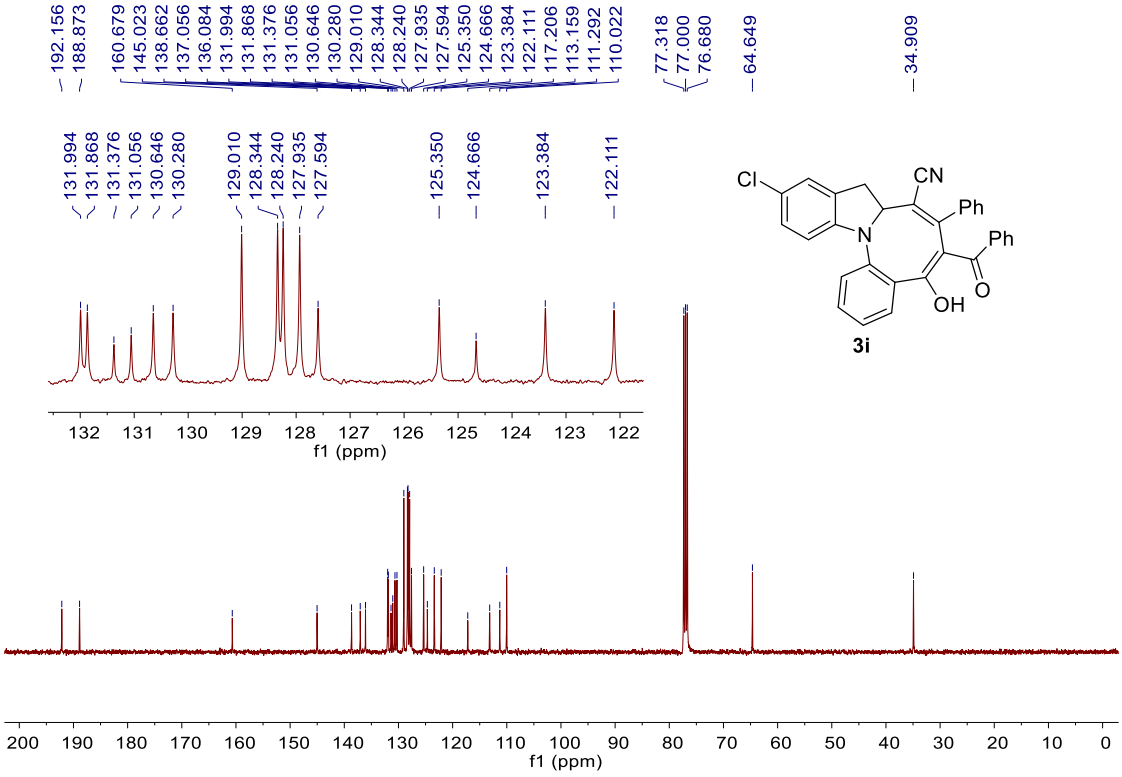

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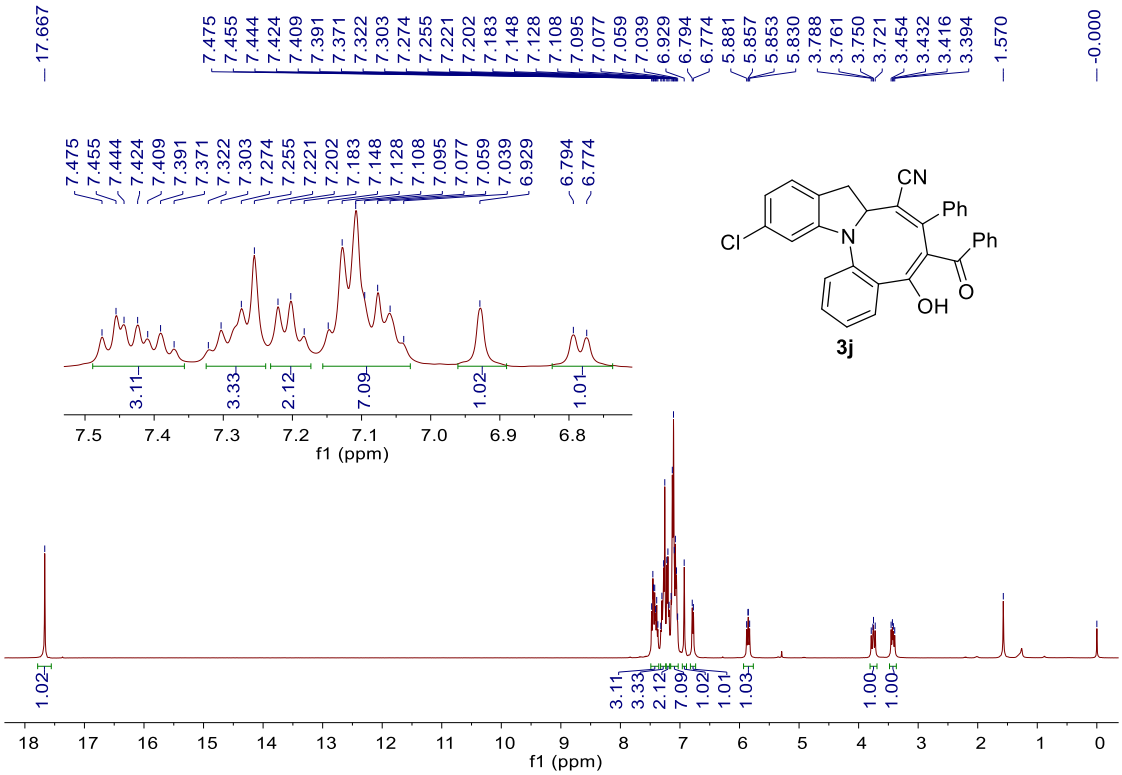

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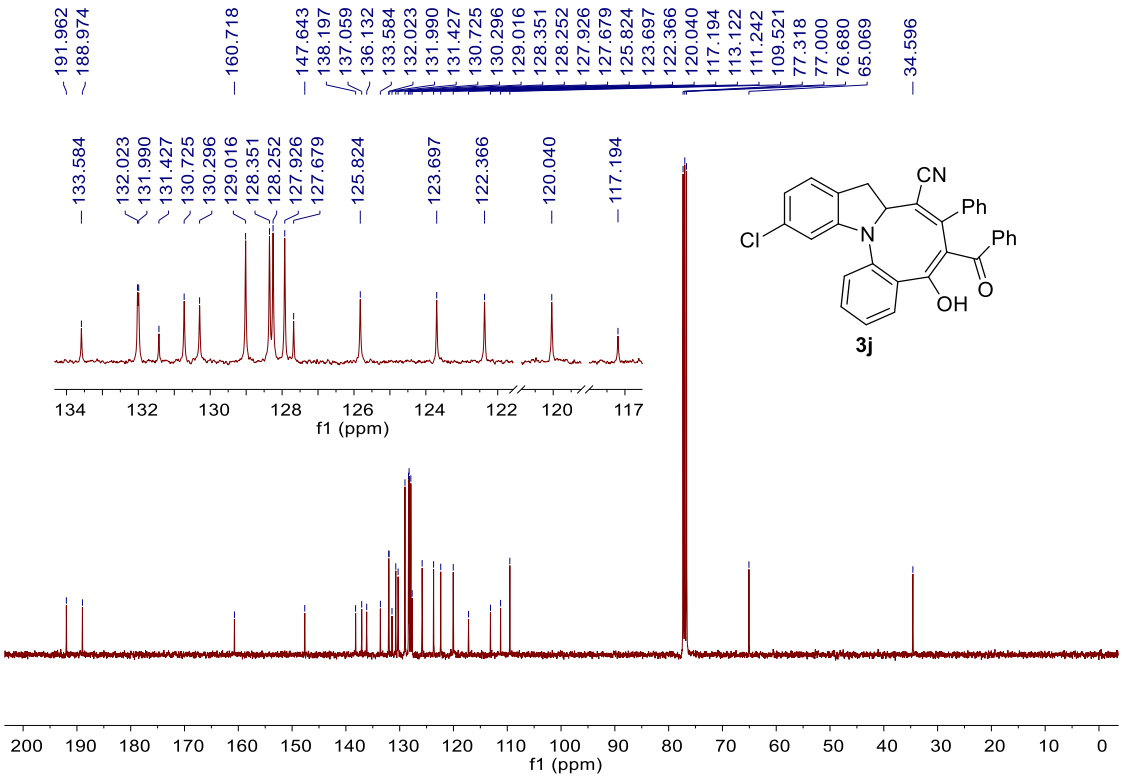

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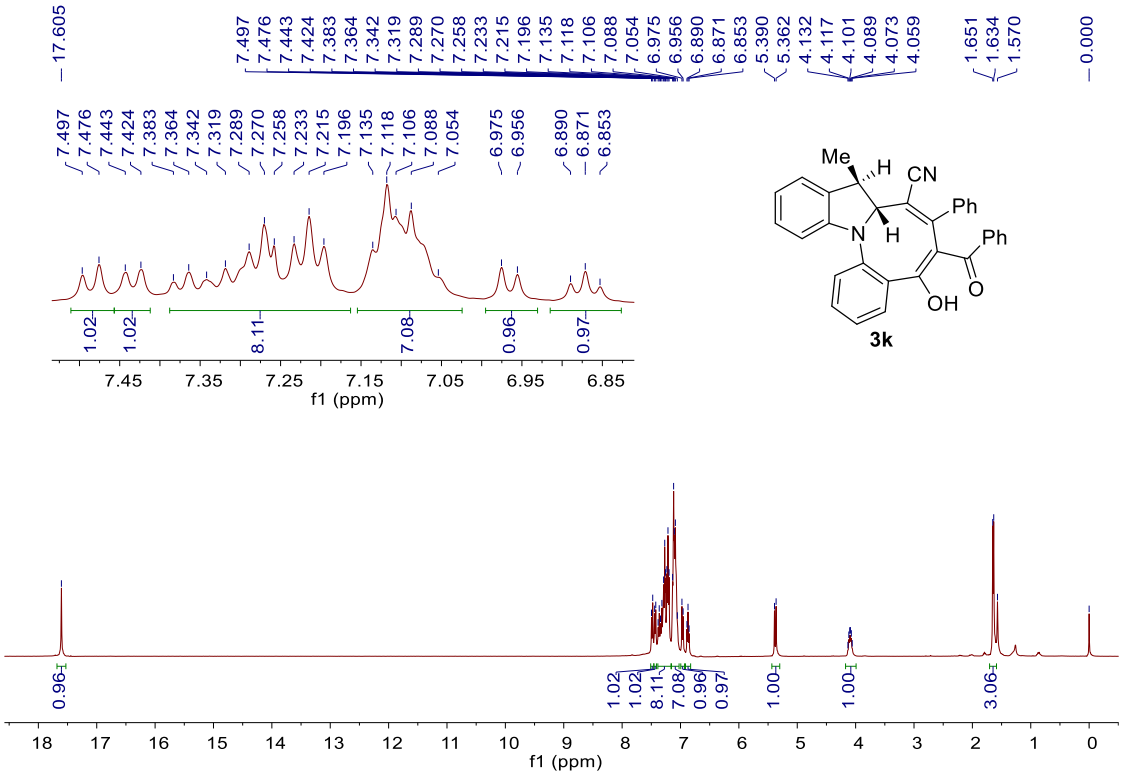

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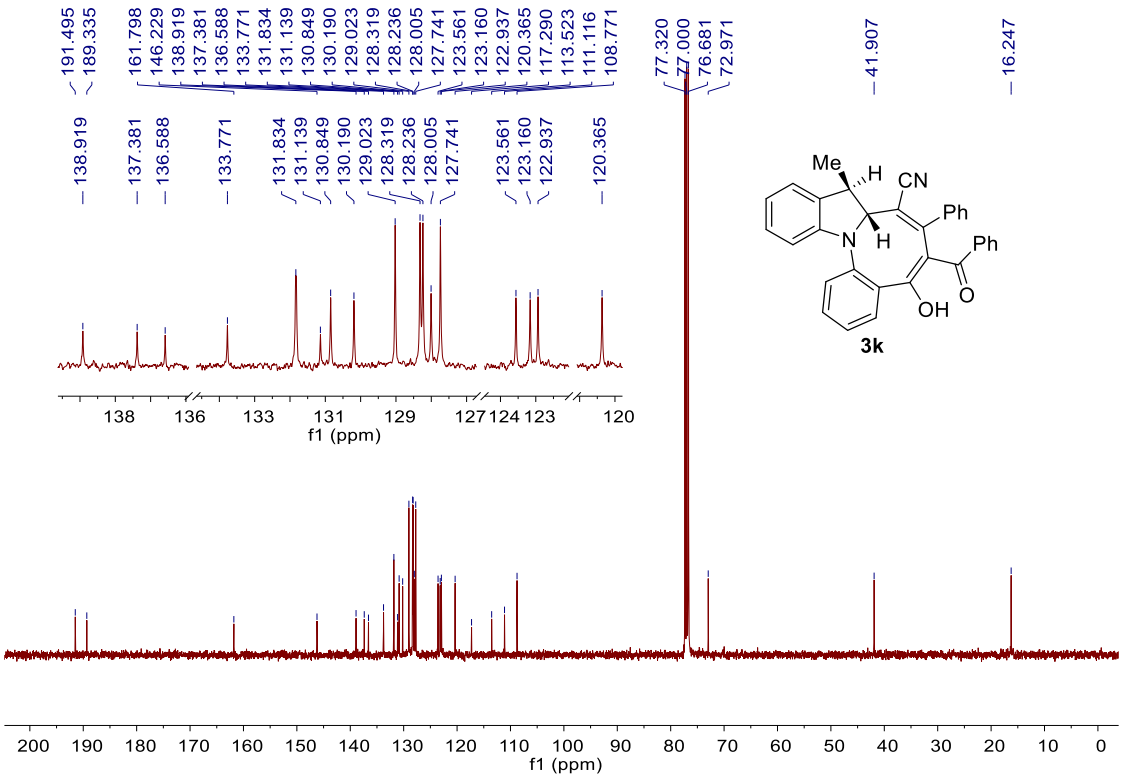

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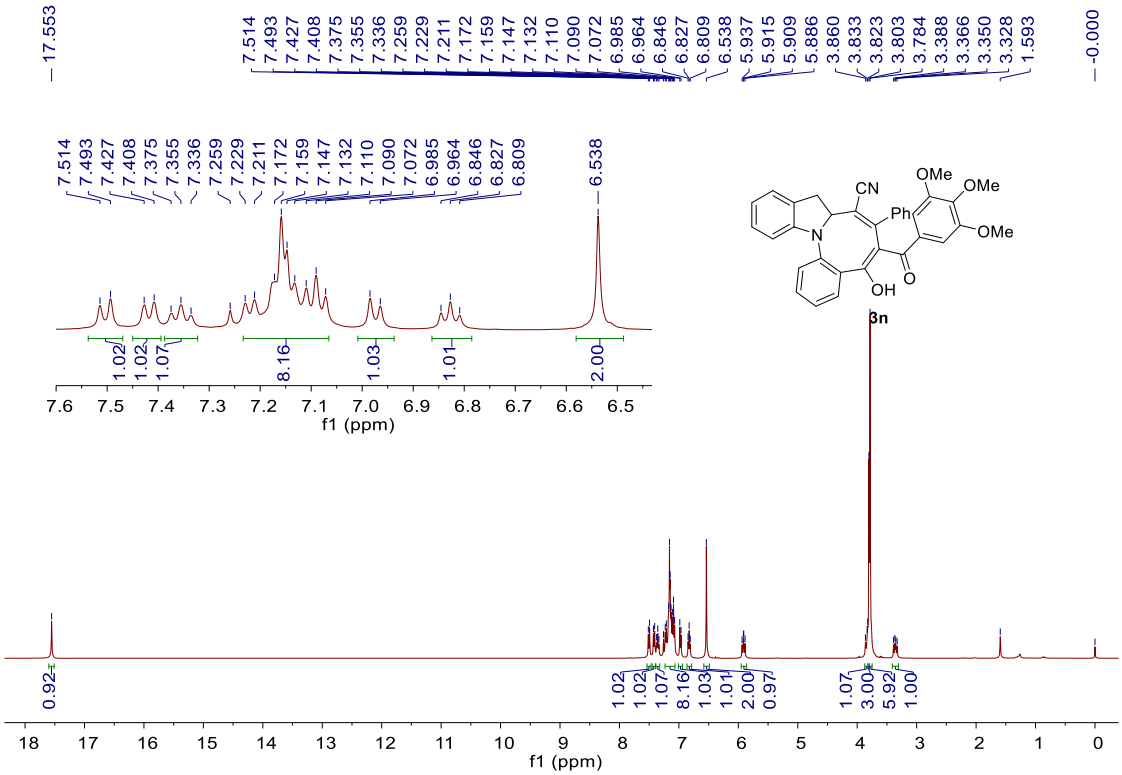

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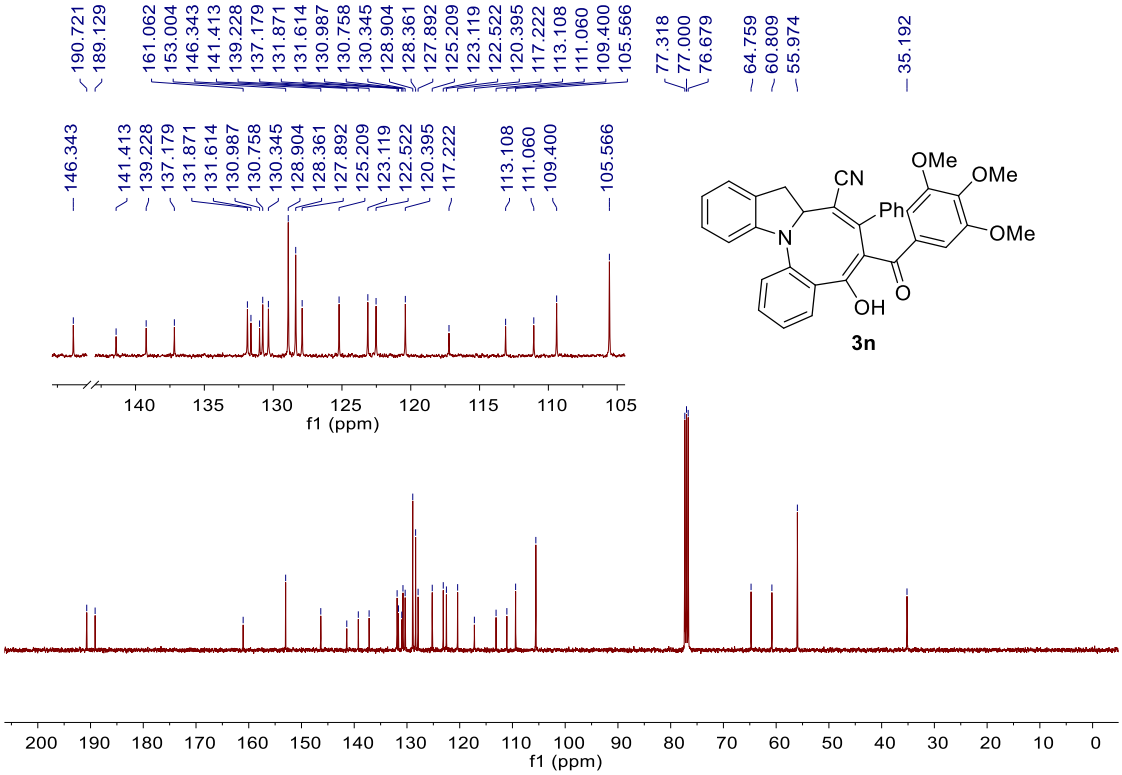

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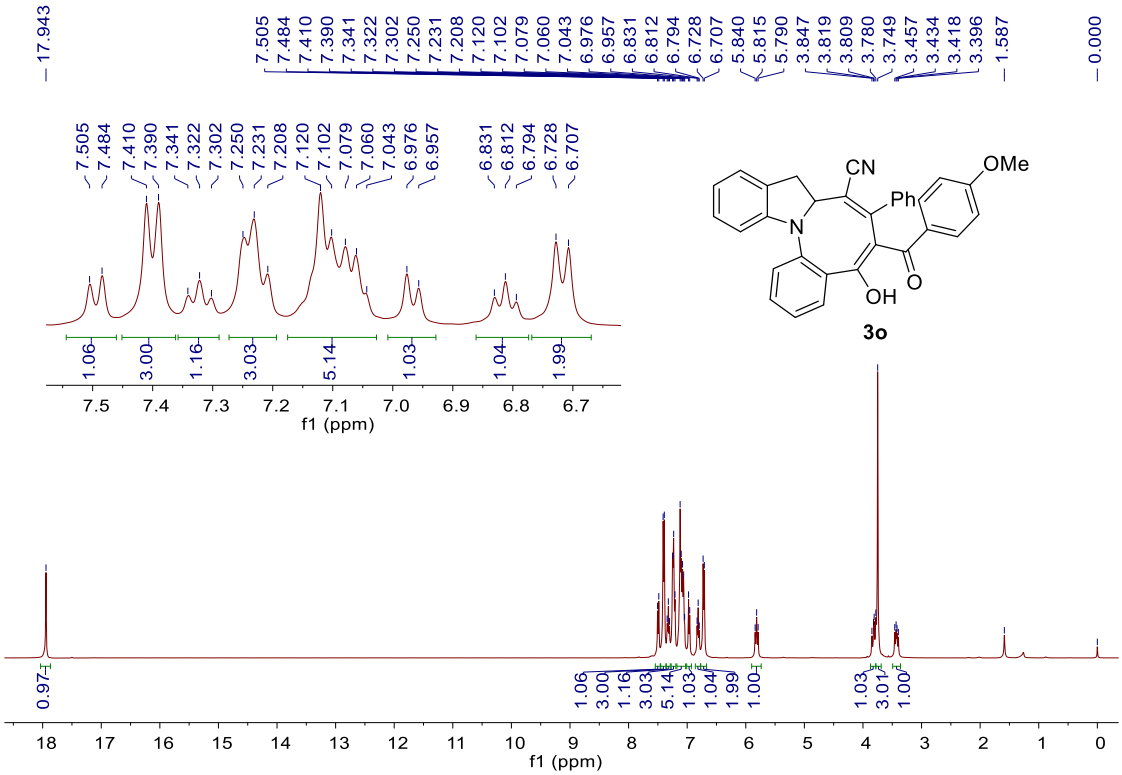

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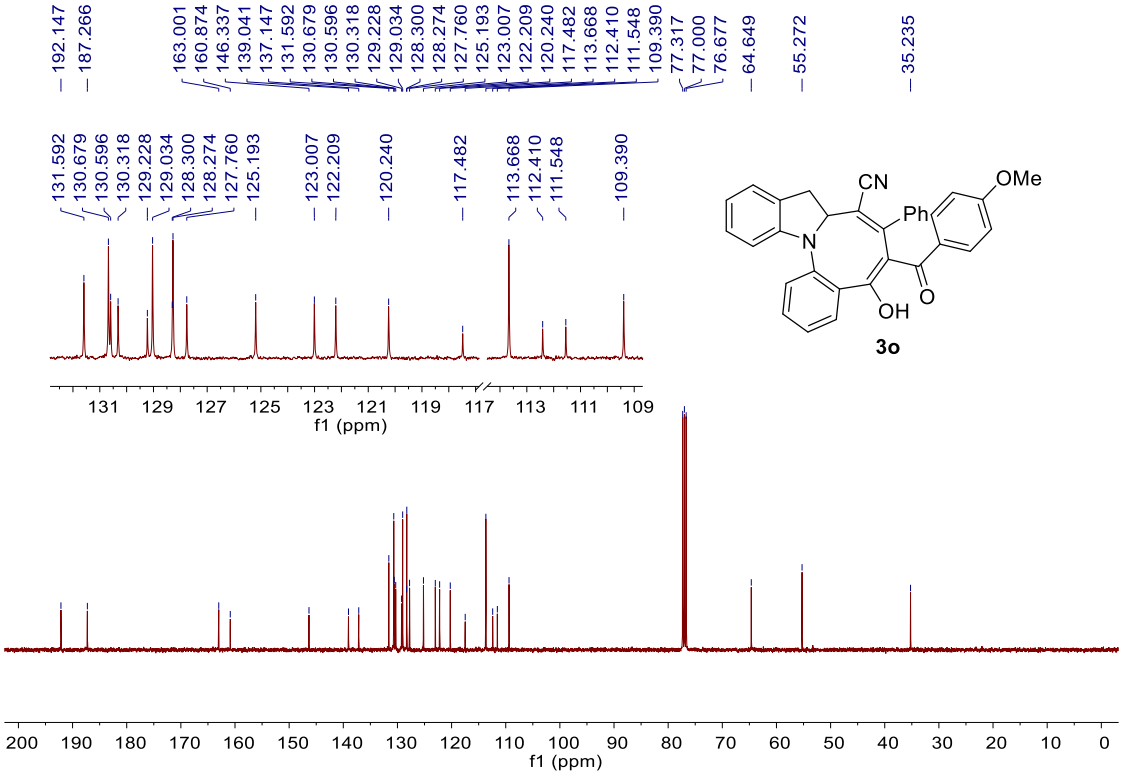

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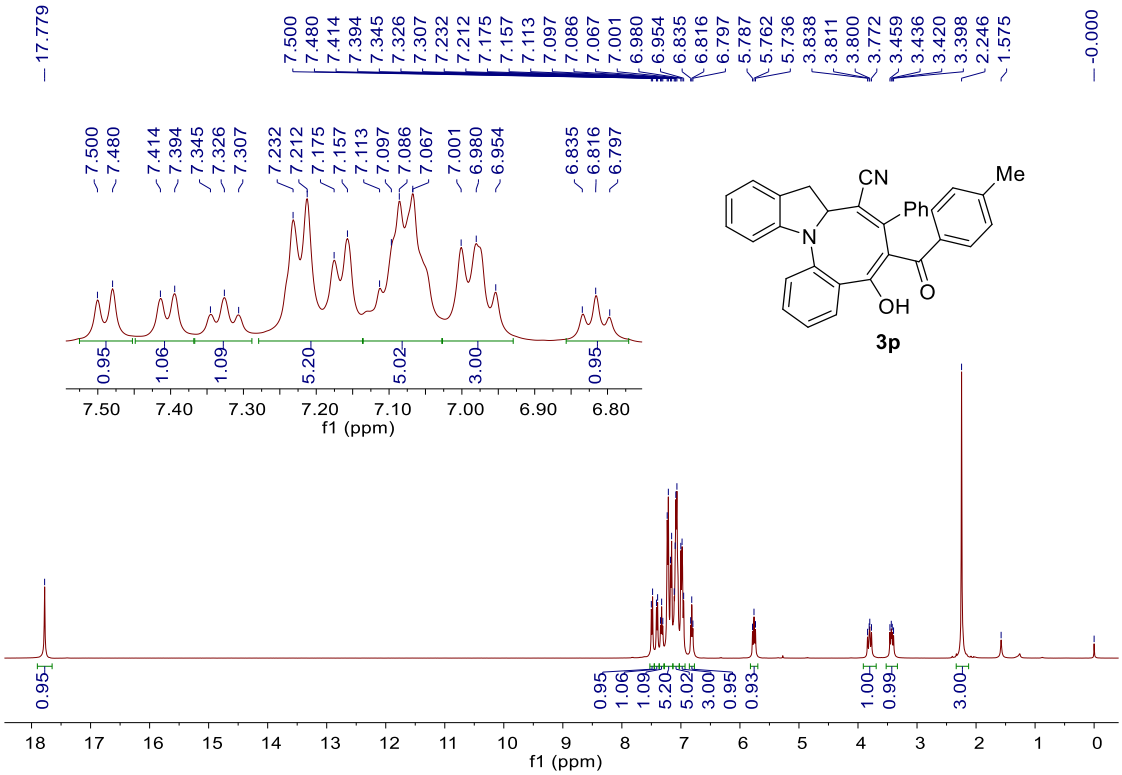

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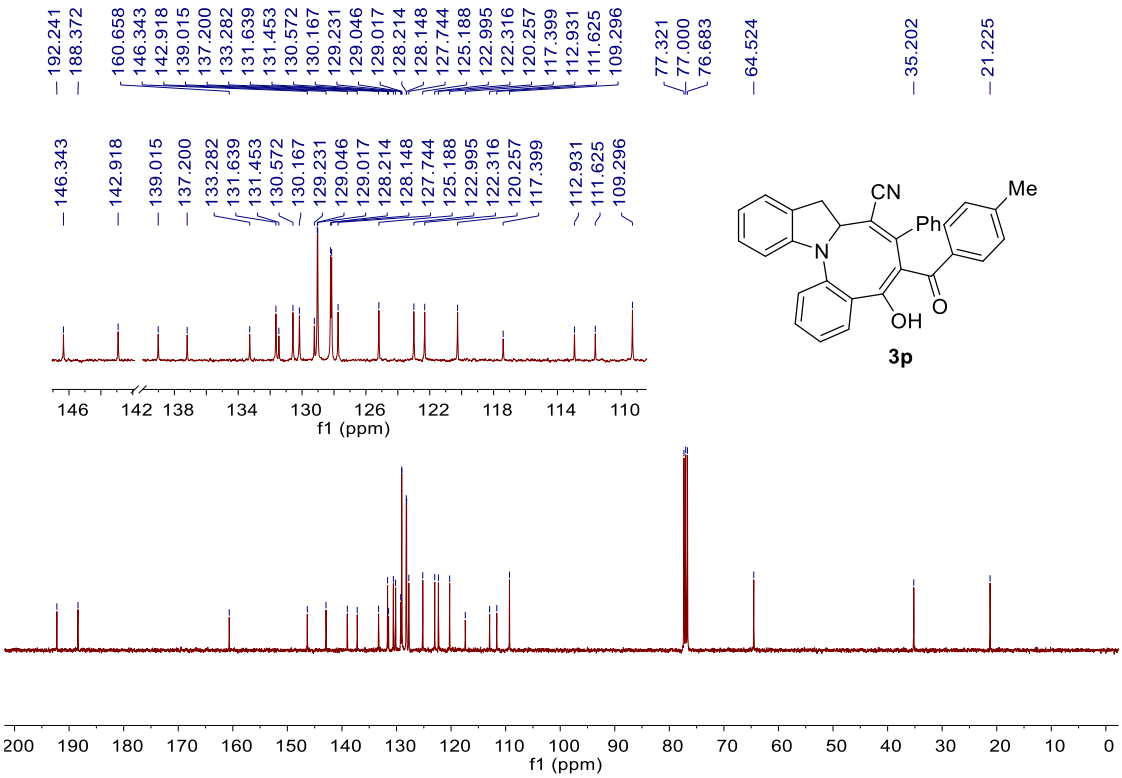

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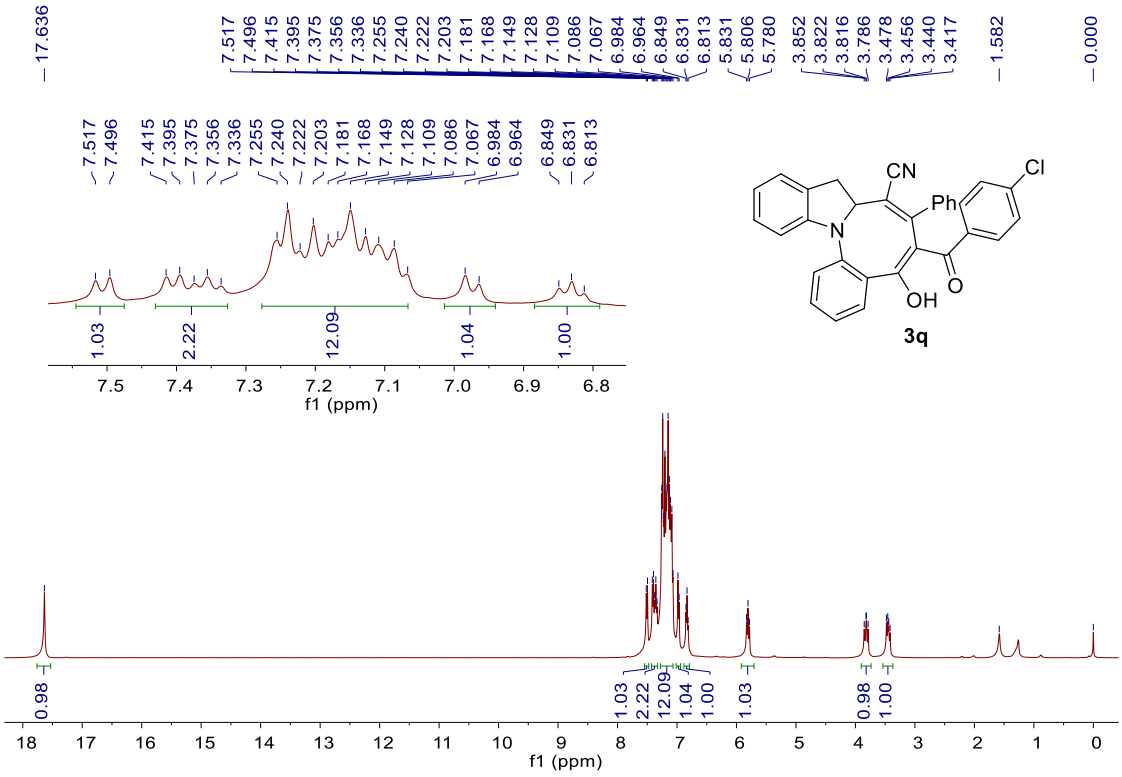

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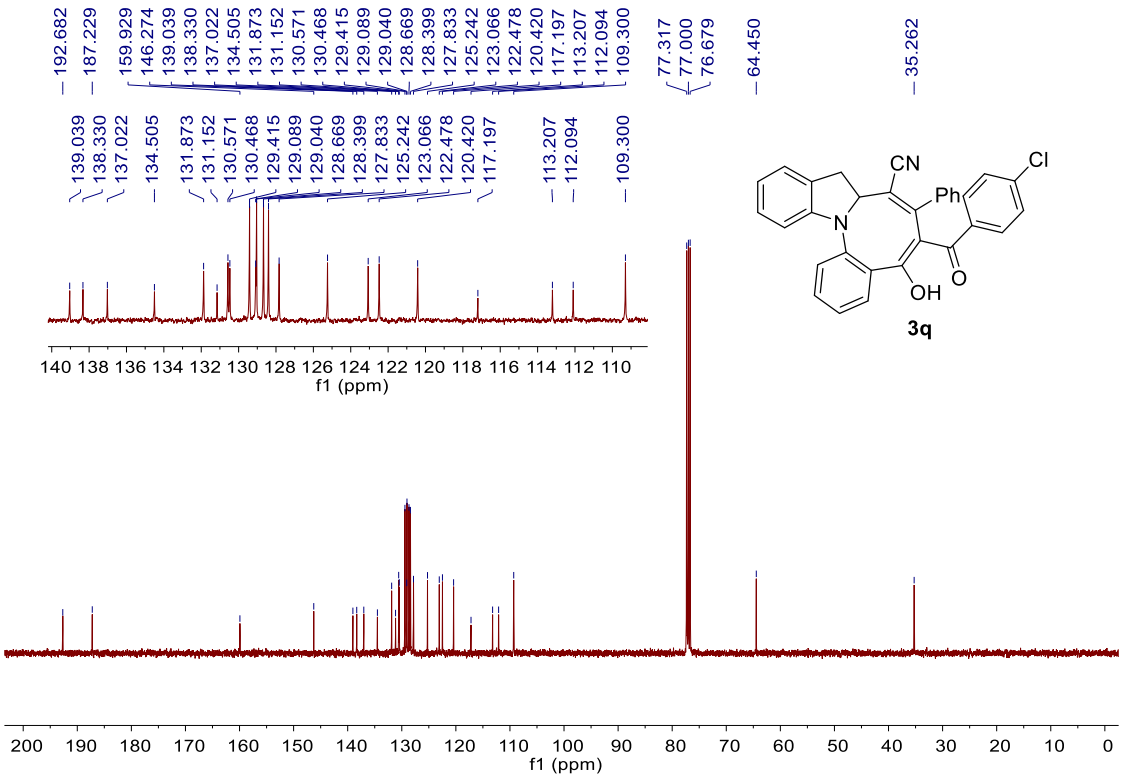

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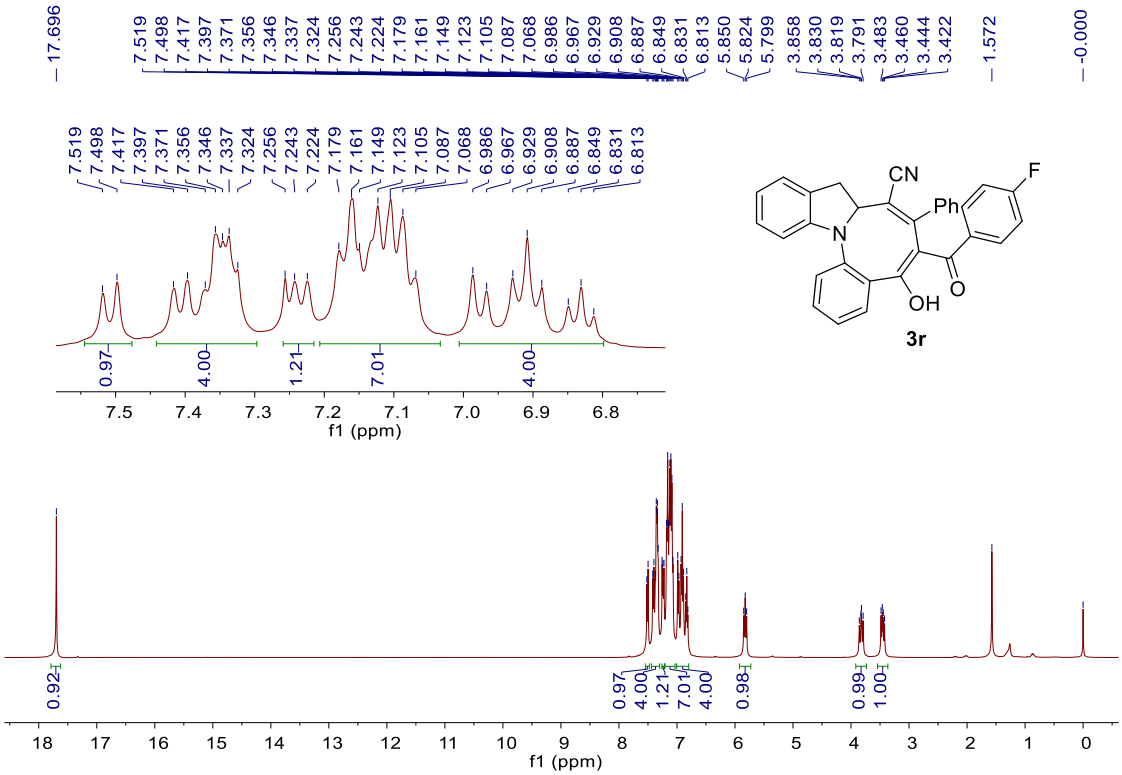

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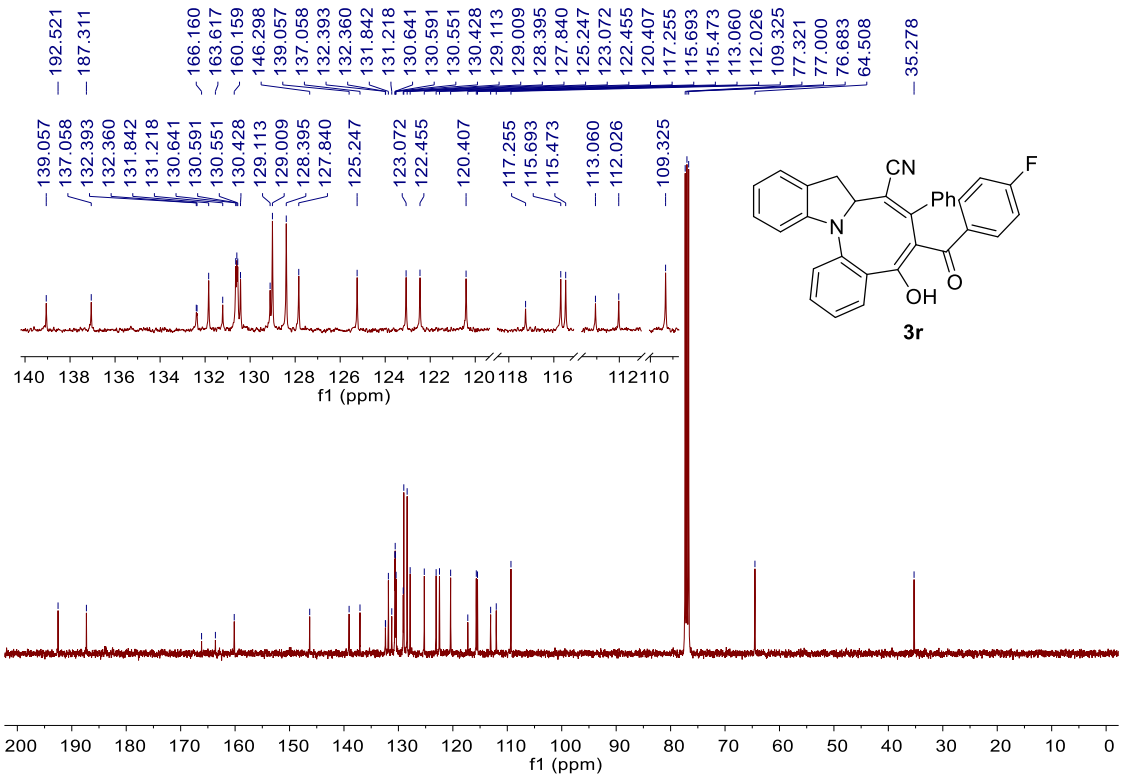

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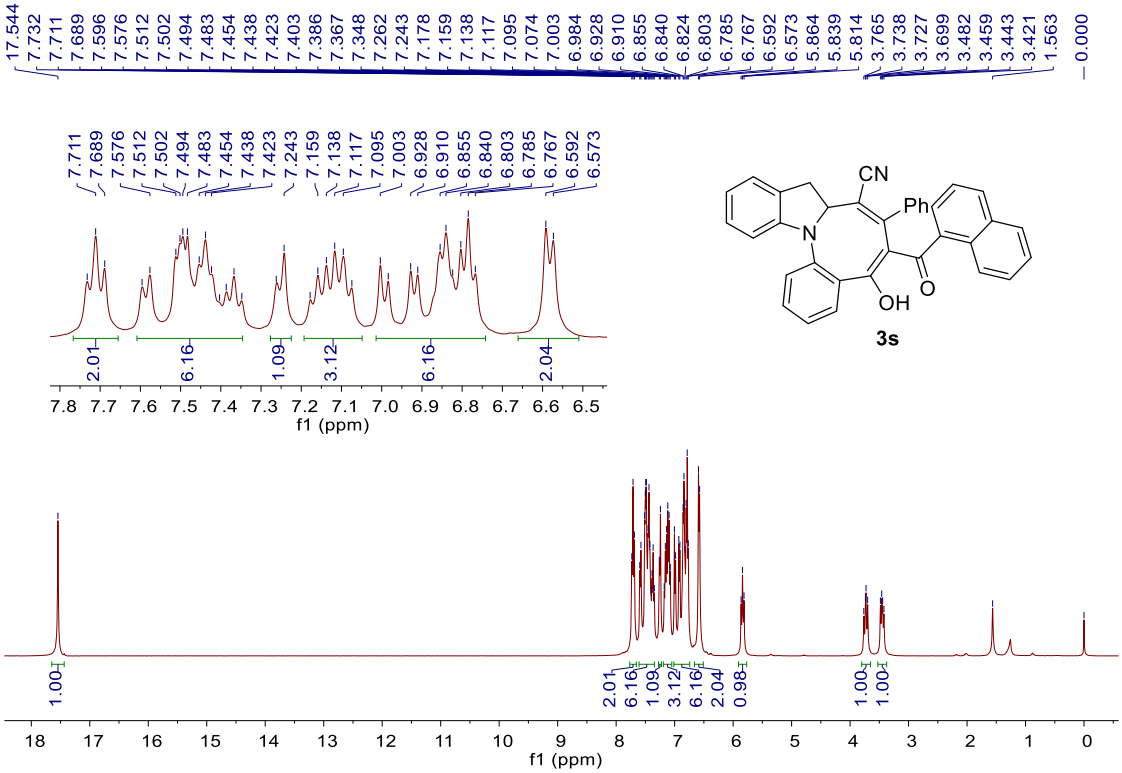

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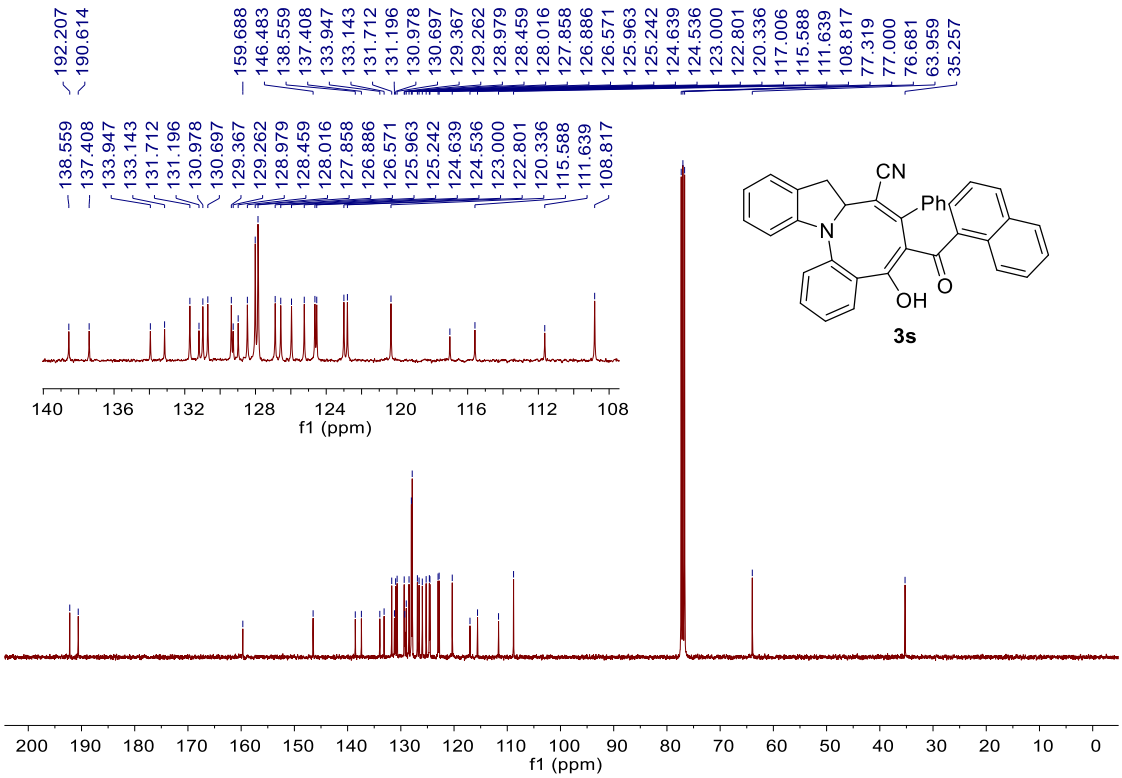

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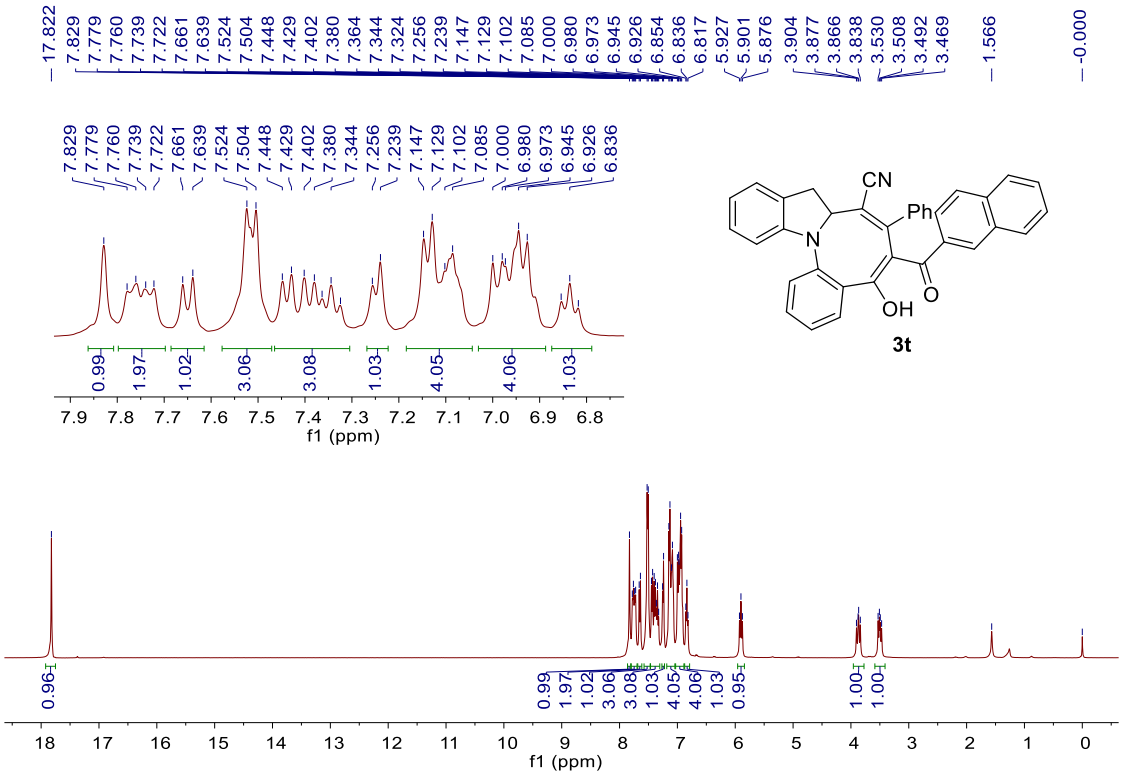

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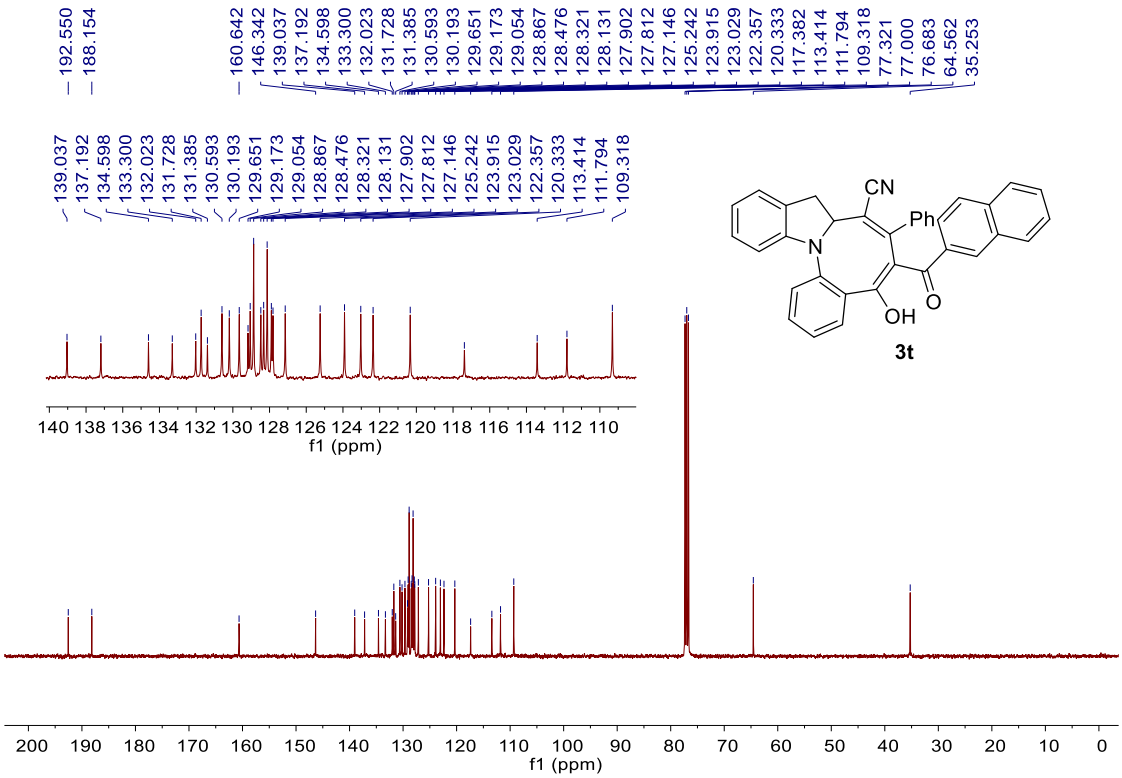

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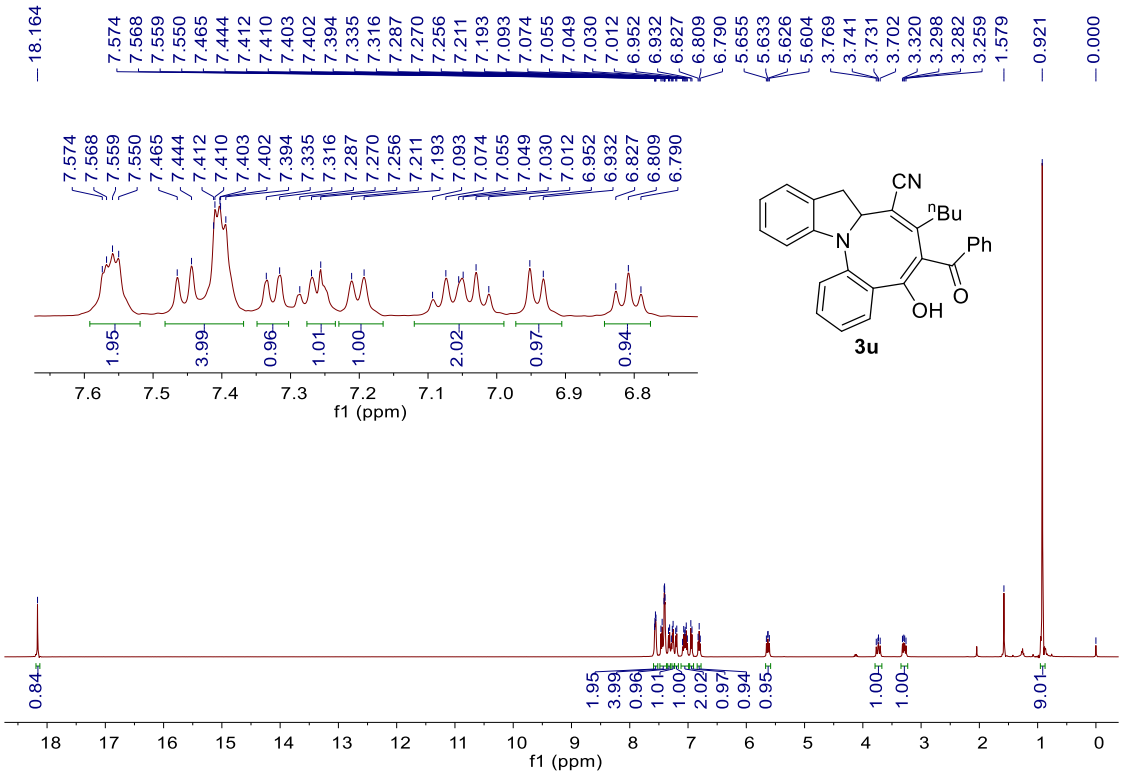

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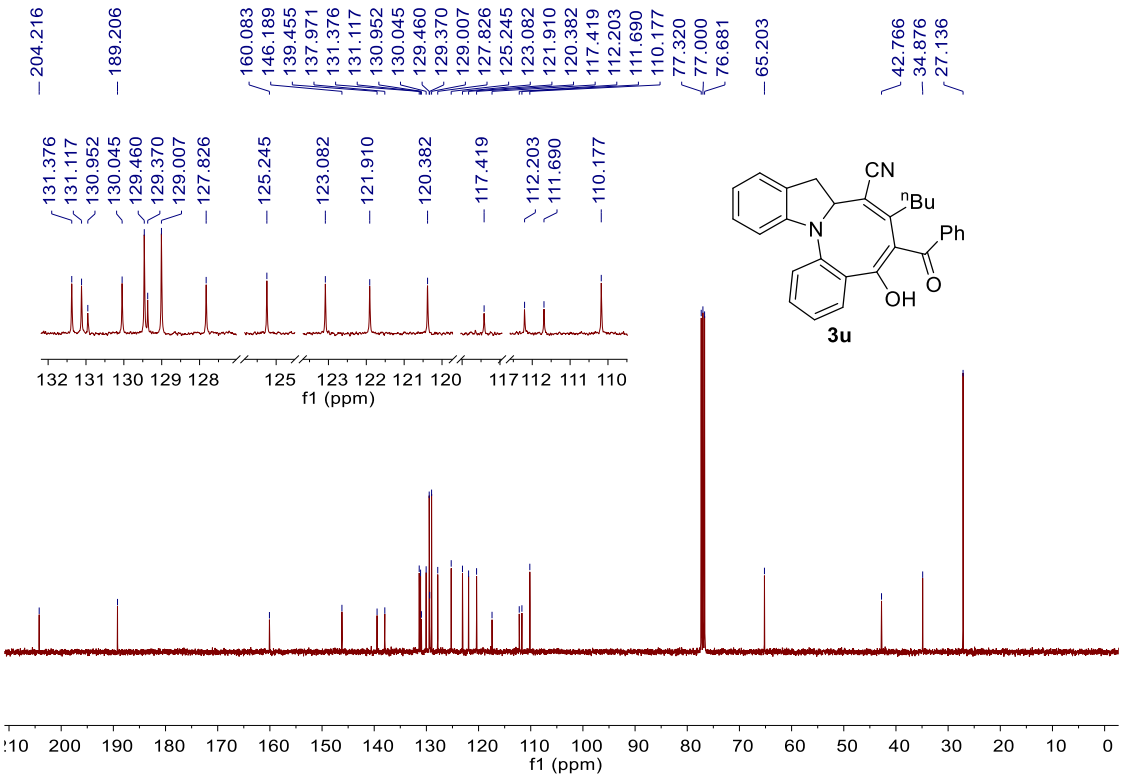

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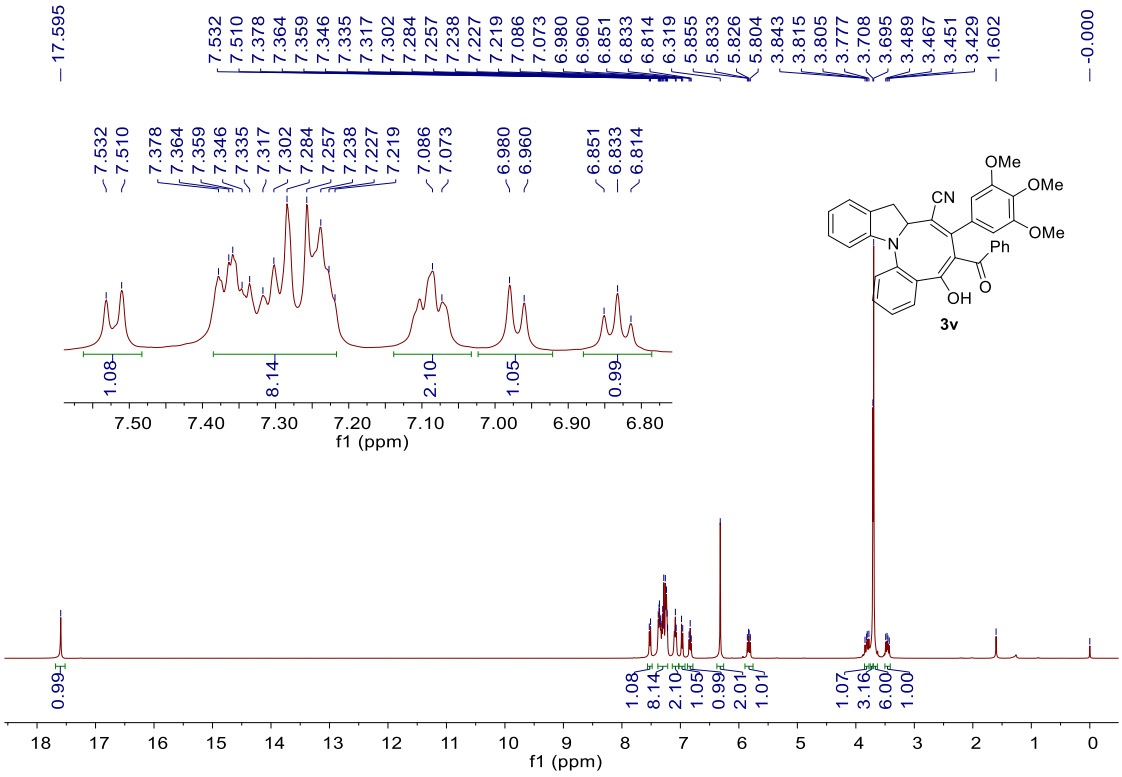

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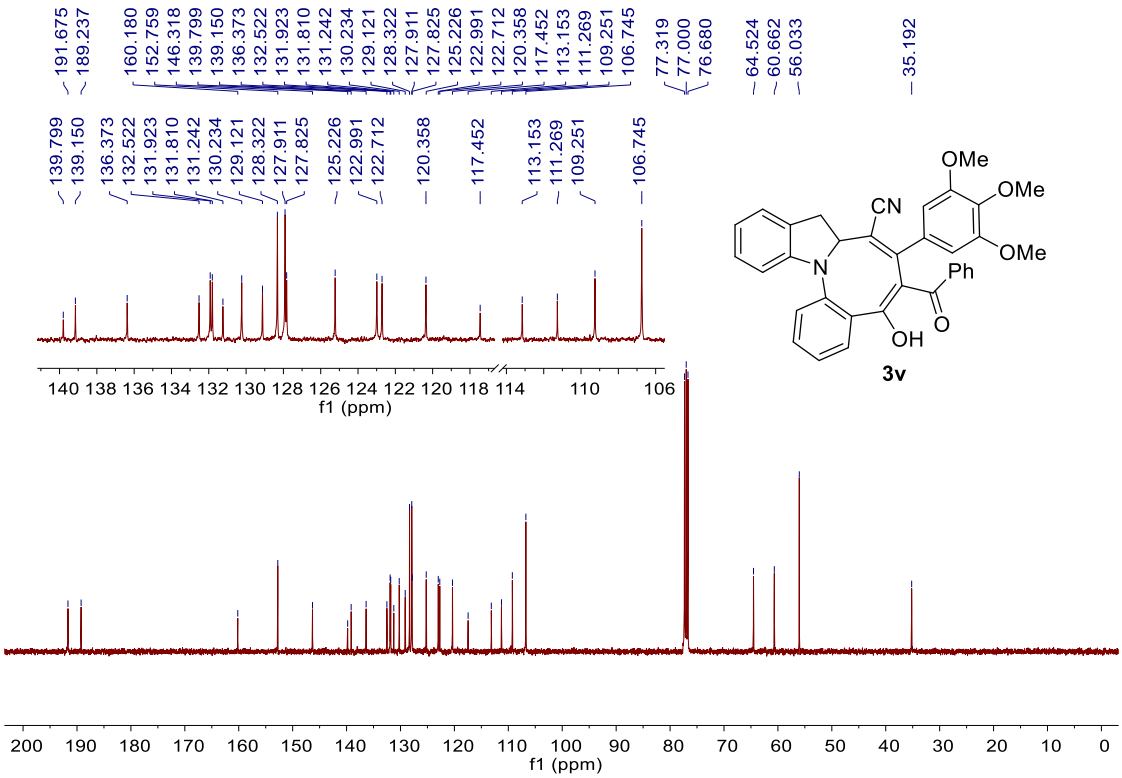

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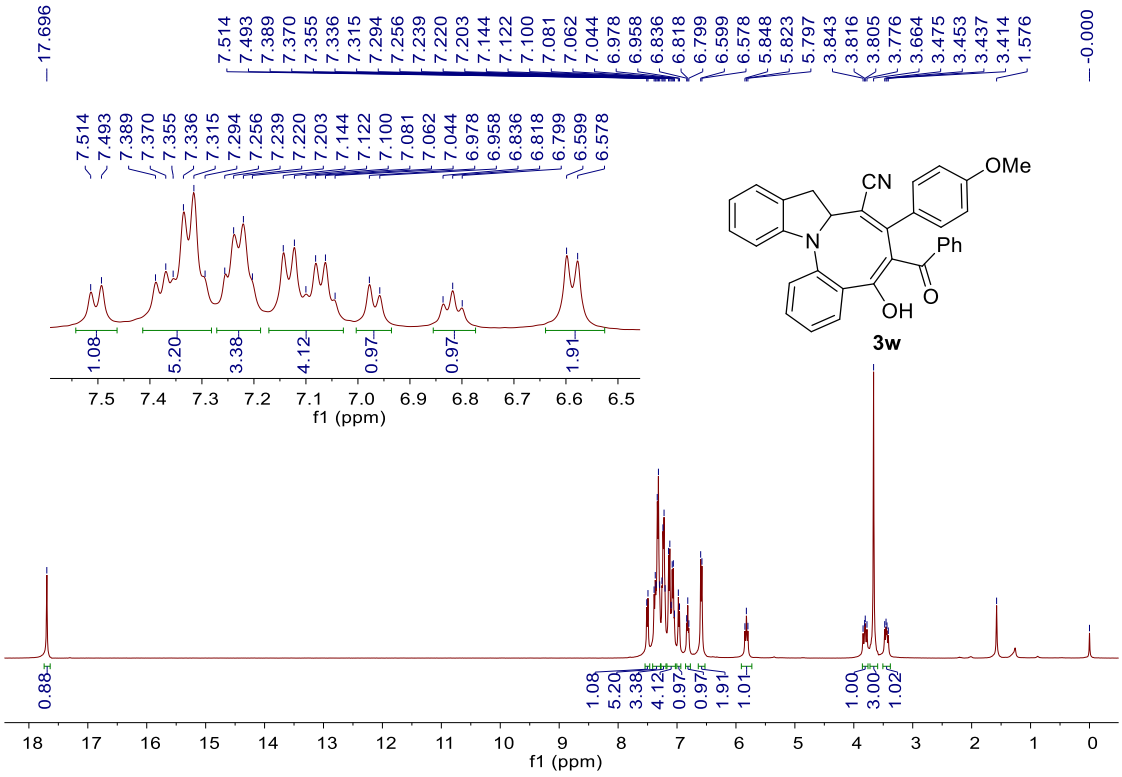

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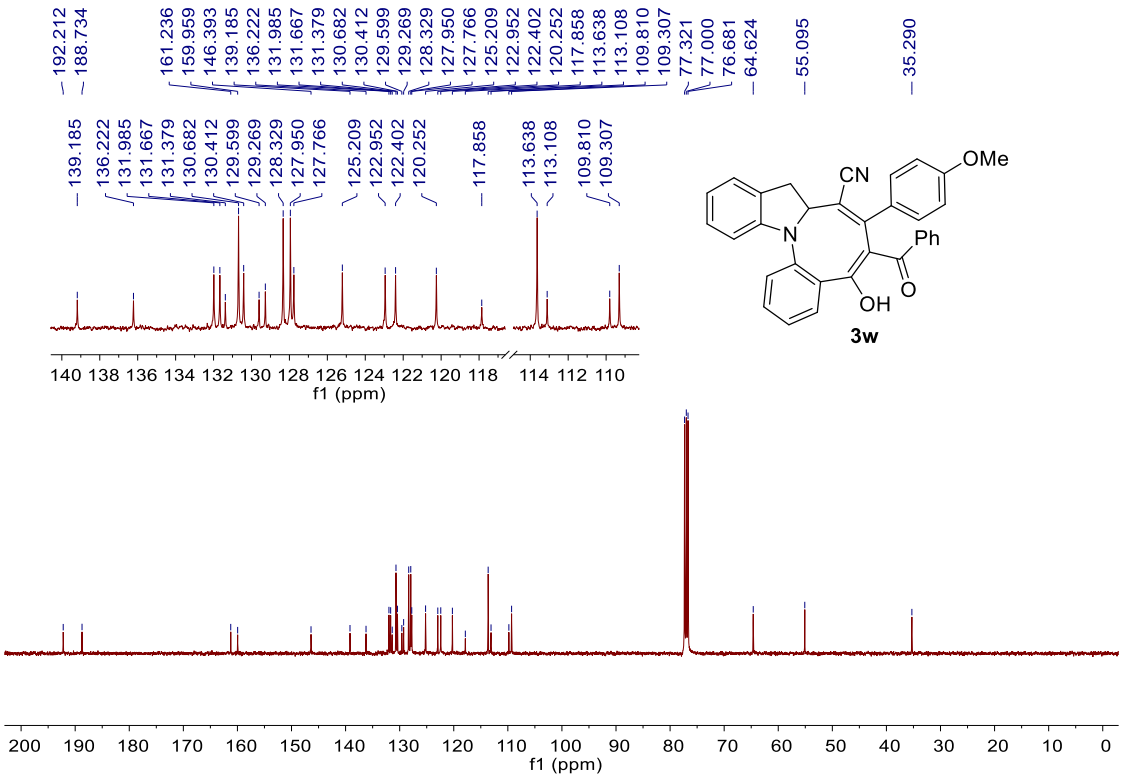

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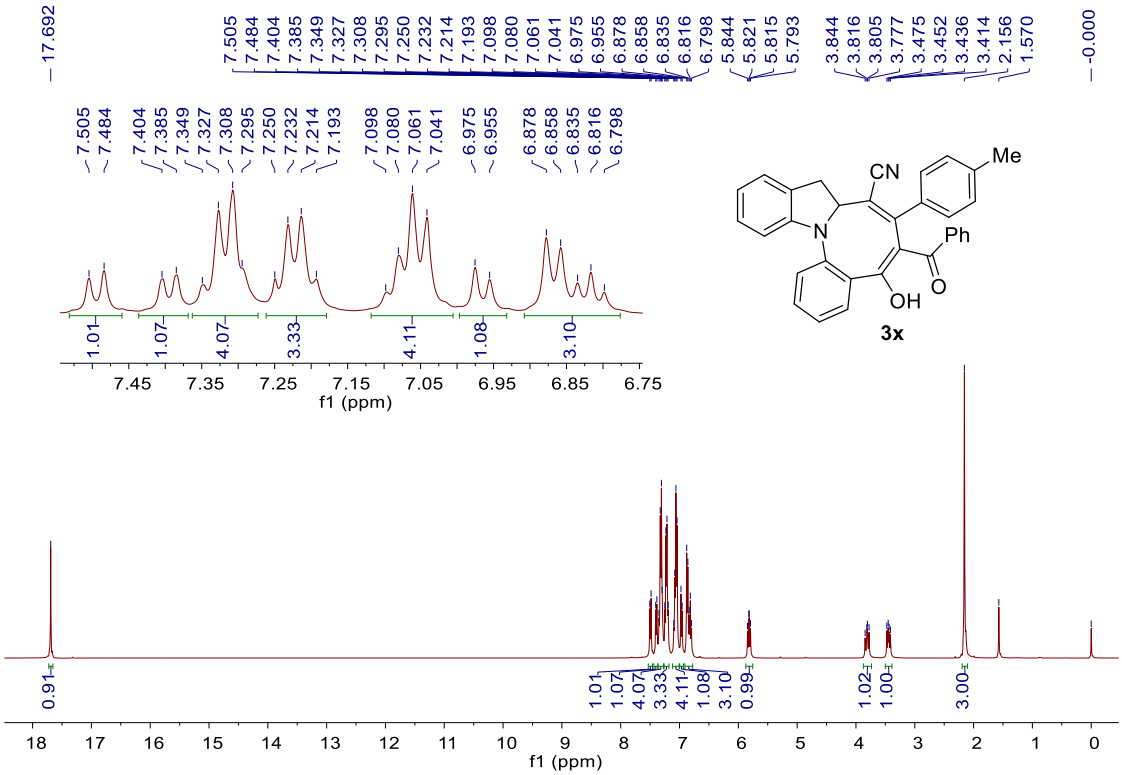

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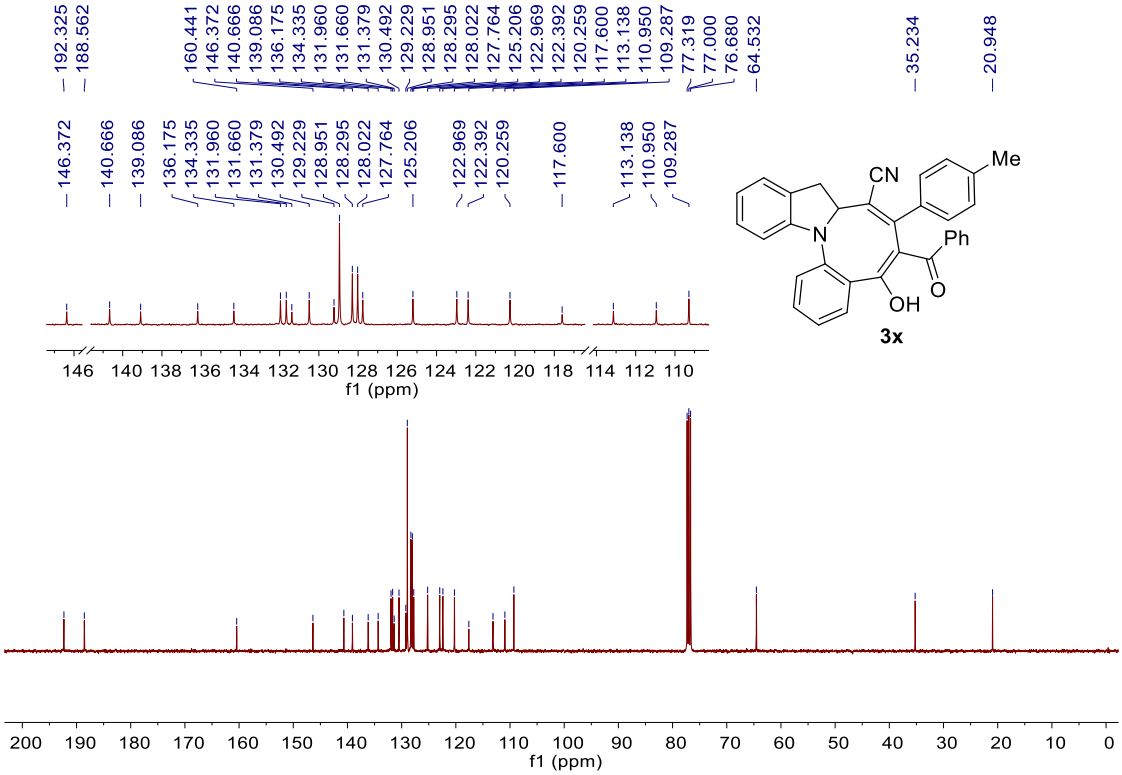

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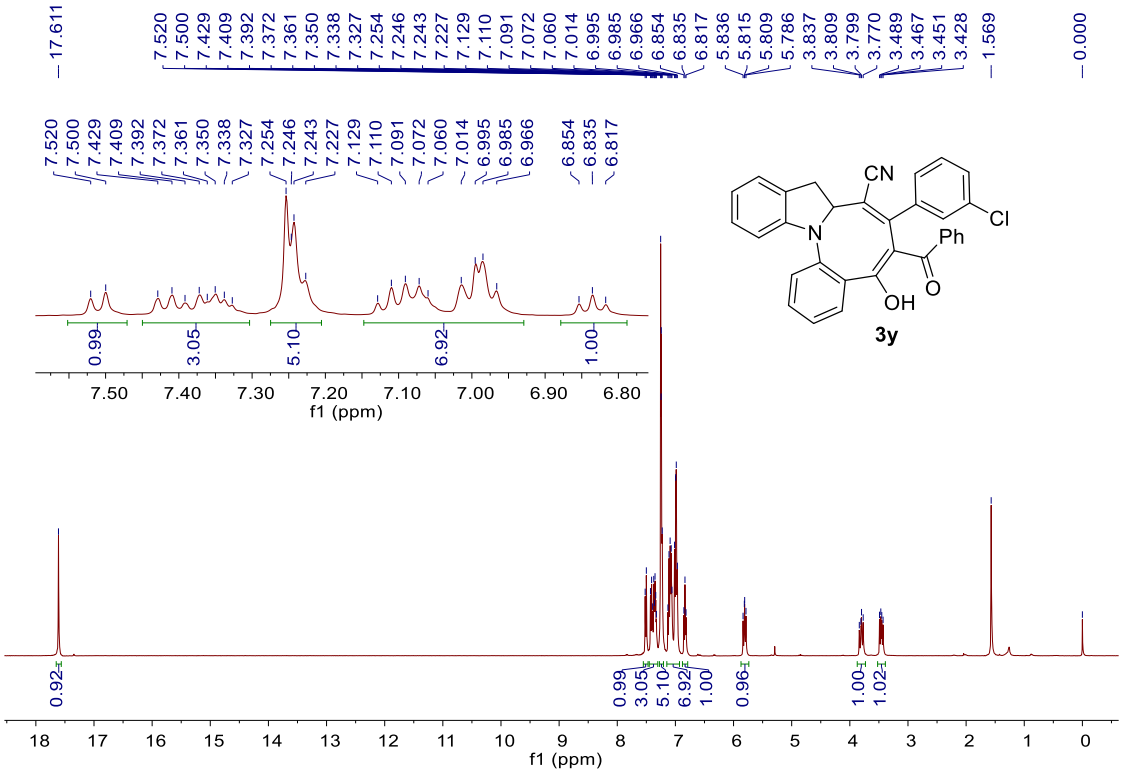

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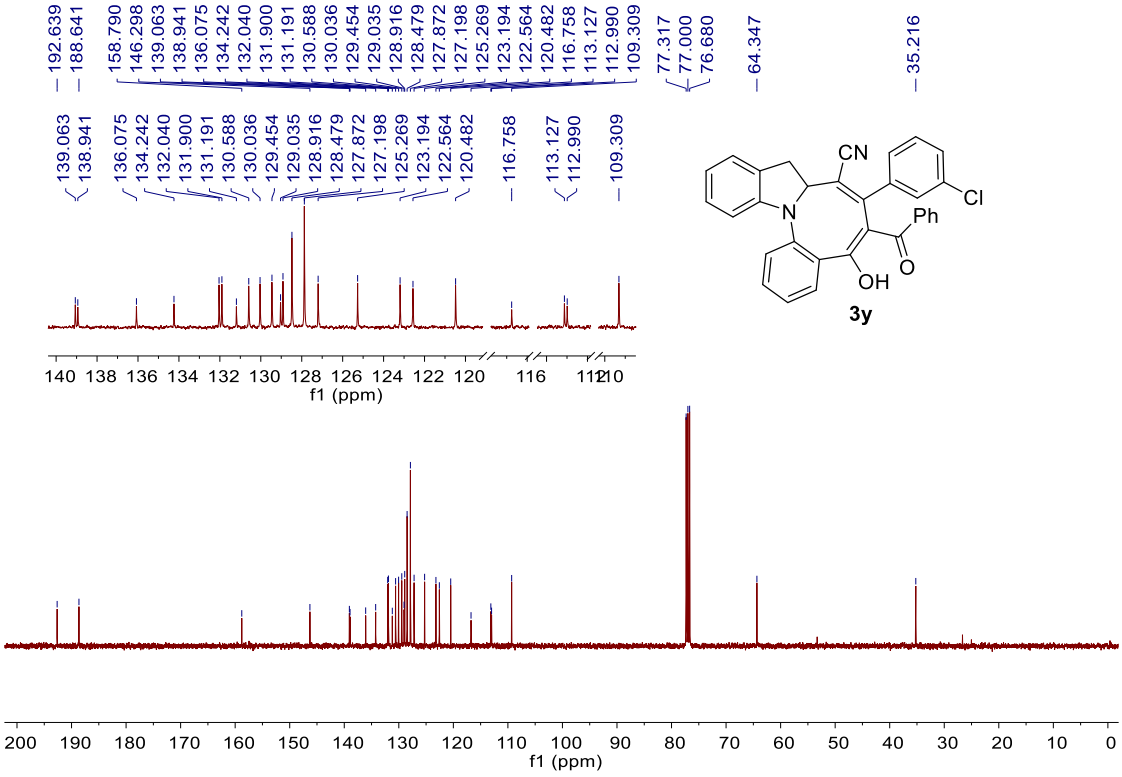

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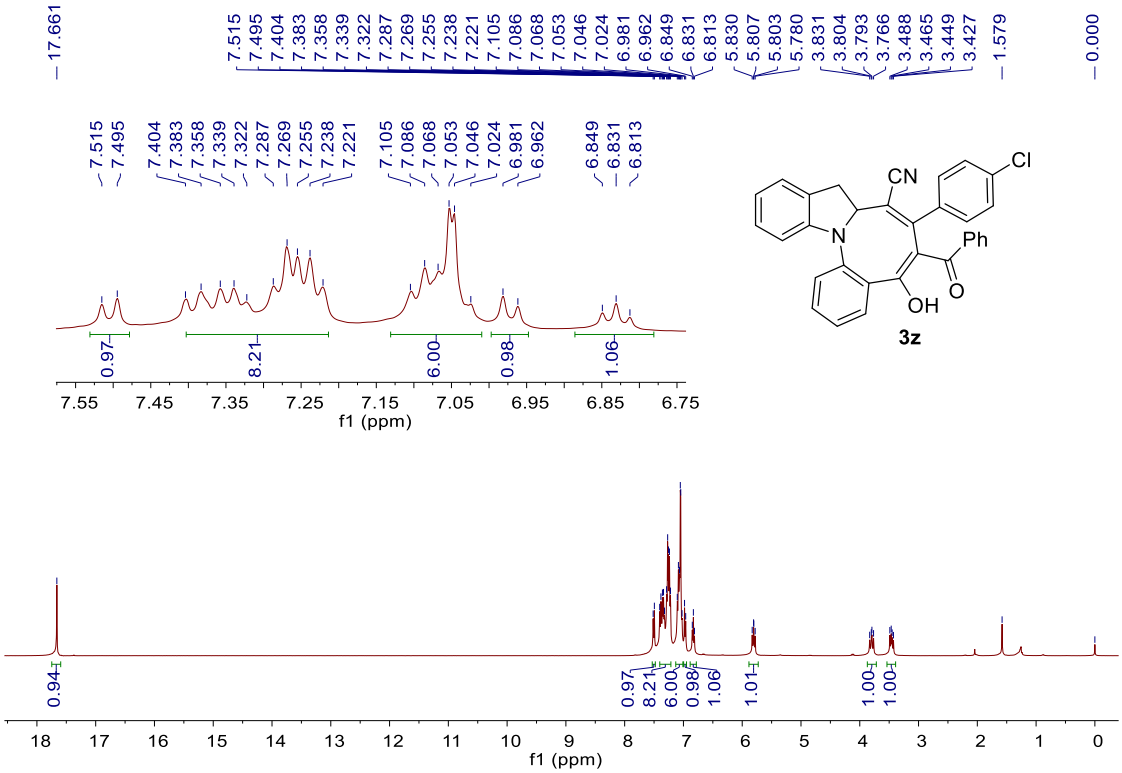

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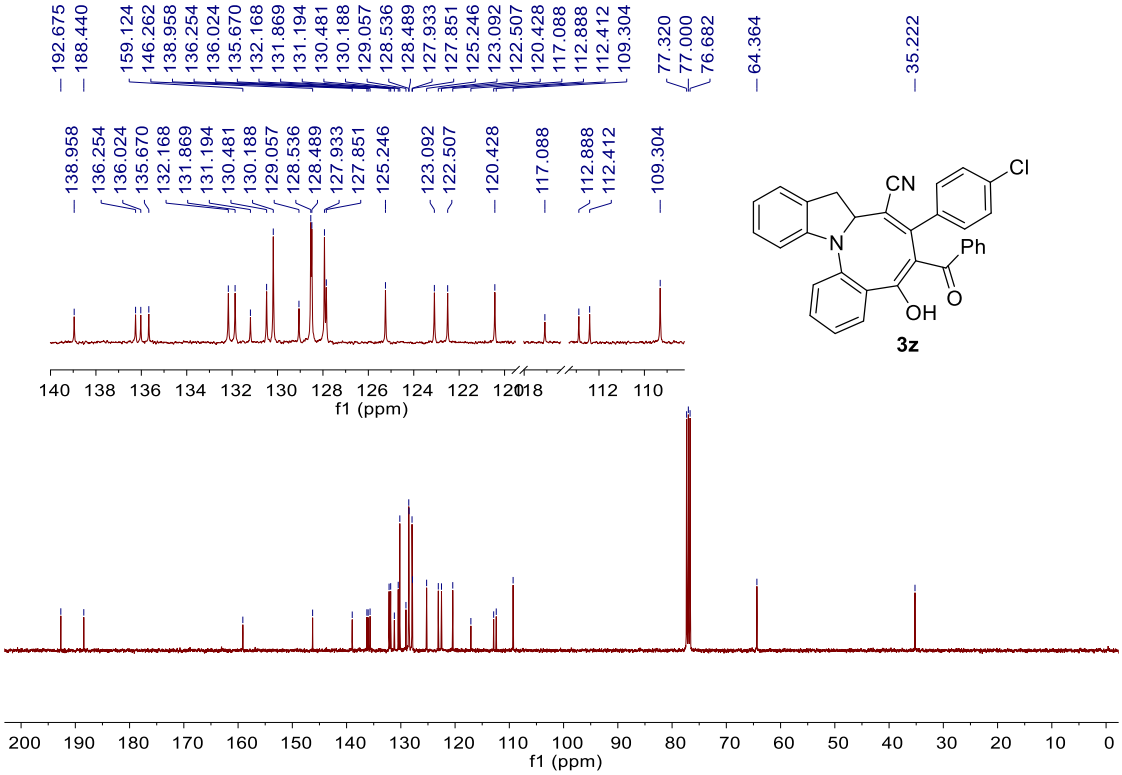

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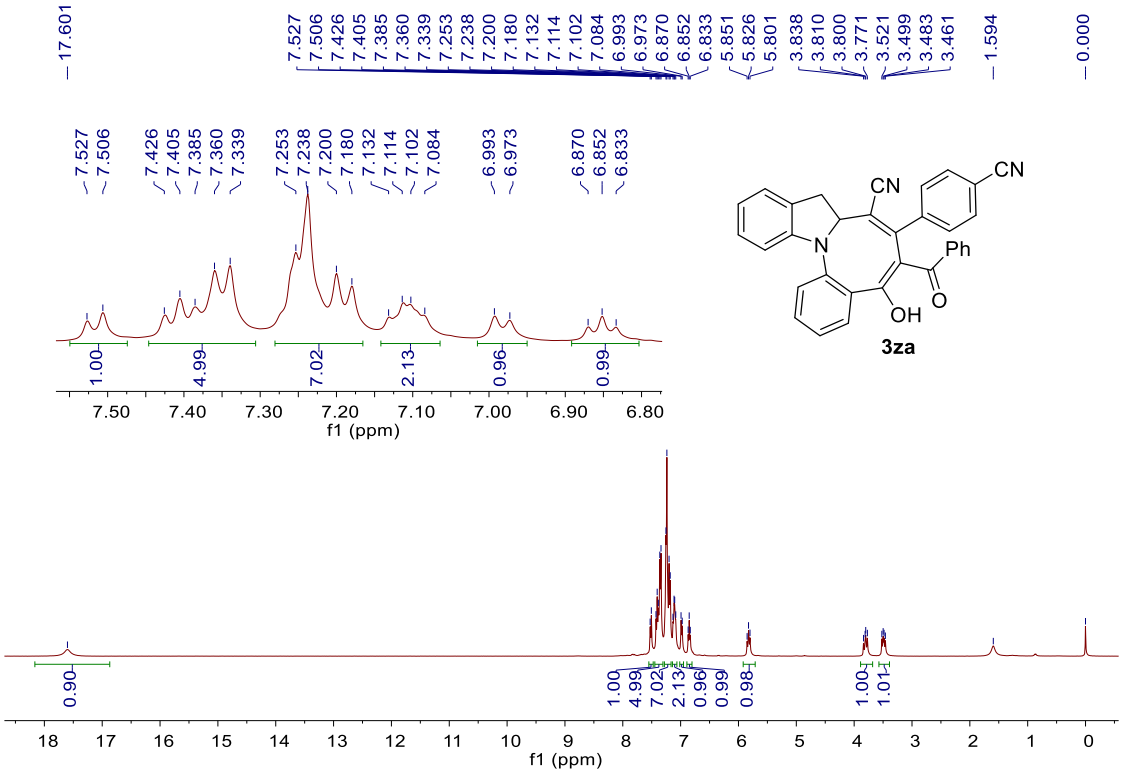

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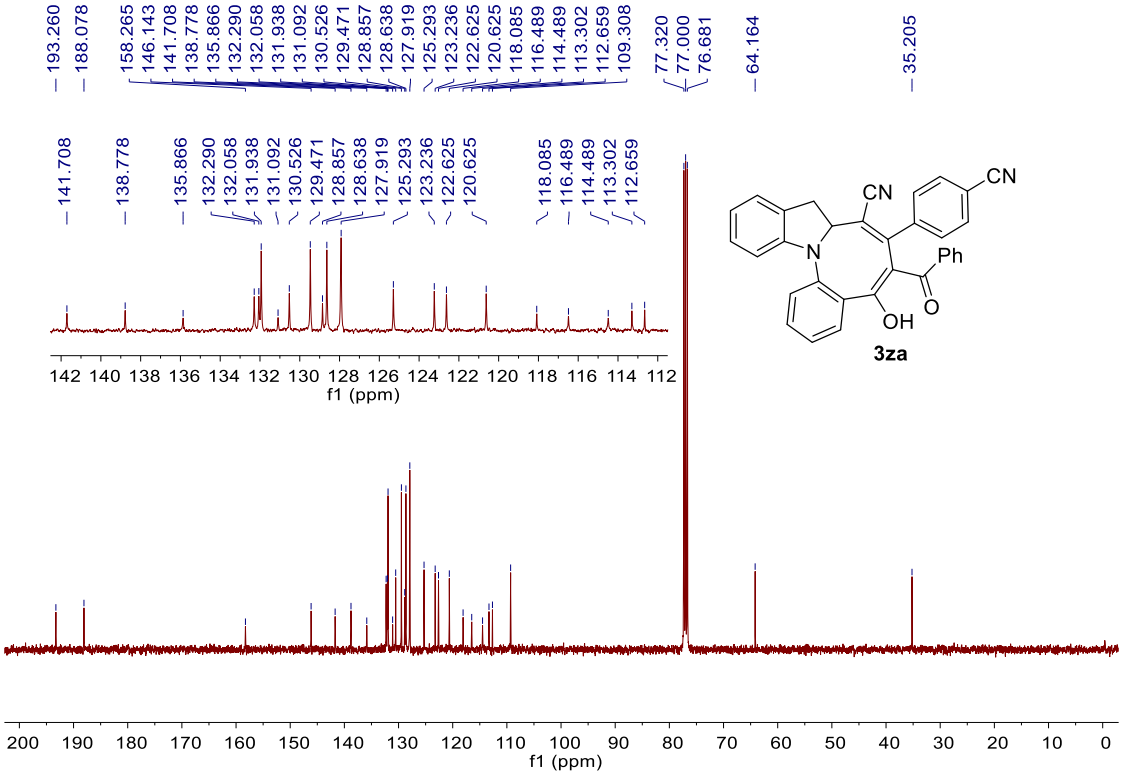

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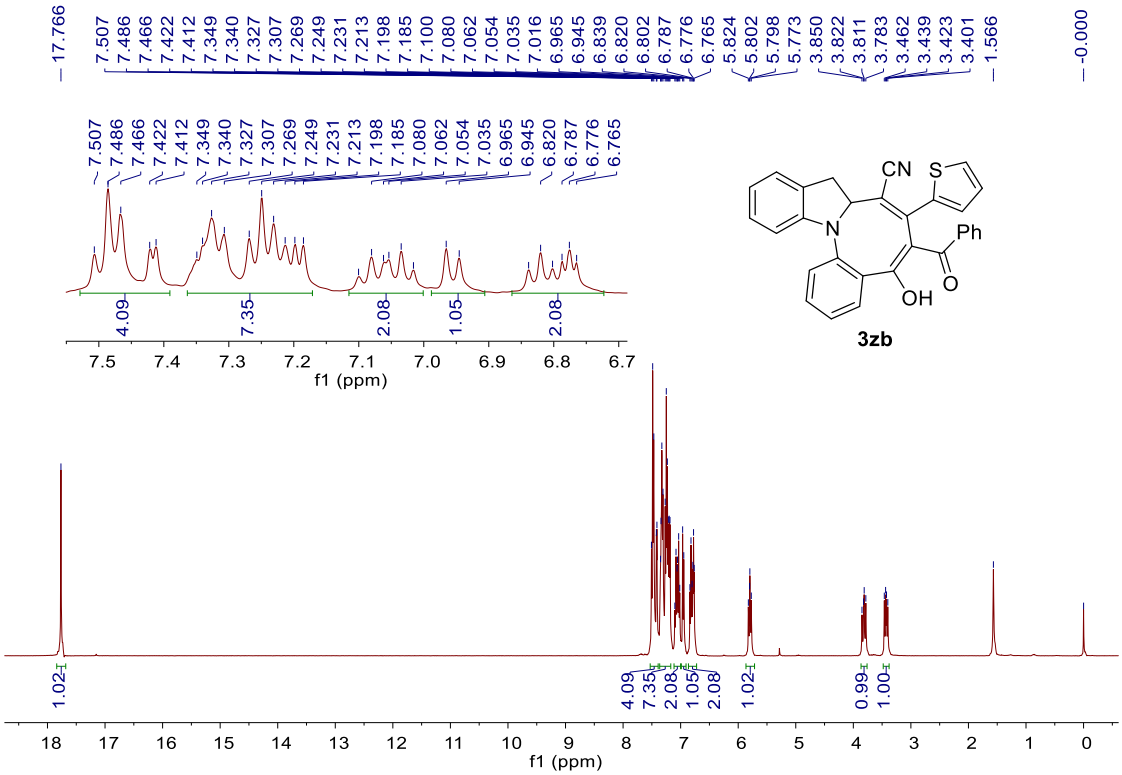

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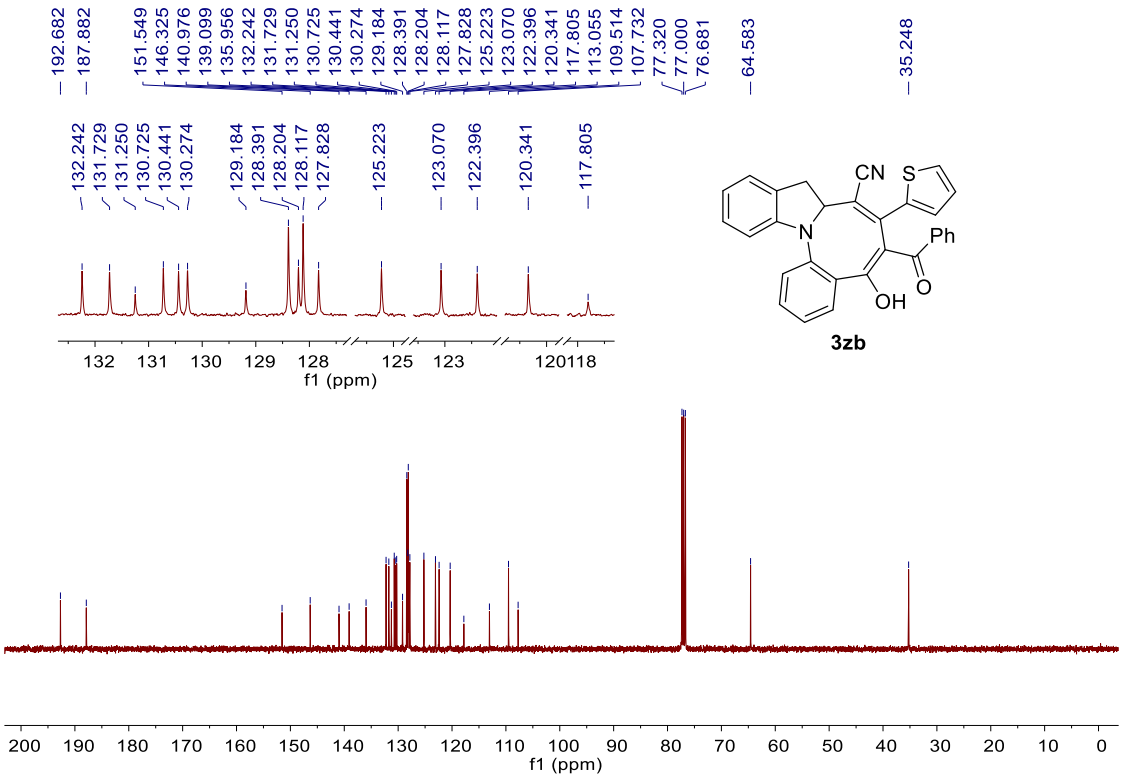

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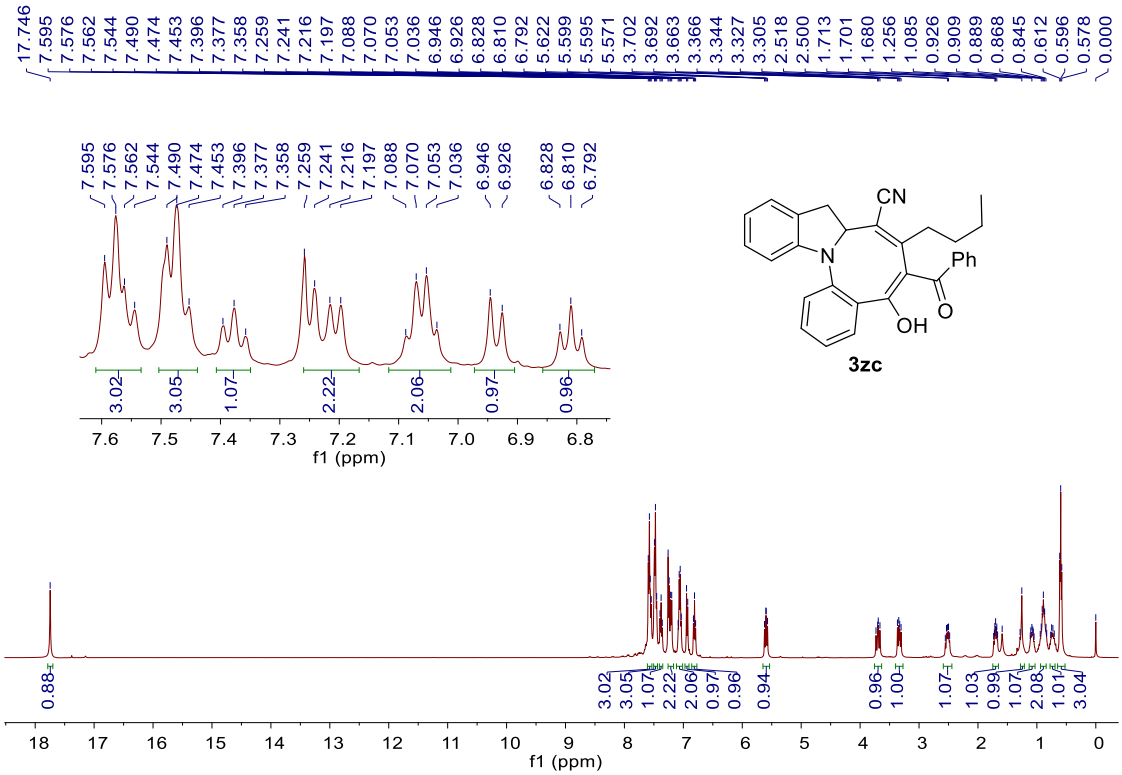

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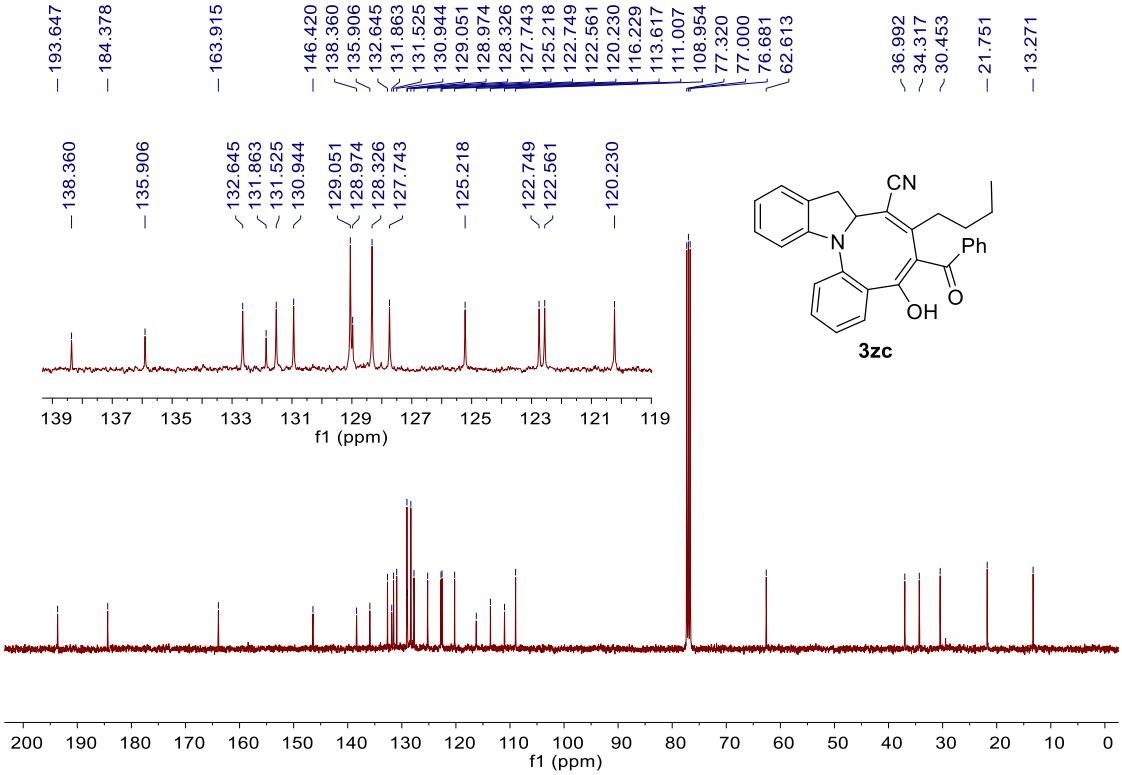
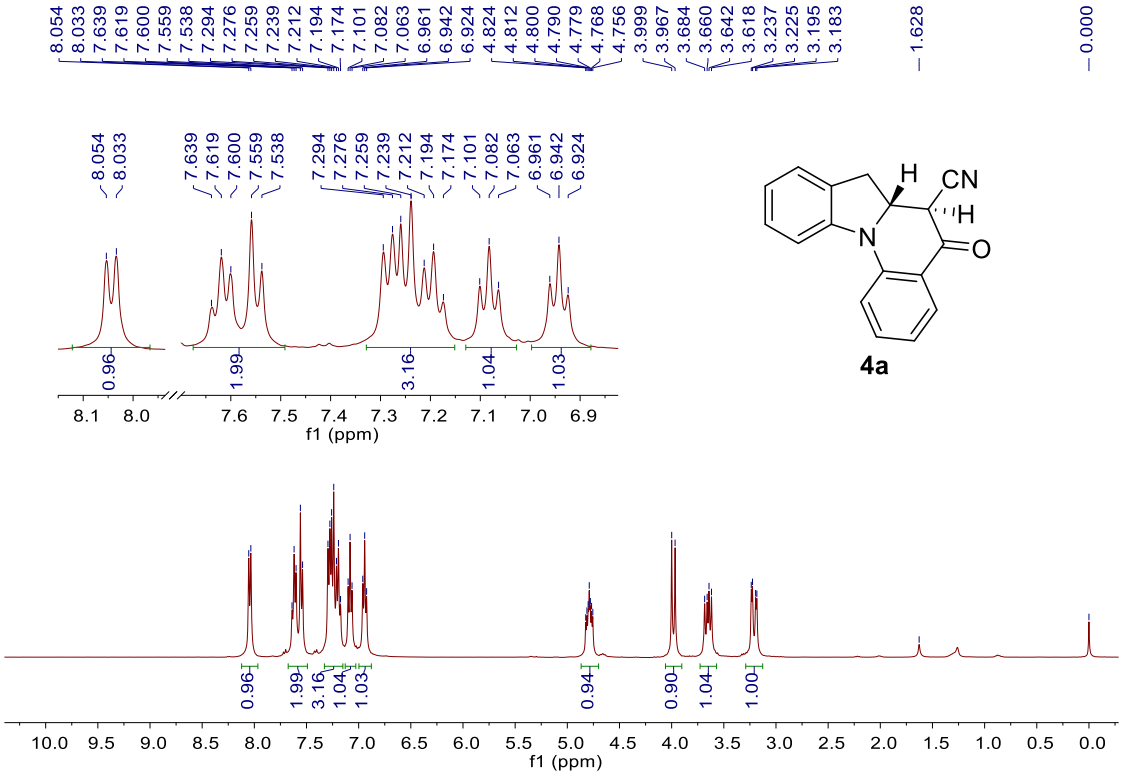
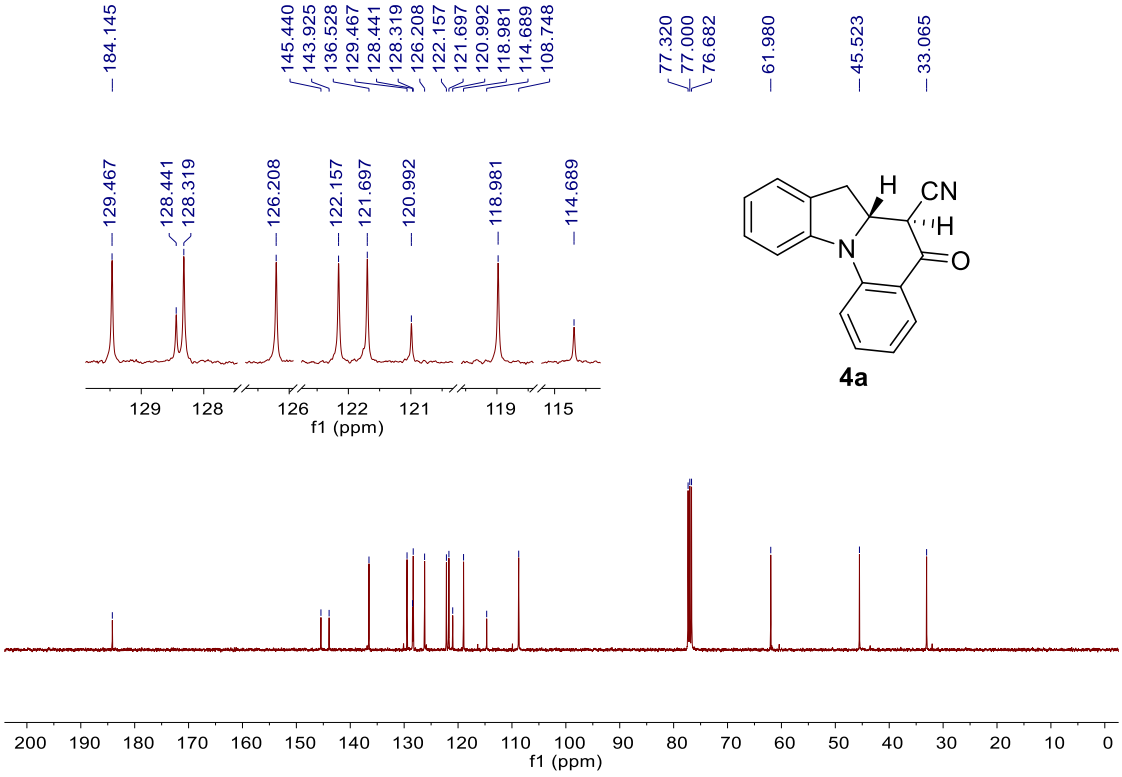


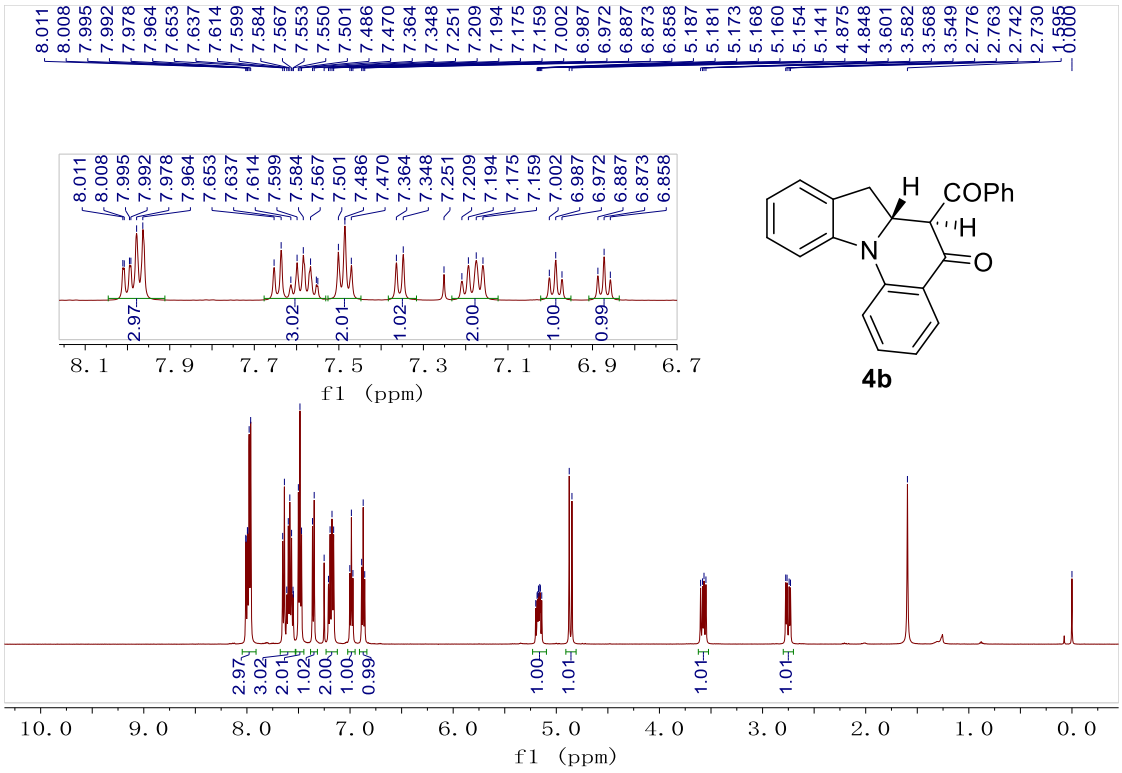
^{1}H NMR (400 MHz, $CDCl_3$)



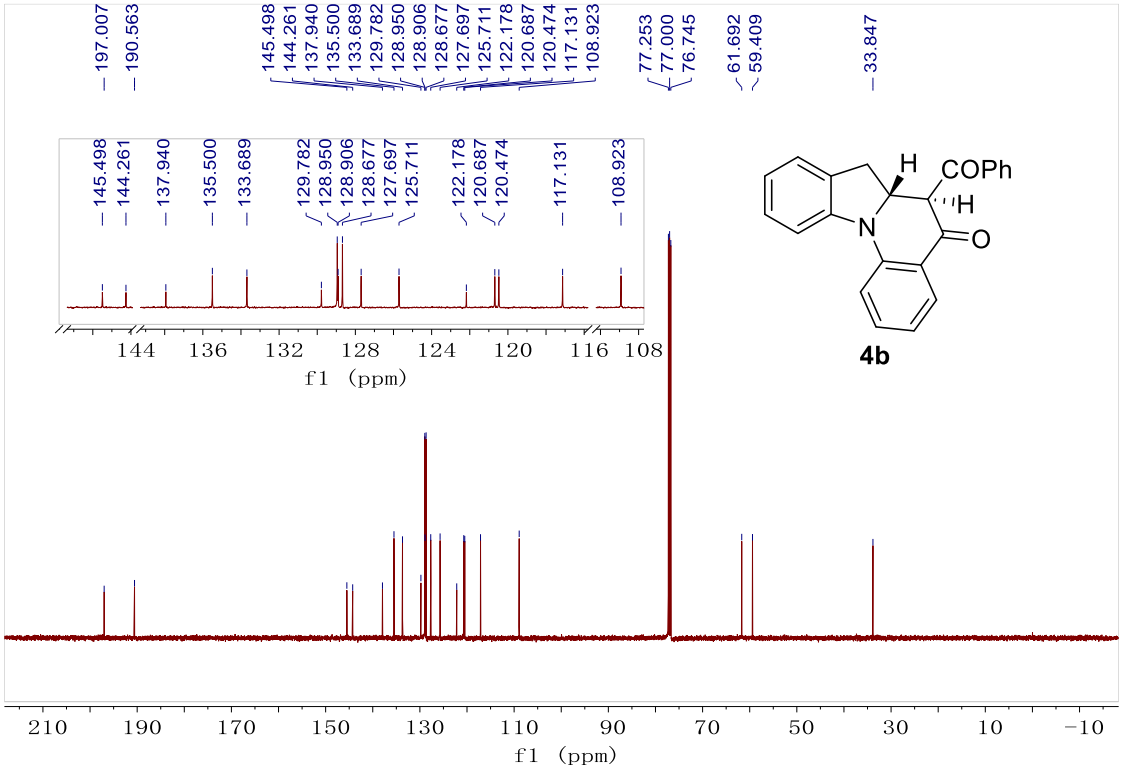
^{13}C NMR (100 MHz, $CDCl_3$)



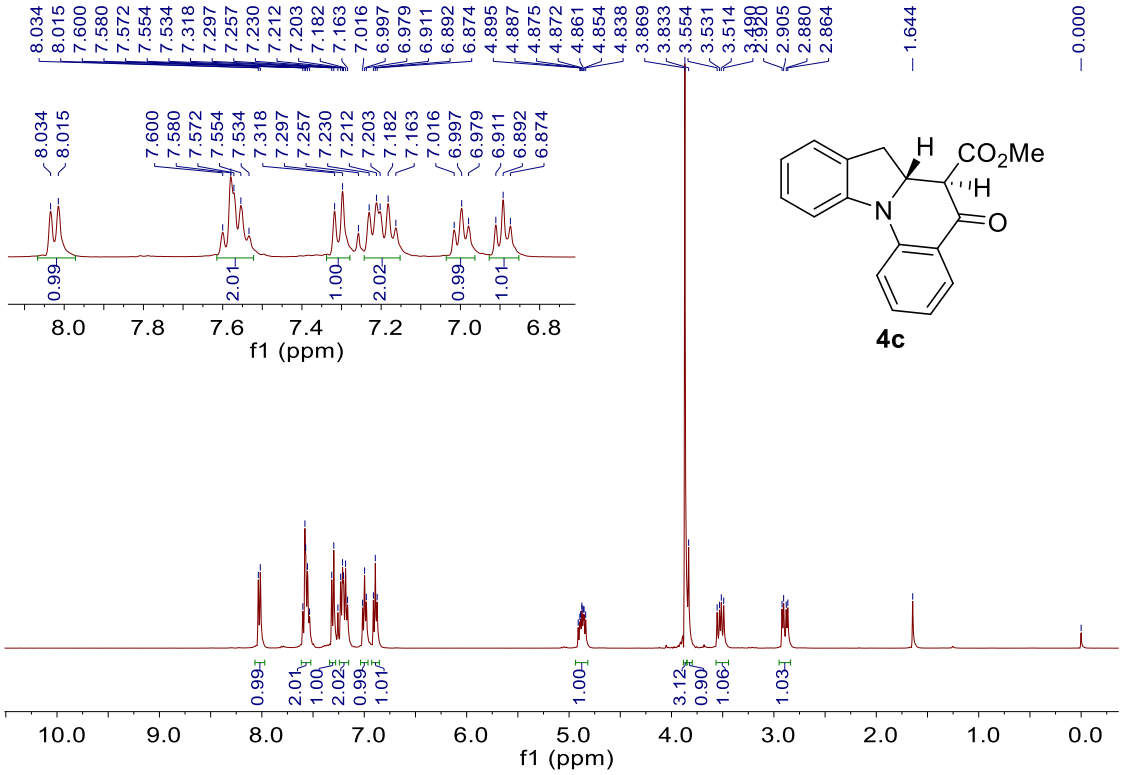
^{1}H NMR (500 MHz, $CDCl_3$)



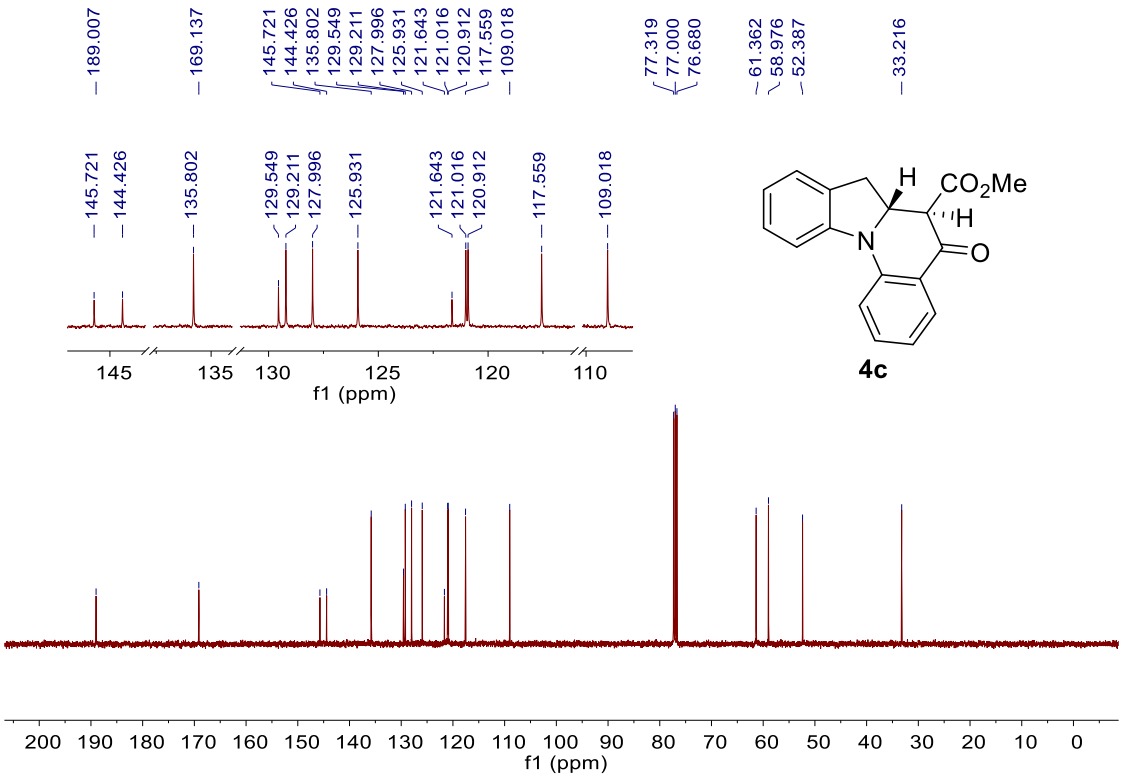
^{13}C NMR (125 MHz, $CDCl_3$)



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



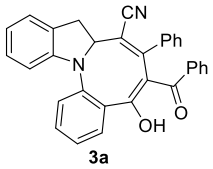
^{13}C NMR (100 MHz, $CDCl_3$)



9. X-ray Crystallography of Compounds 3a.

***(5Z,7E)-6-benzoyl-5-hydroxy-7-phenyl-8a,9-dihydrobenzo[7,8]azocino[1,2-a]indole-8-carbonitrile* (3a, mo_d8v18819_0m)**

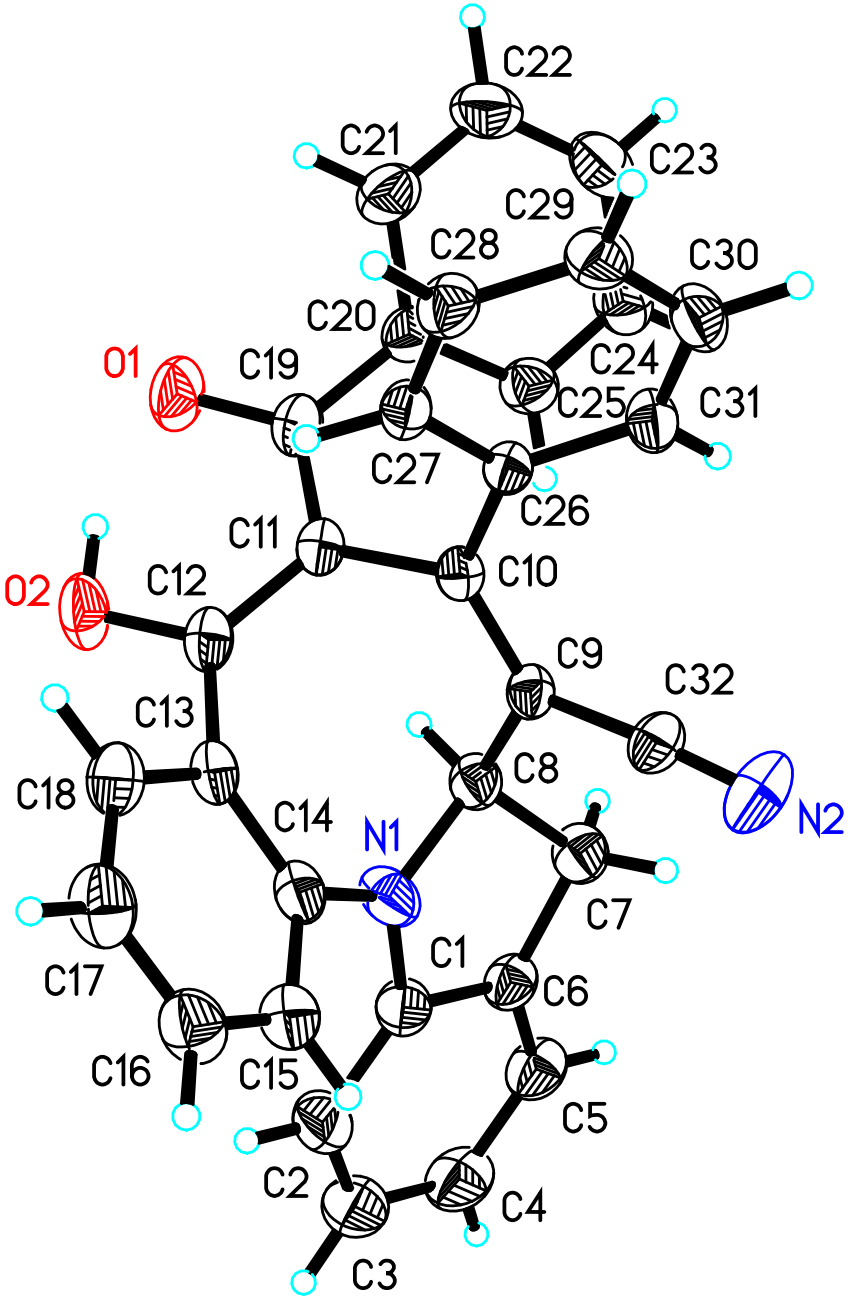
(Ortep ellipsoids are depicted at the 50% level)



3a

Table S1. Crystal data and structure refinement for 3a.

Identification code	**3a**
Empirical formula	$C_{32}H_{22}N_2O_2$
Formula weight	466.51
Temperature	296(2) K
Wavelength	0.71073 Å
Crystal system	Triclinic
Space group	P -1
Unit cell dimensions	a = 13.6000(4) Å, α= 84.3160(10)°. b = 14.2775(3) Å, β= 67.8310(10)°. c = 14.8066(4) Å, γ = 65.8620(10)°
Volume	2424.52(11) $Å^3$
Z	4
Density (calculated)	1.278 Mg/m^3
Absorption coefficient	0.080 mm^{-1}
F(000)	976
Crystal size	0.200 x 0.150 x 0.110 mm^3
Theta range for data collection	2.700 to 26.000°.
Index ranges	-16<=h<=16, -17<=k<=17, -18<=l<=18
Reflections collected	48277
Independent reflections	9493 [R(int) = 0.0465]
Completeness to theta = 26.000°	99.5 %
Absorption correction	Semi-empirical from equivalents
Max. and min. transmission	0.7456 and 0.6484
Refinement method	Full-matrix least-squares on F^2
Data / restraints / parameters	9493 / 2 / 658
Goodness-of-fit on F^2	1.038
Final R indices [I>2sigma(I)]	R1 = 0.0456, wR2 = 0.1008
R indices (all data)	R1 = 0.0695, wR2 = 0.1164
Extinction coefficient	0.030(2)
Largest diff. peak and hole	0.172 and -0.143 $e.Å^{-3}$


C22
C21
C23
C29
C28
C30
C20
O1
C19
C24
C25
C31
C27
C26
C11
C10
O2
C12
C9
C32
C13
C8
C18
C14
N1
N2
C7
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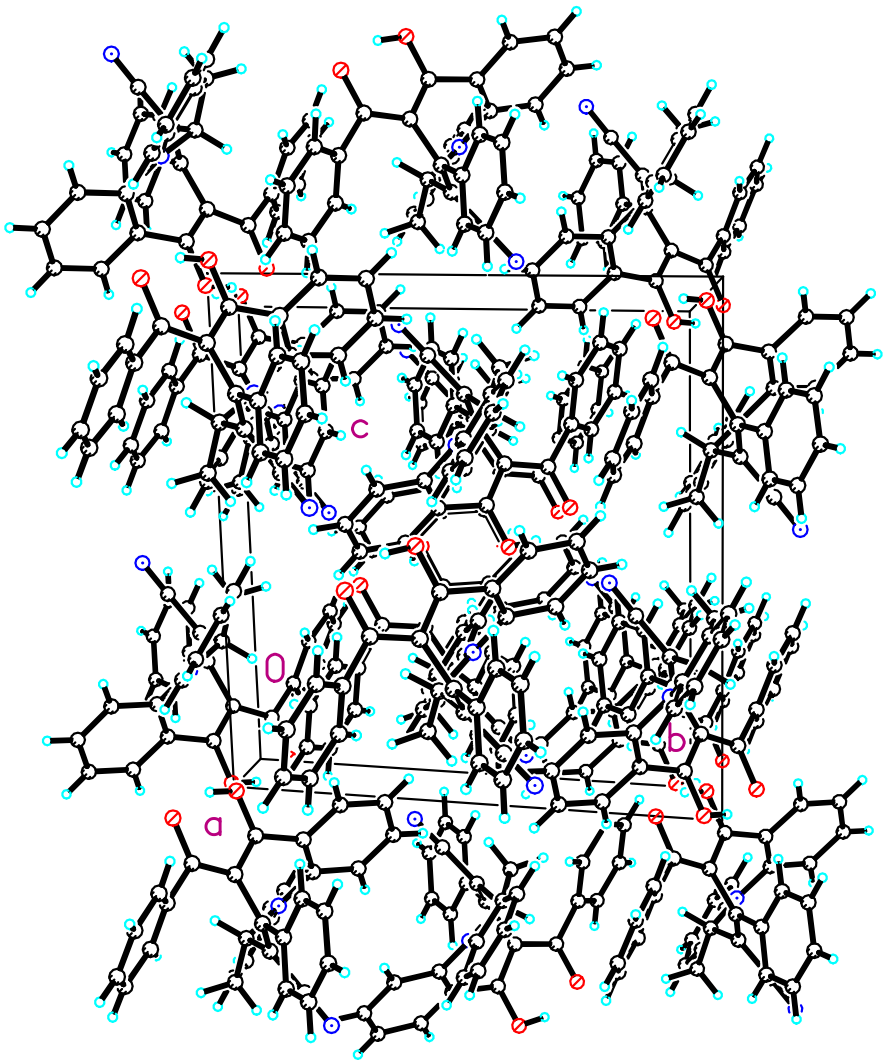
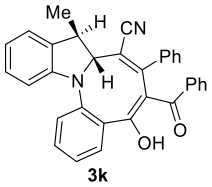
C17
C6
C16
C15
C5
C2
C4
C3


c
0
b
a

10. X-ray Crystallography of Compounds 3k.

(5Z,7E,8aR,9R)-6-benzoyl-5-hydroxy-9-methyl-7-phenyl-8a,9-dihydrobenzo[7,8]azocino[1,2-a]indole-8-carbonitrile **(3k, p-1)**

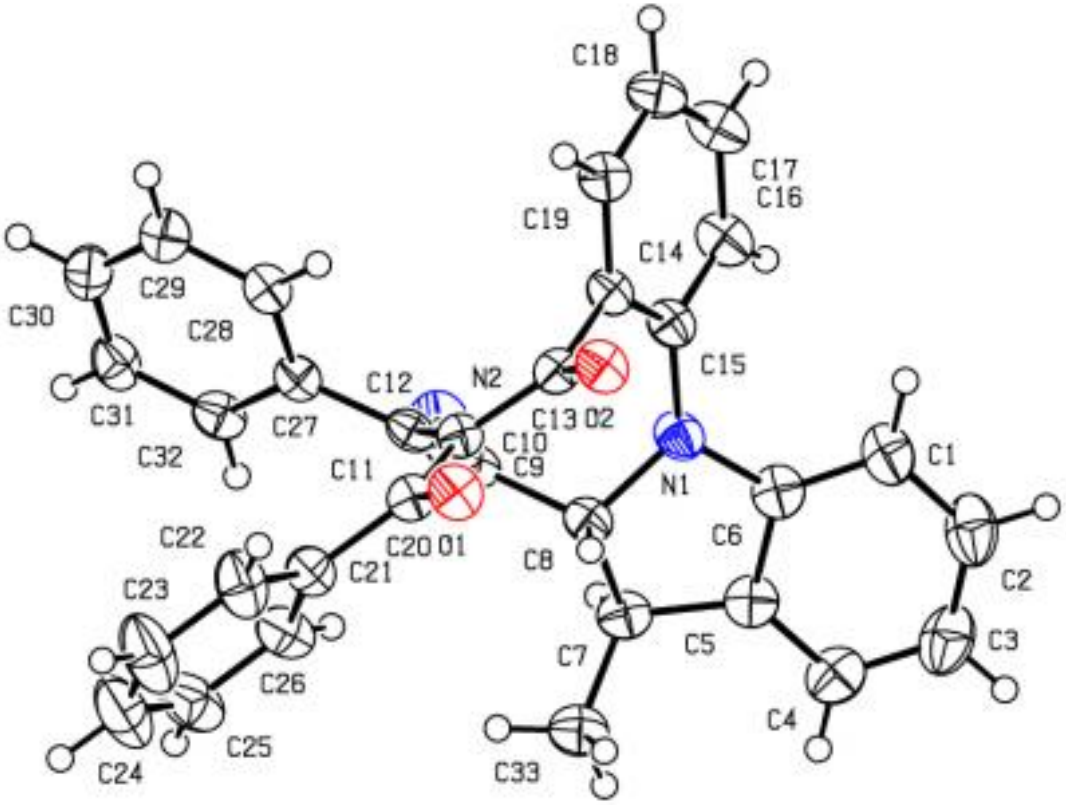
(Ortep ellipsoids are depicted at the 50% level)



3k

Table S1. Crystal data and structure refinement for 3k.

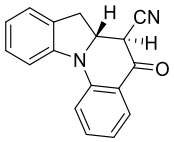
Identification code	**3k**
Empirical formula	$C_{36}H_{30}N_2O_2$
Formula weight	522.62
Temperature	296.15 K
Wavelength	0.71073 Å
Crystal system	Triclinic
Space group	P -1
Unit cell dimensions	a = 10.7752(14) Å, α= 72.994(5)°. b = 11.1091(14) Å, β= 77.380(4)°. c = 12.6118(16) Å, γ = 77.170(5)°
Volume	1388.4(3) $Å^3$
Z	2
Density (calculated)	1.250 Mg/m^3
Absorption coefficient	0.077 mm^{-1}
F(000)	552.0
Theta range for data collection	3.93 to 59.392°.
Index ranges	-14<=h<=14, -15<=k<=15, -17<=l<=17
Reflections collected	40555
Independent reflections	7749 [R_{int} = 0.0926, R_{sigma} = 0.0960]
Data / restraints / parameters	7749 / 0 / 363
Goodness-of-fit on F^2	1.042
Final R indices [I>2sigma(I)]	R1 = 0.0696, wR2 = 0.1668
R indices (all data)	R1 = 0.1425, wR2 = 0.1938
Largest diff. peak/hole / e $Å^{-3}$	0.42/-0.40


C18
C17
C16
C19
C14
C29
C30
C28
C15
C12
N2
C13
O2
C31
C27
C10
C32
C11
C9
N1
C1
C22
C20
O1
C8
C6
C21
C2
C23
C7
C5
C3
C26
C4
C25
C24
C33

11. X-ray Crystallography of Compounds 4a.

(6S,6aR)-5-oxo-5,6,6a,7-tetrahydroindolo[1,2-a]quinoline-6-carbonitrile **(4a, mo_d8v181004_0m)**

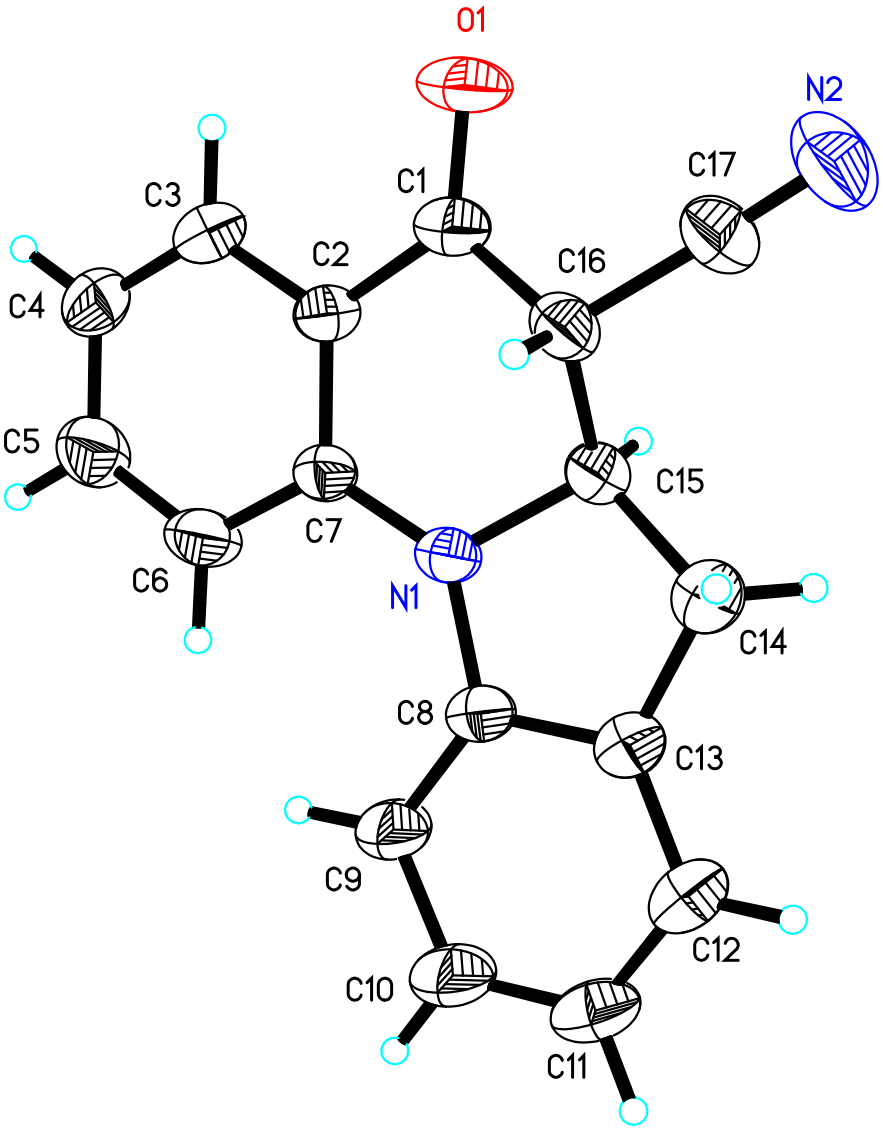
(Ortep ellipsoids are depicted at the 50% level)

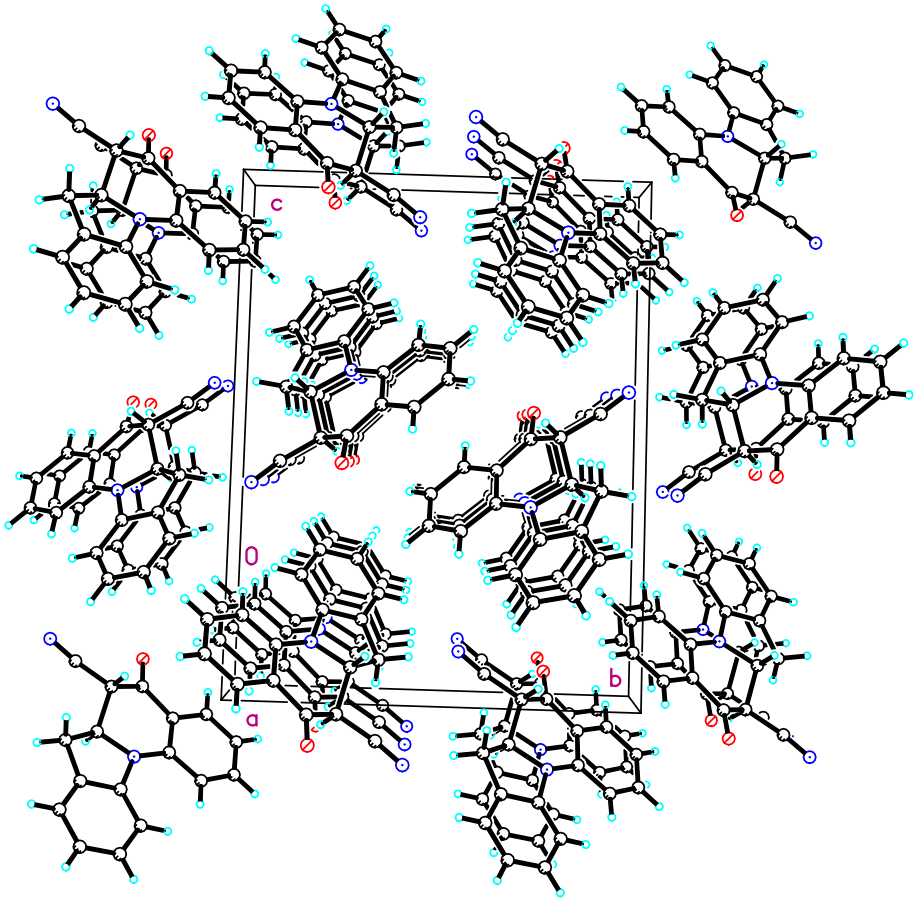


4a

Table S2. Crystal data and structure refinement for 4a.

Identification code	**4a**
Empirical formula	$C_{17}H_{12}N_2O$
Formula weight	260.29
Temperature	293(2) K
Wavelength	0.71073 Å
Crystal system	Monoclinic
Space group	P 21/c
Unit cell dimensions	a = 5.6800(3) Å, α= 90°. b = 13.3266(7) Å, β= 98.232(2)°. c = 17.2554(10) Å, γ = 90°
Volume	1292.69(12) $Å^3$
Z	4
Density (calculated)	1.337 Mg/m^3
Absorption coefficient	0.085 mm^{-1}
F(000)	544
Crystal size	0.200 x 0.180 x 0.130 mm^3
Theta range for data collection	3.282 to 25.500°.
Index ranges	-5<=h<=6, -16<=k<=16, -20<=l<=17
Reflections collected	5954
Independent reflections	2374 [R(int) = 0.0496]
Completeness to theta = 26.000°	98.8 %
Absorption correction	Semi-empirical from equivalents
Max. and min. transmission	0.7456 and 0.4694
Refinement method	Full-matrix least-squares on F^2
Data / restraints / parameters	2374 / 36 / 200
Goodness-of-fit on F^2	1.016
Final R indices [I>2sigma(I)]	R1 = 0.0547, wR2 = 0.1401
R indices (all data)	R1 = 0.0683, wR2 = 0.1533
Largest diff. peak and hole	0.171 and -0.139 $e.Å^{-3}$


O1
N2
C17
C1
C3
C2
C16
C4
C5
C15
C7
C6
N1
C14
C8
C13
C9
C12
C10
C11


c
0
a
b