Supporting Information

Synthesis of 3-indolyl all-carbon quaternary centers via Rh/Brønsted acid co-catalyzed three-component reactions of azoalkenes with indoles and diazoacetates

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General Information

All reactions were carried out under an atmosphere of argon using oven-dried glassware. Super dry solvents, metal catalysts, were purchased from chemical companies and used without further treatment. Flash column chromatography was performed using silica gel (300-400 mesh). ^{1}H NMR ,^{13}C NMR, ^{19}F NMR spectra were recorded in $CDCl_3$ or DMSO-d_6 on a 400 MHz spectrometer; chemical shifts are reported in ppm with the solvent signals as reference, and coupling constants (*J*) are given in Hertz. The peak information is described as: s = singlet, d = doublet, t = triplet, q = quartet, m= multiplet. High-resolution mass spectra (HRMS) were obtained using an Agilent LC-MSAD-Trap-XCT instrument using electrospray ionization time-of-flight (ESI-TOF). Melting points were determined using YRT-3 melting point apparatus. The instrumentation used for the crystal measurement is Oxford Gemini E X-ray single-crystal diffractometer. Azoalkenes[1-2] and diazoacetates[3] were synthesized according to the literature.

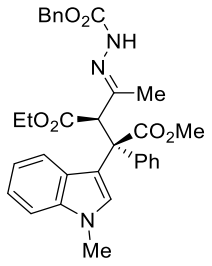
General Procedure for optimization of the reaction conditions

A mixture of $Rh_2(OAc)_4$ (0.002 mmol) and azoalkene **3a** (0.2 mmol) in 2 mL of solvent under an argon atmosphere was stirred at corresponding temperature. Indole **1a** (0.24 mmol) and diazoacetate **2a** (0.3 mmol) in 1 mL of solvent was then added over 1 h via a syringe pump. After completion of the addition, the reaction mixture was stirred for another 3 h, then filtrated and evaporated in vacuo to give the crude product. The crude products was purified by flash chromatography on silica gel (PE/EtOAc = 3:1) to give the pure product **4a** as a white solid.

Synthesis of three-component product 4

A mixture of $Rh_2(OAc)_4$ (0.002 mmol) and azoalkene **3** (0.2 mmol) in 2 mL of EtOAc under an argon atmosphere was stirred at 0 °C. Diazoacetate **2** (0.3 mmol) and indole **1** (0.24 mmol) in 1 mL of EtOAc was then added over 1 h via a syringe pump. After completion of the addition, the reaction mixture was stirred for another 3 h, then filtrated and evaporated in vacuo to give the crude product. The crude products was purified by flash chromatography on silica gel (PE/EtOAc = 3:1) to give the pure product **4** as a white solid.

4-ethyl 1-methyl (2*S*,3*R*)-3-((*E*)-1-(2-((benzyloxy)carbonyl)hydrazono)ethyl)-2-(1-methyl-1*H*-indol-3-yl)-2-phenylsuccinate (4a):

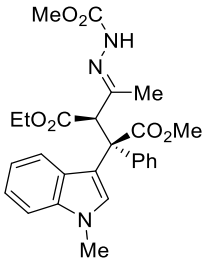


4a

Followed the general procedure, using **1a** (0.24 mmol, 31.5 mg), **2a** (0.3 mmol, 52.8 mg) and **3a** (0.2 mmol, 55.2 mg). Purified by flash column chromatography (petroleum ether/ethyl acetate 3:1) to afforded **4a** as a white solid (88.8 mg, 80% yield, >20:1 dr); **m.p.** = 147.0-147.5°C; **^{1}H NMR** (400 MHz, DMSO-d_6) δ 10.01 (s, 1H), 8.19 (s, 1H), 7.48 – 7.44 (m, 2H), 7.42 – 7.29 (m, 6H), 7.23 – 7.16 (m, 3H), 7.06 – 7.01 (m, 1H), 6.77 – 6.70 (m, 2H), 5.30 – 5.17 (m, 2H), 4.96 (s, 1H), 4.13 (q, *J* = 6.9 Hz, 2H), 3.70 (s, 3H), 3.47 (s, 3H), 1.15 (t, *J* = 7.1 Hz, 3H), 0.84 (s, 3H); **^{13}C NMR** (101 MHz, DMSO-d_6) δ 172.5, 171.1, 154.5, 138.5, 137.2, 137.0, 131.6, 131.4, 128.9, 128.6, 127.5, 127.4, 126.3, 122.0, 121.4, 118.9, 113.2, 110.0, 66.7, 61.5, 60.0, 56.7, 52.3, 33.0, 15.6, 14.4; **HRMS** (ESI): m/z [M + Na]$^{+}$ calcd for [$C_{32}H_{33}N_3O_6Na$]$^{+}$: 578.2267, found: 578.2258.

4-ethyl 1-methyl (2*S*,3*R*)-3-((*E*)-1-(2-(methoxycarbonyl)hydrazono)ethyl)-2-(1-methyl-1*H*-indol-3

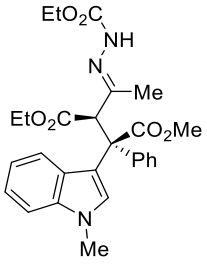
-yl)-2-phenylsuccinate (4b):



4b

Followed the general procedure, using **1a** (0.24 mmol, 31.5 mg), **2a** (0.3 mmol, 52.8 mg) and **3b** (0.2 mmol, 40.0 mg). Purified by flash column chromatography (petroleum ether/ethyl acetate 3:1) to afforded **4b** as a white solid (64.2 mg, 67% yield, >20:1 dr); **m.p.** = 194.8-195.0 ℃; **^{1}H NMR** (400 MHz, DMSO-d_6) δ 9.92 (s, 1H), 8.22 (s, 1H), 7.38 – 7.35 (m, 1H), 7.34 – 7.24 (m, 2H), 7.24 – 7.15 (m, 3H), 7.08 – 7.00 (m, 1H), 6.81 – 6.69 (m, 2H), 4.94 (s, 1H), 4.13 (q, *J* = 6.6 Hz, 2H), 3.82 (s, 3H), 3.74 (s, 3H), 3.47 (s, 3H), 1.15 (t, *J* = 7.1 Hz, 3H), 0.82 (s, 3H); **^{13}C NMR** (101 MHz, DMSO-d_6) δ 172.5, 171.1, 155.1, 138.5, 137.2, 131.7, 131.5, 127.4, 126.3, 121.9, 121.4, 118.8, 113.2, 110.0, 61.5, 59.9, 56.7, 52.5, 52.3, 40.6, 40.4, 40.2, 40.0, 39.7, 39.5, 39.3, 33.1, 15.4, 14.4.; **HRMS** (ESI): m/z [M + Na]$^+$ calcd for [$C_{26}H_{29}N_3O_6Na$]$^+$: 502.1954 , found: 502.1959.

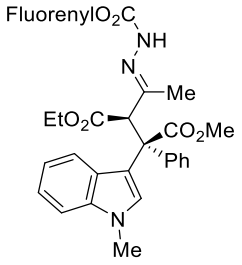
4-ethyl 1-methyl (2*S*,3*R*)-3-((*E*)-1-(2-(ethoxycarbonyl)hydrazono)ethyl)-2-(1-methyl-1*H*-indol -3-yl)-2-phenylsuccinate (4c):



4c

Followed the general procedure, using **1a** (0.24 mmol, 31.5 mg), **2a** (0.3 mmol, 52.8 mg) and **3c** (0.2 mmol, 42.8 mg). Purified by flash column chromatography (petroleum ether/ethyl acetate 3:1) to afforded **4c** as a white solid (68.1 mg, 69% yield, >20:1 dr); **m.p.** = 126.9-127.5 ℃; **^{1}H NMR** (400 MHz, DMSO-d_6) δ 9.85 (s, 1H), 8.17 (s, 1H), 7.37 – 7.34 (m, 1H), 7.33 – 7.25 (m, 2H), 7.22 – 7.16 (m, 3H), 7.05 – 7.01 (m, 1H), 6.75 – 6.69 (m, 2H), 4.92 (s, 1H), 4.20 (q, *J* = 14.8, 8.0 Hz, 2H), 4.12 (q, *J* = 13.0, 6.4 Hz, 2H), 3.81 (s, 3H), 3.46 (s, 3H), 1.28 (t, *J* = 6.8 Hz, 3H), 1.14 (t, *J* = 7.1 Hz, 3H), 0.80 (s, 3H); **^{13}C NMR** (101 MHz, DMSO-d_6) δ 172.5, 171.1, 154.6, 138.5, 137.2, 131.6, 131.4, 127.4, 127.2, 126.2, 121.9, 121.4, 118.9, 113.2, 110.1, 61.5, 61.2, 60.0, 56.6, 52.3, 33.1, 15.5, 15.1, 14.4; **HRMS** (ESI): m/z [M + Na]$^+$ calcd for [$C_{27}H_{31}N_3O_6Na$]$^+$: 516.2111, found: 516.2109.

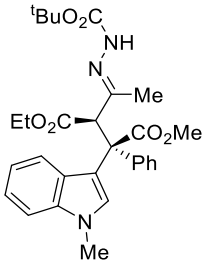
4-ethyl 1-methyl (2*S*,3*R*)-3-((*E*)-1-(2-(((9*H*-fluoren-9-yl)oxy)carbonyl)hydrazono)ethyl)-2-(1-meth yl-1*H*-indol-3-yl)-2-phenylsuccinate (4d):



4d

Followed the general procedure, using **1a** (0.24 mmol, 31.5 mg), **2a** (0.3 mmol, 52.8 mg) and **3d** (0.2 mmol, 70.0 mg). Purified by flash column chromatography (petroleum ether/ethyl acetate 3:1) to afforded **4d** as a white solid (90.6 mg, 72% yield, >20:1 dr); **m.p.** = 139.2-140.0 ℃; **^{1}H NMR** (400 MHz, DMSO-d_6) δ 10.02 (s, 1H), 8.18 (s, 1H), 7.91 (m, 2H), 7.79 – 7.71 (m, 2H), 7.44 – 7.39 (m, 2H), 7.35 – 7.28 (m, 3H), 7.24 – 7.18 (m, 3H), 7.05 – 6.99 (m, 1H), 6.80 – 6.68 (m, 2H), 4.96 (s, 1H), 4.55 – 4.40 (m, 2H), 4.34 (s, 1H), 4.15 (q, *J* = 6.9 Hz, 2H), 3.74 (s, 3H), 3.48 (s, 3H), 1.17 (t, *J* = 7.0 Hz, 3H), 0.87 (s, 3H); **^{13}C NMR** (101 MHz, DMSO-d_6) δ 172.5, 171.1, 154.5, 144.2, 144.1, 141.2, 138.5, 137.2, 131.4, 128.2, 127.5, 127.4, 126.2, 125.8, 121.9, 121.4, 120.7, 118.9, 113.2, 110.1, 66.8, 61.5, 60.0, 56.7, 52.4, 47.0, 33.0, 15.7, 14.4; **HRMS** (ESI): m/z [M + Na]$^+$ calcd for [$C_{39}H_{37}N_3O_6Na$]$^+$: 666.2580, found: 666.2570.

4-ethyl 1-methyl (2*S*,3*R*)-3-((*E*)-1-(2-(tert-butoxycarbonyl)hydrazono)ethyl)-2-(1-methyl-1*H*-indol-3-yl)-2-phenylsuccinate (4e):

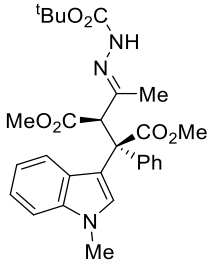


4e

Followed the general procedure, using **1a** (0.24 mmol, 31.5 mg), **2a** (0.3 mmol, 52.8 mg) and **3e** (0.2 mmol, 48.4 mg). Purified by flash column chromatography (petroleum ether/ethyl acetate 3:1) to afforded **4e** as a white solid (80.3 mg, 77% yield, >20:1 dr); **m.p.** = 130.0-131.0 ℃; **^{1}H NMR** (400 MHz, DMSO-d_6) δ 9.54 (s, 1H), 8.20 (s, 1H), 7.38 – 7.34 (m, 1H), 7.33 – 7.24 (m, 2H), 7.23 – 7.16 (m, 3H), 7.06 – 7.01 (m, 1H), 6.76 – 6.69 (m, 2H), 4.90 (s, 1H), 4.11 (q, *J* = 7.0 Hz, 2H), 3.81 (s, 3H), 3.46 (s, 3H), 1.50 (s, 9H), 1.14 (t, *J* = 7.1 Hz, 3H), 0.82 – 0.75 (s, 3H); **^{13}C NMR** (101 MHz, DMSO-d_6) δ 172.5, 171.1, 153.5, 138.5, 137.2, 131.6, 131.4, 127.4, 126.3, 122.0, 121.4, 118.9, 113.3, 110.1, 80.1, 61.4, 60.0, 56.6, 52.3, 33.1, 28.6, 15.5, 14.4; **HRMS** (ESI): m/z [M + Na]$^+$ calcd for [$C_{29}H_{35}N_3O_6Na$]$^+$: 544.2424, found: 544.2427.

Dimethyl (2*S*,3*R*)-3-((*E*)-1-(2-(tert-butoxycarbonyl)hydrazono)ethyl)-2-(1-methyl-1*H*-indol-3-yl)-

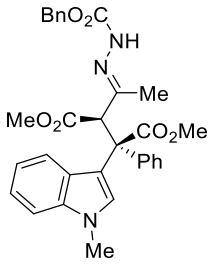
2-phenylsuccinate (4f):



4f

Followed the general procedure, using **1a** (0.24 mmol, 31.5 mg), **2a** (0.3 mmol, 52.8 mg) and **3f** (0.2 mmol, 45.6 mg). Purified by flash column chromatography (petroleum ether/ethyl acetate 3:1) to afforded **4f** as a white solid (80.1 mg, 79% yield, >20:1 dr); **m.p.** = 158.2-160.0 ℃; **^{1}H NMR** (400 MHz, DMSO-d_6) δ 9.56 (s, 1H), 8.19 (s, 1H), 7.39 – 7.35 (m, 1H), 7.33 – 7.23 (m, 2H), 7.21 – 7.18 (m, 2H), 7.07 – 7.00 (m, 1H), 6.76 – 6.67 (m, 2H), 4.93 (s, 1H), 3.81 (s, 3H), 3.62 (s, 3H), 3.47 (s, 3H), 1.50 (s, 9H), 0.78 (s, 3H); **^{13}C NMR** (101 MHz, DMSO-d_6) δ 172.6, 171.7, 153.5, 138.5, 137.2, 131.6, 131.4, 127.5, 127.4, 126.2, 122.0, 121.4, 118.9, 113.2, 110.1, 80.1, 60.0, 56.6, 52.7, 52.4, 33.1, 28.6, 15.5; **HRMS** (ESI): m/z [M + Na]$^+$ calcd for [$C_{28}H_{33}N_3O_6Na$]$^+$: 530.2267, found: 530.2265.

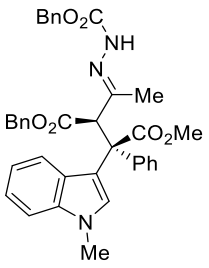
Dimethyl (2*S*,3*R*)-3-((*E*)-1-(2-((benzyloxy)carbonyl)hydrazono)ethyl)-2-(1-methyl-1*H*-indol-3-yl)-2-phenylsuccinate (4g):



4g

Followed the general procedure, using **1a** (0.24 mmol, 31.5 mg), **2a** (0.3 mmol, 52.8 mg) and **3g** (0.2 mmol, 52.4 mg). Purified by flash column chromatography (petroleum ether/ethyl acetate 3:1) to afforded **4g** as a white solid (89.8 mg, 83% yield, >20:1 dr); **m.p.** = 189.7-190.0 ℃; **^{1}H NMR** (400 MHz, DMSO-d_6) δ 10.05 (s, 1H), 8.20 (s, 1H), 7.50 – 7.43 (m, 2H), 7.43 – 7.28 (m, 7H), 7.27 – 7.15 (m, 4H), 7.08 – 6.98 (m, 1H), 6.78 – 6.71 (m, 2H), 5.31 – 5.18 (m, 2H), 4.99 (s, 1H), 3.71 (s, 3H), 3.64 (s, 3H), 3.47 (s, 3H), 0.84 (s, 3H); **^{13}C NMR** (101 MHz, DMSO-d_6) δ 172.5, 171.6, 154.5, 138.4, 137.2, 137.0, 131.6, 131.4, 130.0, 128.6, 127.5, 127.4, 126.3, 122.0, 121.4, 118.9, 113.2, 110.1, 66.7, 59.9, 56.7, 52.7, 52.4, 33.0, 15.6; **HRMS** (ESI): m/z [M + Na]$^+$ calcd for [$C_{31}H_{31}N_3O_6Na$]$^+$: 564.2111, found: 564.2107.

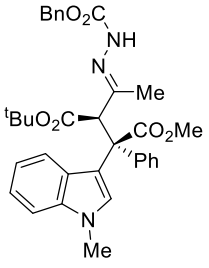
5-benzyl 1-methyl (2*S*,3*R*)-3-((*E*)-1-(2-((benzyloxy)carbonyl)hydrazono)ethyl)-2-(1-methyl-1*H*-indol-3-yl)-2-phenylsuccinate (4h):



4h

Followed the general procedure, using **1a** (0.24 mmol, 31.5 mg), **2a** (0.3 mmol, 52.8 mg) and **3h** (0.2 mmol, 67.6 mg). Purified by flash column chromatography (petroleum ether/ethyl acetate 3:1) to afforded **4h** as a white solid (90.1 mg, 73% yield, >20:1 dr); **m.p.** = 71.0-72.0 ℃; **^{1}H NMR** (400 MHz, DMSO-d_6) δ 9.99 (s, 1H), 8.15 (s, 1H), 7.46 – 7.42 (m, 2H), 7.40 – 7.33 (m, 9H), 7.30 – 7.24 (m, 2H), 7.21 – 7.14 (m, 3H), 7.04 – 7.00 (m, 1H), 6.74 – 6.70 (m, 2H), 5.26 – 5.18 (m, 2H), 5.17 – 5.08 (m, 2H), 4.98 (s, 1H), 3.68 (s, 3H), 3.35 (s, 3H), 0.77 (s, 3H); **^{13}C NMR** (101 MHz, DMSO-d_6) δ 172.4, 171.0, 154.5, 138.4, 137.2, 137.0, 136.0, 131.5, 131.4, 129.0, 128.9, 128.8, 128.6, 128.1, 127.5, 127.4, 127.2, 126.2, 121.9, 121.4, 118.9, 113.1, 110.1, 67.0, 66.7, 60.0, 56.7, 52.3, 33.0, 15.6; **HRMS** (ESI): m/z [M + Na]$^+$ calcd for [$C_{37}H_{35}N_3O_6Na$]$^+$: 640.2424, found: 640.2426.

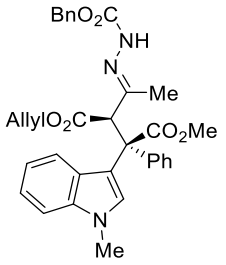
5-(tert-butyl) 1-methyl (2*S*,3*R*)-3-((*E*)-1-(2-((benzyloxy)carbonyl)hydrazono)ethyl)-2-(1-methyl-1*H*-indol-3-yl)-2-phenylsuccinate (4i):



4i

Followed the general procedure, using **1a** (0.24 mmol, 31.5 mg), **2a** (0.3 mmol, 52.8 mg) and **3i** (0.2 mmol, 60.8 mg). Purified by flash column chromatography (petroleum ether/ethyl acetate 3:1) to afforded **4i** as a white solid (86.3 mg, 74% yield, >20:1 dr); **m.p.** = 197.0-198.0 ℃; **^{1}H NMR** (400 MHz, DMSO-d_6) δ 9.95 (s, 1H), 8.16 (s, 1H), 7.46 – 7.43 (m, 2H), 7.41 – 7.28 (m, 6H), 7.20 – 7.15 (m, 3H), 7.04 – 7.00 (m, 1H), 6.76 – 6.69 (m, 2H), 5.26 – 5.15 (m, 2H), 4.84 (s, 1H), 3.70 (s, 3H), 3.46 (s, 3H), 1.39 (s, 9H), 0.82 (s, 3H); **^{13}C NMR** (101 MHz, DMSO-d_6) δ 172.5, 170.3, 154.5, 138.6, 137.2, 137.0, 131.4, 128.9, 128.6, 127.3, 127.1, 126.2, 122.0, 121.4, 118.8, 113.4, 110.0, 82.1, 66.7, 60.6, 56.5, 52.2, 33.0, 28.0, 15.4; **HRMS** (ESI): m/z [M + Na]$^+$ calcd for [$C_{34}H_{37}N_3O_6Na$]$^+$: 606.2580, found: 606.2585.

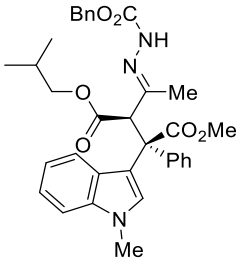
5-allyl 1-methyl (2*S*,3*R*)-3-((*E*)-1-(2-((benzyloxy)carbonyl)hydrazono)ethyl)-2-(1-methyl-1*H*-indol-3-yl)-2-phenylsuccinate (4j):



4j

Followed the general procedure, using **1a** (0.24 mmol, 31.5 mg), **2a** (0.3 mmol, 52.8 mg) and **3j** (0.2 mmol, 57.6 mg). Purified by flash column chromatography (petroleum ether/ethyl acetate 3:1) to afforded **4j** as a white solid (79.4 mg, 70% yield, >20:1 dr); **m.p.** = 132.5-134.0 ℃; **^{1}H NMR** (400 MHz, DMSO-d_6) δ 10.03 (s, 1H), 8.19 (s, 1H), 7.49 – 7.43 (m, 2H), 7.42 – 7.29 (m, 6H), 7.23 – 7.16 (m, 3H), 7.06 – 7.01 (m, 1H), 6.76 – 6.70 (m, 2H), 5.92 – 5.81 (m, 1H), 5.34 – 5.19 (m, 4H), 5.00 (s, 1H), 4.66 – 4.55 (m, 2H), 3.69 (s, 3H), 3.46 (s, 3H), 0.84 (s, 3H); **^{13}C NMR** (101 MHz, DMSO-d_6) δ 172.5, 170.8, 154.5, 138.4, 137.2, 137.0, 132.5, 131.6, 131.4, 128.9, 128.6, 127.5, 127.4, 126.2, 122.0, 121.4, 119.1, 118.9, 113.2, 110.1, 66.7, 65.9, 59.9, 56.7, 52.4, 33.0, 15.7; **HRMS** (ESI): m/z [M + Na]$^+$ calcd for [$C_{33}H_{33}N_3O_6Na$]$^+$: 590.2267, found: 590.2270.

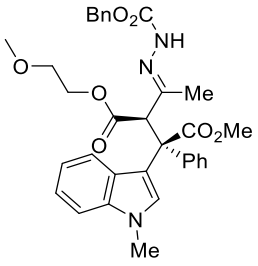
4-isobutyl 1-methyl (2*S*,3*R*)-3-((*E*)-1-(2-((benzyloxy)carbonyl)hydrazono)ethyl)-2-(1-methyl-1*H*-indol-3-yl)-2-phenylsuccinate (4k):



4k

Followed the general procedure, using **1a** (0.24 mmol, 31.5 mg), **2a** (0.3 mmol, 52.8 mg) and **3k** (0.2 mmol, 60.8 mg). Purified by flash column chromatography (petroleum ether/ethyl acetate 3:1) to afforded **4k** as a white solid (84.0 mg, 72% yield, >20:1 dr); **m.p.** = 103.2-103.8 ℃; **^{1}H NMR** (400 MHz, DMSO-d_6) δ 10.05 (s, 1H), 8.21 (s, 1H), 7.48 – 7.43 (m, 2H), 7.41 – 7.31 (m, 6H), 7.23 – 7.16 (m, 3H), 7.06 – 7.01 (m, 1H), 6.78 – 6.70 (m, 2H), 5.30 – 5.18 (m, 2H), 5.00 (s, 1H), 3.94 – 3.89 (m, 1H), 3.84 – 3.79 (m, 1H), 3.70 (s, 3H), 3.46 (s, 3H), 1.88 – 1.79 (m, 1H), 0.87 (s, 3H), 0.85 (s, 3H), 0.83 (s, 3H); **^{13}C NMR** (101 MHz, DMSO-d_6) δ 172.5, 171.2, 154.6, 138.5, 137.2, 137.0, 131.6, 131.4, 128.9, 128.6, 127.5, 127.4, 126.3, 122.0, 121.4, 118.9, 113.2, 110.0, 71.3, 66.7, 60.0, 56.7, 52.3, 52.2, 33.0, 27.6, 19.2, 15.7.; **HRMS** (ESI): m/z [M + Na]$^+$ calcd for [$C_{34}H_{37}N_3O_6Na$]$^+$: 606.2580, found: 606.2573.

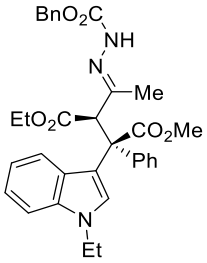
5-(2-methoxyethyl) 1-methyl (2*S*,3*R*)-3-((*E*)-1-(2-((benzyloxy)carbonyl)hydrazono)ethyl)-2-(1-methyl-1*H*-indol-3-yl)-2-phenylsuccinate (4l):



4l

Followed the general procedure, using **1a** (0.24 mmol, 31.5 mg), **2a** (0.3 mmol, 52.8 mg) and **3l** (0.2 mmol, 61.2 mg). Purified by flash column chromatography (petroleum ether/ethyl acetate 3:1) to afforded **4l** as a white solid (94.8 mg, 81% yield, >20:1 dr); **m.p.** = 90.3-91.0 ℃; **^{1}H NMR** (400 MHz, DMSO-d_6) δ 10.03 (s, 1H), 8.18 (s, 1H), 7.49 – 7.43 (m, 2H), 7.43 – 7.31 (m, 5H), 7.30 – 7.27 (m, 1H), 7.22 – 7.16 (m, 3H), 7.05 – 7.01 (m, 1H), 6.75 – 6.70 (m, 2H), 5.28 – 5.16 (m, 2H), 4.95 (s, 1H), 4.21 (t, *J* = 4.1 Hz, 2H), 3.70 (s, 3H), 3.51 – 3.47 (m, 2H), 3.46 (s, 3H), 3.22 (s, 3H), 0.81 (s, 3H); **^{13}C NMR** (101 MHz, DMSO-d_6) δ 172.4, 171.1, 154.5, 138.4, 137.2, 137.0, 131.4, 128.9, 128.6, 127.5, 127.4, 126.2, 122.0, 121.4, 118.9, 113.2, 110.1, 70.0, 66.7, 64.3, 59.9, 58.4, 56.6, 52.4, 33.0, 15.5; **HRMS** (ESI): m/z [M + Na]$^+$ calcd for [$C_{33}H_{35}N_3O_7Na$]$^+$: 608.2373, found: 608.2371.

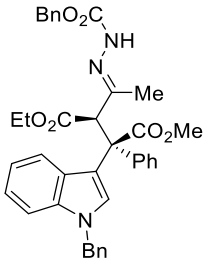
5-ethyl 1-methyl (2*S*,3*R*)-3-((*E*)-1-(2-((benzyloxy)carbonyl)hydrazono)ethyl)-2-(1-ethyl-1*H*-indol-3-yl)-2-phenylsuccinate (4m):



4m

Followed the general procedure, using **1m** (0.24 mmol, 34.8 mg), **2a** (0.3 mmol, 52.8 mg) and **3a** (0.2 mmol, 55.2 mg). Purified by flash column chromatography (petroleum ether/ethyl acetate 3:1) to afforded **4m** as a white solid (85.4 mg, 75% yield, >20:1 dr); **m.p.** = 176.8-177.0 ℃; **^{1}H NMR** (400 MHz, DMSO-d_6) δ 10.01 (s, 1H), 8.26 (s, 1H), 7.48 – 7.43 (m, 2H), 7.41 – 7.35 (m, 4H), 7.34 – 7.25 (m, 2H), 7.22 – 7.17 (m, 3H), 7.04 – 6.99 (m, 1H), 6.77 – 6.69 (m, 2H), 5.22 (s, 2H), 4.97 (s, 1H), 4.15 (q, 2H), 4.10 (q, 2H), 3.47 (s, 3H), 1.40 (s, 3H), 1.15 (t, *J* = 7.1 Hz, 3H), 0.82 (s, 3H); **^{13}C NMR** (101 MHz, DMSO-d_6) δ 172.5, 171.1, 154.5, 138.5, 137.0, 136.4, 131.4, 129.7, 128.9, 128.6, 127.5, 127.4, 126.4, 122.1, 121.3, 118.8, 113.3, 110.0, 66.6, 61.5, 60.0, 56.7, 52.3, 40.9, 15.5, 15.5, 14.4.; **HRMS** (ESI): m/z [M + Na]$^+$ calcd for [$C_{33}H_{35}N_3O_6Na$]$^+$: 592.2424, found: 592.2431.

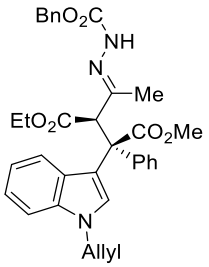
4-ethyl 1-methyl (2*S*,3*R*)-2-(1-benzyl-1*H*-indol-3-yl)-3-((*E*)-1-(2-((benzyloxy)carbonyl)hydrazono)ethyl)-2-phenylsuccinate (4n):



4n

Followed the general procedure, using **1n** (0.24 mmol, 49.7 mg), **2a** (0.3 mmol, 52.8 mg) and **3a** (0.2 mmol, 55.2 mg). Purified by flash column chromatography (petroleum ether/ethyl acetate 3:1) to afforded **4n** as a white solid (88.4 mg, 70% yield, >20:1 dr); **m.p.** = 181.0-181.6 ℃; **^{1}H NMR** (400 MHz, DMSO-d_6) δ 10.06 (s, 1H), 8.40 (s, 1H), 7.46 – 7.26 (m, 13H), 7.23 – 7.19 (m, 3H), 6.99 – 6.94 (m, 1H), 6.75 – 6.68 (m, 2H), 5.32 (s, 2H), 5.19 – 5.06 (m, 2H), 5.00 (s, 1H), 4.15 – 4.07 (m, 2H), 3.48 (s, 3H), 1.12 (t, J = 7.1 Hz, 3H), 0.88 (s, 3H); **^{13}C NMR** (101 MHz, DMSO-d_6) δ 172.5, 171.0, 154.5, 138.4, 136.9, 136.5, 131.4, 131.3, 129.0, 128.5, 127.9, 127.5, 126.7, 122.2, 121.5, 119.1, 113.8, 110.6, 66.6, 61.5, 60.0, 56.7, 52.4, 50.0, 15.7, 14.4; **HRMS** (ESI): m/z [M + Na]$^+$ calcd for [$C_{38}H_{37}N_3O_6Na$]$^+$: 654.2580, found: 654.2583.

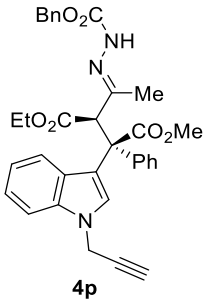
5-ethyl 1-methyl (2*S*,3*R*)-2-(1-allyl-1*H*-indol-3-yl)-3-((E)-1-(2-((benzyloxy)carbonyl)hydrazono) ethyl)-2-phenylsuccinate (4o):



4o

Followed the general procedure, using **1o** (0.24 mmol, 37.7 mg), **2a** (0.3 mmol, 52.8 mg) and **3a** (0.2 mmol, 55.2 mg). Purified by flash column chromatography (petroleum ether/ethyl acetate 3:1) to afforded **4o** as a white solid (84.9 mg, 73% yield, >20:1 dr); **m.p.** = 139.8-140.5 ℃; **^{1}H NMR** (400 MHz, DMSO-d_6) δ 10.00 (s, 1H), 8.22 (s, 1H), 7.46 – 7.35 (m, 6H), 7.34 – 7.25 (m, 2H), 7.24 – 7.17 (m, 3H), 7.04 – 6.98 (m, 1H), 6.77 – 6.69 (m, 2H), 6.05 (s, 1H), 5.21 (s, 2H), 5.14 (d, J = 9.9 Hz, 1H), 4.95 (s, 1H), 4.73 (s, 2H), 4.16 – 4.07 (m, 2H), 3.47 (s, 3H), 1.14 (t, J = 7.1 Hz, 3H), 0.84 (s, 3H); **^{13}C NMR** (101 MHz, DMSO-d_6) δ 172.5, 171.0, 154.5, 138.4, 137.0, 136.6, 134.5, 131.4, 130.7, 128.9, 128.6, 127.5, 127.4, 126.4, 122.1, 121.4, 119.0, 117.4, 113.7, 110.4, 66.6, 61.5, 60.0, 56.7, 52.4, 48.7, 15.6, 14.4; **HRMS** (ESI): m/z [M + Na]$^+$ calcd for [$C_{34}H_{35}N_3O_6Na$]$^+$: 604.2424, found: 604.2419.

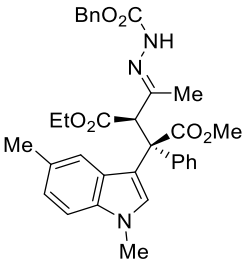
4-ethyl 1-methyl (2*S*,3*R*)-3-((*E*)-1-(2-((benzyloxy)carbonyl)hydrazono)ethyl)-2-phenyl-2-(1-(prop -2-yn-1-yl)-1*H*-indol-3-yl)succinate (4p):



4p

Followed the general procedure, using **1p** (0.24 mmol, 37.2 mg), **2a** (0.3 mmol, 52.8 mg) and **3a** (0.2 mmol, 55.2 mg). Purified by flash column chromatography (petroleum ether/ethyl acetate 3:1) to afforded **4p** as a white solid (75.3 mg, 65% yield, >20:1 dr); **m.p.** = 74.4-75.0 ℃; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.14 (s, 1H), 7.56 (s, 1H), 7.42 – 7.32 (m, 7H), 7.22 – 7.15 (m, 3H), 7.12 – 7.08 (m, 1H), 6.91 – 6.87 (m, 1H), 6.84 – 6.79 (m, 1H), 5.33 – 5.20 (m, 2H), 5.15 (s, 1H), 4.78 (s, 2H), 4.20 – 4.13 (m, 2H), 3.57 (s, 3H), 2.40 (s, 1H), 1.21 (t, *J* = 7.1 Hz, 3H), 0.84 (s, 3H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 172.5, 171.0, 154.5, 138.4, 137.0, 136.3, 131.3, 130.2, 129.0, 128.6, 127.5, 126.8, 122.2, 121.7, 119.4, 114.4, 110.4, 79.3, 76.3, 66.7, 61.5, 60.1, 56.7, 52.4, 35.9, 15.6, 14.4; **HRMS** (ESI): m/z $[M + Na]^+$ calcd for $[C_{34}H_{33}N_3O_6Na]^+$: 602.2267, found: 602.2272.

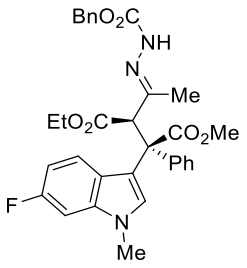
4-ethyl 1-methyl (2*S*,3*R*)-3-((*E*)-1-(2-((benzyloxy)carbonyl)hydrazono)ethyl)-2-(1,5-dimethyl-1*H*-indol-3-yl)-2-phenylsuccinate (4q):



4q

Followed the general procedure, using **1q** (0.24 mmol, 34.8 mg), **2a** (0.3 mmol, 52.8 mg) and **3a** (0.2 mmol, 55.2 mg). Purified by flash column chromatography (petroleum ether/ethyl acetate 3:1) to afforded **4q** as a white solid (85.4 mg, 75% yield, >20:1 dr); **m.p.** = 158.2-158.9 ℃; **^{1}H NMR** (400 MHz, DMSO-d_6) δ 9.98 (s, 1H), 8.12 (s, 1H), 7.56 – 7.44 (m, 2H), 7.42 – 7.35 (m, 3H), 7.33 – 7.25 (m, 2H), 7.24 – 7.17 (m, 4H), 6.87 – 6.84 (m, 1H), 6.54 (s, 1H), 5.33 – 5.11 (m, 2H), 4.91 (s, 1H), 4.12 (q, *J* = 7.0 Hz, 2H), 3.66 (s, 3H), 3.46 (s, 3H), 2.09 (s, 3H), 1.14 (t, *J* = 7.1 Hz, 3H), 0.79 (s, 3H); **^{13}C NMR** (101 MHz, DMSO-d_6) δ 172.4, 171.1, 154.5, 138.4, 137.0, 135.7, 131.4, 129.0, 128.6, 127.4, 127.1, 126.4, 123.1, 121.5, 112.6, 109.8, 66.7, 61.5, 60.0, 56.5, 52.3, 33.0, 21.8, 15.5, 14.4; **HRMS** (ESI): m/z $[M + Na]^+$ calcd for $[C_{33}H_{35}N_3O_6Na]^+$: 592.2424, found: 592.2426.

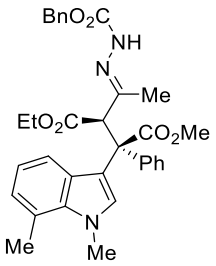
5-ethyl 1-methyl (2*S*,3*R*)-3-((*E*)-1-(2-((benzyloxy)carbonyl)hydrazono)ethyl)-2-(6-fluoro-1-methyl-1*H*-indol-3-yl)-2-phenylsuccinate (4r):



4r

Followed the general procedure, using **1r** (0.24 mmol, 35.8 mg), **2a** (0.3 mmol, 52.8 mg) and **3a** (0.2 mmol, 55.2 mg). Purified by flash column chromatography (petroleum ether/ethyl acetate 3:1) to afforded **4r** as a white solid (79.1 mg, 69% yield, >20:1 dr); **m.p.** = 135.1-135.4 ℃; **^{1}H NMR** (400 MHz, DMSO-d_6) δ 10.02 (s, 1H), 8.17 (s, 1H), 7.49 – 7.33 (m, 6H), 7.29 – 7.18 (m, 5H), 6.75 – 6.56 (m, 2H), 5.32 – 5.16 (m, 2H), 4.90 (s, 1H), 4.12 (q, *J* = 13.9, 6.9 Hz, 2H), 3.68 (s, 3H), 3.47 (s, 3H), 1.14 (t, *J* = 7.0 Hz, 3H), 0.82 (s, 3H); **^{13}C NMR** (101 MHz, DMSO-d_6) δ 172.5, 171.0, 159.1 (d, *J* = 235.4 Hz), 154.5, 138.3, 137.4, 137.3, 137.0, 132.3, 131.3, 128.9, 128.6, 127.55, 127.48, 123.0, 113.6, 107.4 (d, *J* = 24.4 Hz), 96.5 (d, *J* = 25.7 Hz), 66.7, 61.5, 59.9, 56.6, 52.4, 33.2, 15.5, 14.4; **^{19}F NMR** (376 MHz, DMSO-d_6) δ -121.48; **HRMS** (ESI): m/z [M + Na]$^+$ calcd for $[C_{32}H_{32}FN_3O_6Na]^+$: 596.2173, found: 596.2178.

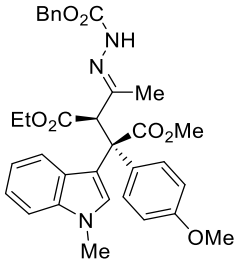
4-ethyl 1-methyl (2*S*,3*R*)-3-((*E*)-1-(2-((benzyloxy)carbonyl)hydrazono)ethyl)-2-(1,7-dimethyl-1*H*-indol-3-yl)-2-phenylsuccinate (4s):



4s

Followed the general procedure, using **1s** (0.24 mmol, 34.8 mg), **2a** (0.3 mmol, 52.8 mg) and **3a** (0.2 mmol, 55.2 mg). Purified by flash column chromatography (petroleum ether/ethyl acetate 3:1) to afforded **4s** as a white solid (86.5 mg, 76% yield, >20:1 dr); **m.p.** = 163.5-163.7 ℃; **^{1}H NMR** (400 MHz, DMSO-d_6) δ 10.05 (s, 1H), 8.13 (s, 1H), 7.48 – 7.44 (m, 2H), 7.42 – 7.32 (m, 5H), 7.22 – 7.17 (m, 3H), 6.73 – 6.69 (m, 1H), 6.64 – 6.60 (m, 1H), 6.58 – 6.54 (m, 1H), 5.30 – 5.20 (m, 2H), 4.98 (s, 1H), 4.13 (q, *J* = 7.0 Hz, 2H), 3.96 (s, 3H), 3.47 (s, 3H), 2.66 (s, 3H), 1.16 (t, *J* = 7.1 Hz, 3H), 0.84 (s, 3H); **^{13}C NMR** (101 MHz, DMSO-d_6) δ 172.4, 171.1, 154.6, 147.6, 138.4, 137.0, 135.9, 133.2, 131.5, 128.9, 128.8, 128.6, 127.4, 127.3, 123.9, 121.5, 120.2, 119.0, 112.6, 66.7, 61.5, 60.0, 56.5, 52.3, 37.0, 19.6, 15.5, 14.4; **HRMS** (ESI): m/z [M + Na]$^+$ calcd for $[C_{33}H_{35}N_3O_6Na]^+$: 592.2424, found: 592.2424.

5-ethyl 1-methyl (2*S*,3*R*)-3-((*E*)-1-(2-((benzyloxy)carbonyl)hydrazono)ethyl)-2-(4-methoxyphenyl)-2-(1-methyl-1*H*-indol-3-yl)succinate (4t):

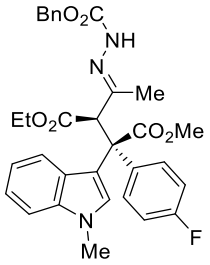


4t

Followed the general procedure, using **1a** (0.24 mmol, 31.5 mg), **2t** (0.3 mmol, 61.8 mg) and **3a** (0.2 mmol, 55.2 mg). Purified by flash column chromatography (petroleum ether/ethyl acetate 3:1) to afforded **4t** as a white solid (89.0 mg,76% yield, >20:1 dr); **m.p.** = 137.3-140.0 ℃; **^{1}H NMR** (400 MHz, DMSO-d_6) δ 10.01 (s, 1H), 8.16 (s, 1H), 7.48 – 7.44 (m, 2H), 7.43 – 7.30 (m, 5H), 7.26 – 7.14 (m, 2H), 7.05 – 7.01 (m, 1H), 6.80 – 6.73 (m, 4H), 5.29 – 5.18 (m, 2H), 4.91 (s, 1H), 4.12 (q, *J* = 6.9 Hz, 2H), 3.71 (s, 6H), 3.45 (s, 3H), 1.15 (t, *J* = 7.1 Hz, 3H), 0.87 (s, 3H); **^{13}C NMR** (101 MHz, DMSO-d_6) δ 172.7,

171.2, 158.5, 154.5, 137.2, 137.0, 132.6, 131.4, 130.2, 129.0, 128.8, 128.64, 128.58, 128.2, 126.3, 122.0, 121.4, 118.9, 113.5, 112.7, 110.0, 66.7, 61.4, 59.9, 56.0, 55.3, 52.3, 33.0, 15.7, 14.4; **HRMS** (ESI): m/z $[M + Na]^+$ calcd for $[C_{33}H_{35}N_3O_7Na]^+$: 608.2373, found: 608.2363.

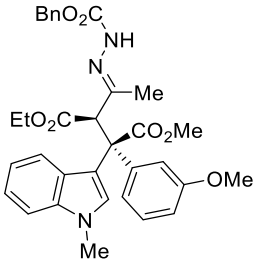
6-ethyl 1-methyl (2*S*,3*R*)-3-((*E*)-1-(2-((benzyloxy)carbonyl)hydrazono)ethyl)-2-(4-fluorophenyl)-2-(1-methyl-1*H*-indol-3-yl)succinate (4u):



4u

Followed the general procedure, using **1a** (0.24 mmol, 31.5 mg), **2u** (0.3 mmol, 58.2 mg) and **3a** (0.2 mmol, 55.2 mg). Purified by flash column chromatography (petroleum ether/ethyl acetate 3:1) to afforded **4u** as a white solid (78.0 mg, 68% yield, >20:1 dr); **m.p.** = 150.1-150.7 ℃; **^{1}H NMR** (400 MHz, DMSO-d_6) δ 10.03 (s, 1H), 8.18 (s, 1H), 7.48 – 7.43 (m, 2H), 7.43 – 7.29 (m, 6H), 7.06 – 7.00 (m, 3H), 6.76 – 6.71 (m, 2H), 5.27 – 5.17 (m, 2H), 4.93 (s, 1H), 4.13 (q, 2H), 3.71 (s, 3H), 3.46 (s, 3H), 1.15 (t, *J* = 7.1 Hz, 3H), 0.87 (s, 3H); **^{13}C NMR** (101 MHz, DMSO-d_6) δ 172.4, 171.1, 161.6 (d, *J* = 244.3 Hz), 154.5, 137.3, 136.9, 134.6, 133.5 (d, *J* = 7.7 Hz), 131.5, 129.0, 128.64, 128.60, 126.0, 121.7, 121.5, 119.0, 114.2 (d, *J* = 20.8 Hz), 113.0, 110.2, 66.7, 61.6, 59.8, 56.1, 52.4, 33.0, 15.7, 14.4; **^{19}F NMR** (376 MHz, DMSO-d_6) δ -115.70; **HRMS** (ESI): m/z $[M + Na]^+$ calcd for $[C_{32}H_{32}FN_3O_6Na]^+$: 596.2173, found: 596.2171.

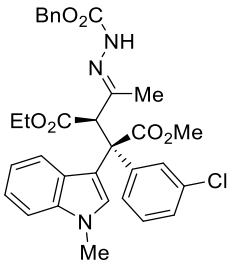
6-ethyl 1-methyl (2*S*,3*R*)-3-((*E*)-1-(2-((benzyloxy)carbonyl)hydrazono)ethyl)-2-(3-methoxyphenyl)-2-(1-methyl-1*H*-indol-3-yl)succinate (4v):



4v

Followed the general procedure, using **1a** (0.24 mmol, 31.5 mg), **2v** (0.3 mmol, 61.8 mg) and **3a** (0.2 mmol, 55.2 mg). Purified by flash column chromatography (petroleum ether/ethyl acetate 3:1) to afforded **4v** as a white solid (86.6 mg, 74% yield, >20:1 dr); **m.p.** =142.8-150.0 ℃; **^{1}H NMR** (400 MHz, DMSO-d_6) δ 10.02 (s, 1H), 8.16 (s, 1H), 7.46 – 7.43 (m, 2H), 7.40 – 7.32 (m, 4H), 7.10 – 7.00 (m, 3H), 6.82 – 6.72 (m, 4H), 5.29 – 5.18 (m, 2H), 4.93 (s, 1H), 4.12 (q, *J* = 7.0 Hz, 2H), 3.69 (s, 3H), 3.62 (s, 3H), 3.45 (s, 3H), 1.14 (t, *J* = 7.1 Hz, 3H), 0.88 (s, 3H); **^{13}C NMR** (101 MHz, DMSO-d_6) δ 172.4, 171.0, 158.5, 154.5, 140.0, 137.2, 137.0, 131.5, 128.9, 128.6, 128.3, 126.3, 123.8, 121.9, 121.4, 118.9, 118.4, 113.2, 112.1, 110.0, 66.7, 61.5, 60.0, 56.6, 55.3, 52.3, 33.0, 15.5, 14.4; **HRMS** (ESI): m/z $[M + Na]^+$ calcd for $[C_{33}H_{35}N_3O_7Na]^+$: 608.2373, found: 608.2374.

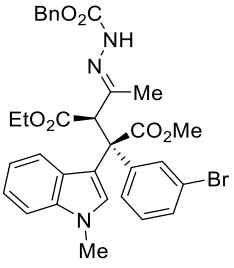
4-ethyl 1-methyl (2*S*,3*R*)-3-((*E*)-1-(2-((benzyloxy)carbonyl)hydrazono)ethyl)-2-(3-chlorophenyl)-2-(1-methyl-1*H*-indol-3-yl)succinate (4w):



4w

Followed the general procedure, using **1a** (0.24 mmol, 31.5 mg), **2w** (0.3 mmol, 63.0 mg) and **3a** (0.2 mmol, 55.2 mg). Purified by flash column chromatography (petroleum ether/ethyl acetate 3:1) to afforded **4w** as a white solid (97.8 mg, 83% yield, >20:1 dr); **m.p.** = 160.0-160.5 ℃; **^{1}H NMR** (400 MHz, DMSO-d_6) δ 10.07 (s, 1H), 8.18 (s, 1H), 7.55 – 7.42 (m, 3H), 7.41 – 7.34 (m, 4H), 7.33 – 7.30 (m, 1H), 7.22 – 7.17 (m, 1H), 7.14 – 7.01 (m, 2H), 6.79 – 6.70 (m, 2H), 5.30 – 5.15 (m, 2H), 4.94 (s, 1H), 4.18 – 4.09 (m, 2H), 3.70 (s, 3H), 3.47 (s, 3H), 1.15 (t, J = 7.1 Hz, 3H), 0.89 (s, 3H); **^{13}C NMR** (101 MHz, DMSO-d_6) δ 172.0, 171.0, 154.5, 140.9, 137.2, 136.9, 132.2, 131.7, 131.4, 130.0, 129.3, 128.9, 128.6, 127.6, 125.9, 121.6, 119.2, 112.3, 110.3, 66.7, 61.7, 59.7, 56.4, 52.6, 33.1, 15.8, 14.4; **HRMS** (ESI): m/z [M + Na]$^+$ calcd for [$C_{32}H_{32}ClN_3O_6Na$]$^+$: 612.1878, found: 612.1868.

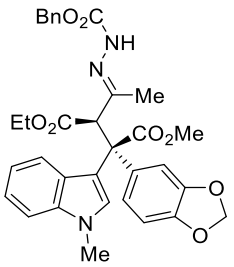
4-ethyl 1-methyl (2*S*,3*R*)-3-((*E*)-1-(2-((benzyloxy)carbonyl)hydrazono)ethyl)-2-(3-bromophenyl)-2-(1-methyl-1*H*-indol-3-yl)succinate (4x):



4x

Followed the general procedure, using **1a** (0.24 mmol, 31.5 mg), **2x** (0.3 mmol, 76.2 mg) and **3a** (0.2 mmol, 55.2 mg). Purified by flash column chromatography (petroleum ether/ethyl acetate 3:1) to afforded **4x** as a white solid (101.3 mg, 80% yield, >20:1 dr); **m.p.** = 162.5-163.0 ℃; **^{1}H NMR** (400 MHz, DMSO-d_6) δ 10.08 (s, 1H), 8.17 (s, 1H), 7.64 (s, 1H), 7.49 – 7.43 (m, 3H), 7.41 – 7.33 (m, 4H), 7.16 – 7.03 (m, 3H), 6.79 – 6.71 (m, 2H), 5.29 – 5.16 (m, 2H), 4.94 (s, 1H), 4.19 – 4.11 (m, 2H), 3.70 (s, 3H), 3.47 (s, 3H), 1.16 (t, J = 7.1 Hz, 3H), 0.89 (s, 3H); **^{13}C NMR** (101 MHz, DMSO-d_6) δ 172.0, 171.0, 154.5, 141.1, 137.2, 136.9, 134.2, 131.7, 130.44, 130.36, 129.6, 129.0, 128.6, 125.8, 121.60, 121.56, 120.8, 119.2, 112.2, 110.3, 66.7, 61.7, 59.7, 56.4, 52.6, 33.1, 15.8, 14.4; **HRMS** (ESI): m/z [M + Na]$^+$ calcd for [$C_{32}H_{32}BrN_3O_6Na$]$^+$: 656.1372, found: 656.1374.

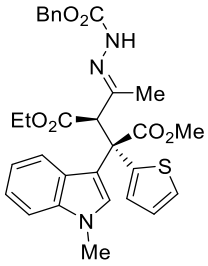
5-ethyl 1-methyl (2*S*,3*R*)-2-(benzo[*d*][1,3]dioxol-5-yl)-3-((*E*)-1-(2-((benzyloxy)carbonyl)hydrazono)ethyl)-2-(1-methyl-1*H*-indol-3-yl)succinate (4y):



4y

Followed the general procedure, using **1a** (0.24 mmol, 31.5 mg), **2y** (0.3 mmol, 66.0 mg) and **3a** (0.2 mmol, 55.2 mg). Purified by flash column chromatography (petroleum ether/ethyl acetate 3:1) to afforded **4y** as a white solid (91.1 mg, 76% yield, >20:1 dr); **m.p.** = 140.1-140.5 ℃; **^{1}H NMR** (400 MHz, DMSO-d_6) δ 10.05 (s, 1H), 8.17 (s, 1H), 7.49 – 7.43 (m, 2H), 7.42 – 7.32 (m, 4H), 7.13 – 6.99 (m, 2H), 6.86 (d, J = 8.0 Hz, 1H), 6.80 – 6.76 (m, 1H), 6.67 (d, J = 8.3 Hz, 1H), 6.50 (s, 1H), 5.99 (d, J = 8.3 Hz, 2H), 5.32 – 5.17 (m, 2H), 4.91 (s, 1H), 4.17 – 4.10 (m, 2H), 3.69 (s, 3H), 3.45 (s, 3H), 1.15 (t, J = 7.1 Hz, 3H), 0.96 (s, 3H); **^{13}C NMR** (101 MHz, DMSO-d_6) δ 172.5, 171.1, 154.5, 137.2, 137.0, 136.2, 132.5, 132.3, 131.7, 130.5, 129.4, 128.9, 128.7, 128.62, 128.58, 127.6, 126.7, 126.4, 126.3, 121.8, 121.4, 118.9, 113.1, 110.1, 66.7, 61.5, 60.0, 56.9, 52.5, 33.1, 15.9, 14.4; **HRMS** (ESI): m/z [M + Na]$^+$ calcd for $[C_{33}H_{33}N_3O_8Na]^+$: 622.2166, found: 622.2172.

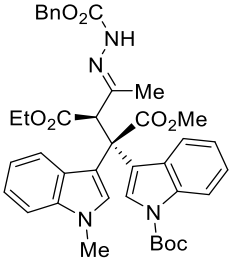
4-ethyl 1-methyl (2*S*,3*R*)-3-((*E*)-1-(2-((benzyloxy)carbonyl)hydrazono)ethyl)-2-(1-methyl-1*H*-indol-3-yl)-2-(thiophen-3-yl)succinate (4z):



4z

Followed the general procedure, using **1a** (0.24 mmol, 31.5 mg), **2z** (0.3 mmol, 54.6 mg) and **3a** (0.2 mmol, 55.2 mg). Purified by flash column chromatography (petroleum ether/ethyl acetate 3:1) to afforded **4z** as a white solid (81.9 mg, 73% yield, >20:1 dr); **m.p.** = 122.0-122.8 ℃; **^{1}H NMR** (400 MHz, DMSO-d_6) δ 10.07 (s, 1H), 8.13 (s, 1H), 7.49 – 7.44 (m, 2H), 7.41 – 7.32 (m, 5H), 7.08 – 6.99 (m, 2H), 6.98 – 6.94 (m, 1H), 6.92 – 6.88 (m, 1H), 6.82 – 6.77 (m, 1H), 5.30 – 5.18 (m, 2H), 4.90 (s, 1H), 4.14 (q, J = 7.1 Hz, 2H), 3.68 (s, 3H), 3.45 (s, 3H), 1.16 (t, J = 7.1 Hz, 3H), 1.00 (s, 3H); **^{13}C NMR** (101 MHz, DMSO-d_6) δ 177.3, 175.8, 159.3, 144.3, 141.8, 141.7, 136.0, 135.5, 133.7, 133.4, 133.3, 131.5, 131.2, 128.8, 126.4, 126.2, 123.7, 118.1, 114.8, 71.5, 66.3, 64.7, 58.6, 57.2, 37.7, 19.8, 19.1; **HRMS** (ESI): m/z [M + Na]$^+$ calcd for $[C_{30}H_{31}N_3O_6SNa]^+$: 584.1832, found: 584.1825.

4-ethyl 1-methyl (2*S*,3*R*)-3-((*E*)-1-(2-((benzyloxy)carbonyl)hydrazono)ethyl)-2-(1-(tert-butoxycarbonyl)-1*H*-indol-3-yl)-2-(1-methyl-1*H*-indol-3-yl)succinate (4aa):

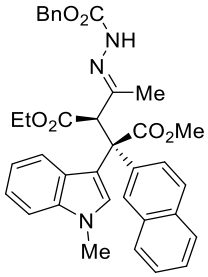


4aa

Followed the general procedure, using **1a** (0.24 mmol, 31.5 mg), **2aa** (0.3 mmol, 94.5 mg) and **3a** (0.2 mmol, 55.2 mg). Purified by flash column chromatography (petroleum ether/ethyl acetate 3:1) to afforded **4aa** as a white solid (94.4 mg, 68% yield, >20:1 dr); **m.p.** = 62.5-63.4 ℃; **^{1}H NMR** (400 MHz, DMSO-d_6) δ 9.93 (s, 1H), 8.17 (s, 1H), 8.08 (s, 1H), 8.01 – 7.97 (m, 1H), 7.48 – 7.45 (m, 2H), 7.43 – 7.38 (m, 3H), 7.35 – 7.32 (m, 1H), 7.09 – 7.05 (m, 1H), 7.00 – 6.95 (m, 1H), 6.93 – 6.88 (m, 1H), 6.67 – 6.60 (m, 2H), 6.48 – 6.37 (m, 1H), 5.34 – 5.23 (m, 2H), 4.99 (s, 1H), 4.16 – 4.06 (m, 2H), 3.77 (s, 3H),

3.53 (s, 3H), 1.71 (s, 9H), 1.14 (t, *J* = 7.0 Hz, 3H), 0.92 (s, 3H); **^{13}C NMR** (101 MHz, DMSO-d_6) δ 176.8, 175.7, 159.2, 154.4, 141.9, 141.6, 139.1, 135.3, 133.7, 133.3, 133.1, 131.6, 128.5, 126.9, 126.3, 126.0, 125.50, 123.7, 119.4, 116.1, 114.7, 89.4, 71.3, 66.3, 63.7, 57.4, 56.7, 37.8, 32.9, 20.8, 19.0; **HRMS** (ESI): m/z [M + Na]$^+$ calcd for [$C_{39}H_{42}N_4O_8Na$]$^+$: 717.2901, found: 717.2913.

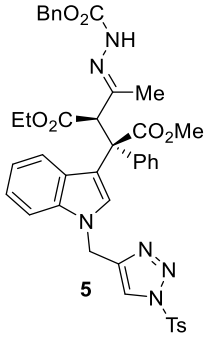
4-ethyl 1-methyl (2*S*,3*R*)-3-((*E*)-1-(2-((benzyloxy)carbonyl)hydrazono)ethyl)-2-(1-methyl-1*H*-indol-3-yl)-2-(naphthalen-2-yl)succinate (4ab):



4ab

Followed the general procedure, using **1a** (0.24 mmol, 31.5 mg), **2ab** (0.3 mmol, 67.8 mg) and **3a** (0.2 mmol, 55.2 mg). Purified by flash column chromatography (petroleum ether/ethyl acetate 3:1) to afforded **4ab** as a white solid (82.3 mg, 68% yield, >20:1 dr); **m.p.** = 78.0-79.0 ℃; **^{1}H NMR** (400 MHz, DMSO-d_6) δ 10.00 (s, 1H), 8.21 (s, 1H), 7.93 – 7.80 (m, 2H), 7.73 – 7.67 (m, 2H), 7.50 – 7.42 (m, 4H), 7.42 – 7.34 (m, 5H), 7.04 – 6.98 (m, 1H), 6.69 – 6.62 (m, 2H), 5.30 – 5.17 (m, 2H), 5.04 (s, 1H), 4.16 – 4.09 (m, 2H), 3.73 (s, 3H), 3.51 (s, 3H), 1.13 (t, *J* = 7.1 Hz, 3H), 0.78 (s, 3H); **^{13}C NMR** (101 MHz, DMSO-d_6) δ 172.5, 171.2, 154.6, 146.6, 146.5, 137.2, 137.0, 132.0, 131.4, 128.9, 128.63, 128.59, 126.2, 124.9, 121.9, 121.5, 119.0, 113.3, 112.1, 110.1, 107.3, 101.4, 66.7, 61.6, 60.0, 56.3, 52.4, 33.0, 15.7, 14.4; **HRMS** (ESI): m/z [M + Na]$^+$ calcd for [$C_{36}H_{35}N_3O_6Na$]$^+$: 628.2424, found: 628.2429.

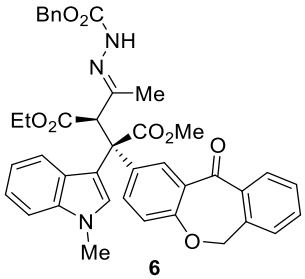
4-ethyl 1-methyl (2*S*,3*R*)-3-((*E*)-1-(2-((benzyloxy)carbonyl)hydrazono)ethyl)-2-phenyl-2-(1-((1-tosyl-1*H*-1,2,3-triazol-5-yl)methyl)-1*H*-indol-3-yl)succinate (5):



5

Followed the general procedure, using **4p** (0.2 mmol, 31.5 mg), sulfonyl azide (0.2 mmol, 51.9 mg). Purified by flash column chromatography (petroleum ether/ethyl acetate 3:1) to afforded product. (155 mg, 84% yield, >20:1 dr) as a yellow solid; **m.p.** = 175.8.0-176.0 ℃; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.85 – 8.02 (m, 2H), 8.01 – 7.92 (m, 2H), 7.63 (s, 1H), 7.46 – 7.30 (m, 9H), 7.25 (s, 1H), 7.23 – 7.15 (m, 3H), 7.07 – 7.00 (m, 1H), 6.86 – 6.74 (m, 2H), 5.49 – 5.32 (m, 2H), 5.25 – 5.14 (m, 2H), 4.22 – 4.08 (m, 2H), 3.58 (s, 3H), 2.43 (s, 3H), 1.77 (s, 1H), 1.20 (t, *J* = 7.1 Hz, 3H), 0.85 (s, 3H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 172.6, 170.7, 147.4, 144.4, 137.7, 136.3, 135.6, 132.9, 131.3, 130.5, 128.9, 128.7, 128.6, 127.3,, 126.9, 122.7, 121.7, 119.4, 114.2, 109.6, 67.9, 61.4, 59.4, 57.0, 52.3, 41.9, 21.9, 14.2, 14.1; **HRMS** (ESI): m/z [M + Na]$^+$ calcd for [$C_{41}H_{40}N_6O_8SNa$]$^+$: 799.2526, found: 799.2512.

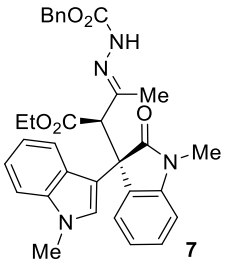
4-ethyl 1-methyl (2*S*,3*R*)-3-((*E*)-1-(2-((benzyloxy)carbonyl)hydrazono)ethyl)-2-(1-methyl-1*H*-indol-3-yl)-2-(11-oxo-6,11-dihydrodibenzo[*b*,*e*]oxepin-9-yl)succinate (6):



6

Followed the general procedure, using **1a** (0.24 mmol, 31.5 mg), **2k** (0.3 mmol, 92.4 mg) and **3a** (0.2 mmol, 55.2 mg). Purified by flash column chromatography (petroleum ether/ethyl acetate 3:1) to afforded **6** as a white solid (96.2 mg, 71% yield, >20:1 dr); **m.p.** =157.2-160.0 ℃; **^{1}H NMR** (400 MHz, DMSO-d_6) δ 10.04 (s, 1H), 8.34 – 8.04 (m, 2H), 7.74 – 7.70 (m, 1H), 7.66 – 7.61 (m, 1H), 7.57 – 7.50 (m, 2H), 7.49 – 7.45 (m, 2H), 7.42 – 7.33 (m, 5H), 7.07 – 7.02 (m, 1H), 6.96 – 6.91 (m, 1H), 6.79 – 6.72 (m, 2H), 5.29 – 5.26 (m, 2H), 5.26 – 5.15 (m, 2H), 4.97 (s, 1H), 4.17 – 4.10 (m, 2H), 3.73 (s, 3H), 3.49 (s, 3H), 1.16 (t, *J* = 7.1 Hz, 3H), 0.94 (s, 3H); **^{13}C NMR** (101 MHz, DMSO-d_6) δ 190.5, 172.4, 171.0, 160.3, 154.5, 140.5, 138.7, 137.3, 137.0, 136.2, 134.7, 133.4, 132.2, 131.6, 129.6, 129.2, 128.9, 128.7, 128.63, 128.58, 126.1, 124.1, 121.7, 121.5, 119.5, 119.1, 112.7, 110.2, 73.2, 66.7, 61.6, 59.8, 56.1, 52.5, 33.1, 16.1, 14.4; **HRMS** (ESI): m/z [M + Na]$^+$ calcd for [$C_{40}H_{37}N_3O_8Na$]$^+$: 710.2479, found: 710.2469.

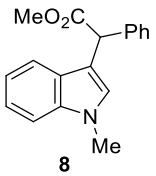
Benzyl (*E*)-2-(4-ethoxy-3-(1-methyl-3-(1-methyl-1*H*-indol-3-yl)-2-oxoindolin-3-yl)-4-oxobutan-2-li dene)hydrazine-1-carboxylate (7):



7

Followed the general procedure, using **1a** (0.24 mmol, 31.5 mg), **2l** (0.3 mmol, 51.9 mg) and **3a** (0.2 mmol, 55.2 mg). Purified by flash column chromatography (petroleum ether/ethyl acetate 3:1) to afforded **7** as a white solid (77.3 mg, 70% yield, >20:1 dr); **m.p.** = 195.2-196.0 ℃; **^{1}H NMR** (400 MHz, DMSO-d_6) δ 9.86 (s, 1H), 8.02 (d, *J* = 7.1 Hz, 1H), 7.89 (d, *J* = 8.0 Hz, 1H), 7.41 – 7.31 (m, 7H), 7.14 – 7.08 (m, 1H), 7.05 – 6.93 (m, 3H), 6.54 (s, 1H), 5.14 (s, 2H), 4.96 (s, 1H), 3.78 (q, *J* = 5.7 Hz, 2H), 3.54 (s, 3H), 3.08 (s, 3H), 1.65 (s, 3H), 0.84 (t, *J* = 6.6 Hz, 3H); **^{13}C NMR** (101 MHz, DMSO-d_6) δ 177.5, 169.6, 154.4, 144.8, 137.8, 137.1, 130.1, 129.5, 128.9, 128.6, 128.5, 128.2, 125.8, 122.5, 122.1, 121.6, 119.1, 111.8, 110.4, 108.5, 66.4, 60.7, 57.7, 54.3, 32.7, 26.7, 18.7, 13.9; **HRMS** (ESI): m/z [M + Na]$^+$ calcd for [$C_{32}H_{32}N_4O_5Na$]$^+$: 575.2271, found: 575.2268.

Methyl 2-(1-methyl-1*H*-indol-3-yl)-2-phenylacetate (8):

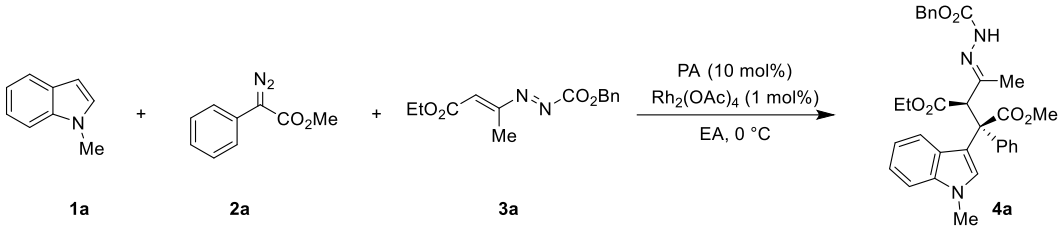


8

Followed the general procedure, using **1a** (0.48 mmol, 31.5 mg), **2a** (0.3 mmol, 51.9 mg). Purified by flash column chromatography (petroleum ether/ethyl acetate 10:1) to afforded **8** (53.5 mg, 96% yield) as a yellow oil; **^{1}H NMR** (400 MHz, DMSO-d_6) δ 7.44 – 7.37 (m, 4H), 7.35 – 7.29 (m, 2H), 7.28 – 7.21 (m, 2H), 7.18 – 7.11 (m, 1H), 7.04 – 6.95 (m, 1H), 5.33 (s, 1H), 3.75 (s, 3H), 3.67 (s, 3H); **^{13}C NMR**

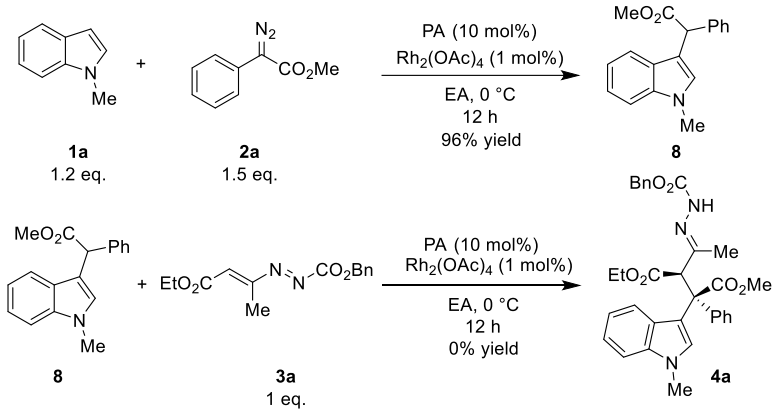
(101 MHz, DMSO-d_6) δ 173.4, 139.5, 137.1, 128.8, 128.8, 128.4, 127.5, 127.0, 121.9, 119.3, 119.2, 111.9, 110.3, 52.5, 48.3, 32.8; **HRMS** (ESI): m/z [M + Na]$^+$ calcd for [$C_{18}H_{17}NO_2Na$]$^+$: 302.1157, found: 302.1154.

Scale-up reaction



To a 25-mL oven-dried vial containing a magnetic stirring bar, a mixture of $Rh_2(OAc)_4$ (1 mol%) , azoalkene **3a (**1 mmol**)** and phosphoric acid (10 mol%) in 8 mL of EtOAc under an argon atmosphere was stirred at 0 ºC.A solution of diazoacetate **2a** (1.5 mmol) and indole **1a** (1.2 mmol) was added in 2.0 mL EtOAc via a syringe pump over 1h . After addition, the reaction mixture was stirred for additional 24 h. Then the reaction mixture was purified by column chromatography on silica gel without any additional treatment (PE: EtOAc = 3:1) to give the pure products **4a** in 73% yield.

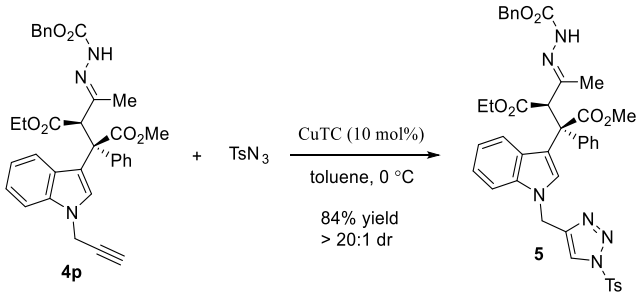
Control experiment



A mixture of $Rh_2(OAc)_4$ (0.002 mmol) and indole **1a** (0.2 mmol) in 2 mL of EtOAc under an argon atmosphere was stirred at 0 ºC. Diazoacetate **2a** (0.3 mmol) in 1 mL of EtOAc was then added over 1 h via a syringe pump.After the completion of the reaction (monitored by TLC), the reaction mixture was filtered through a short pad of Celite and the solvent was evaporated under reduced pressure. The residue was purified by silica column chromatography (PE/EtOAc = 10:1) to give **8** (53.5 mg, 96% yield) as a yellow oil.

Azoalkene **3a** (0.1 mmol) and phosphoric acid (0.01 mmol) in 1 mL of EtOAc under an argon atmosphere was stirred at 0 ℃. Insertion product **8** (0.1 mmol) in 1 mL of EtOAc was then added over 30 min via a syringe pump. After completion of the addition, the reaction mixture was stirred for another 12 h, then monitored by TLC, which indicated that the expected product **4a** was not obtained.

Derivatization



A Schlenk flask was charged with copper(I) thiophene-2-carboxylate (CuTC, 0.02 mmol, 0.1 equiv. in regards to **4p**), toluene (5 mL), and the **4p** (0.2 mmol, 1 equiv.). The reaction mixture was cooled in an ice-water bath. Subsequently, the sulfonyl azide (0.2 mmol, 1 equiv.) was added slowly as the limiting reagent to avoid a run-away exotherm, and the reaction mixture allowed to warm to room temperature and stir until judged complete by TLC. The reaction was diluted with saturated aq NH_4Cl (5 mL) and extracted into EtOAc (2 × 5 mL). The combined organics were dried (Na_2SO_4) and filtered through celite. The eluent was concentrated in vacuo. Then the reaction mixture was purified by column chromatography on silica gel without any additional treatment (PE: EtOAc = 3:1) to give the pure product in 84% yields.

References

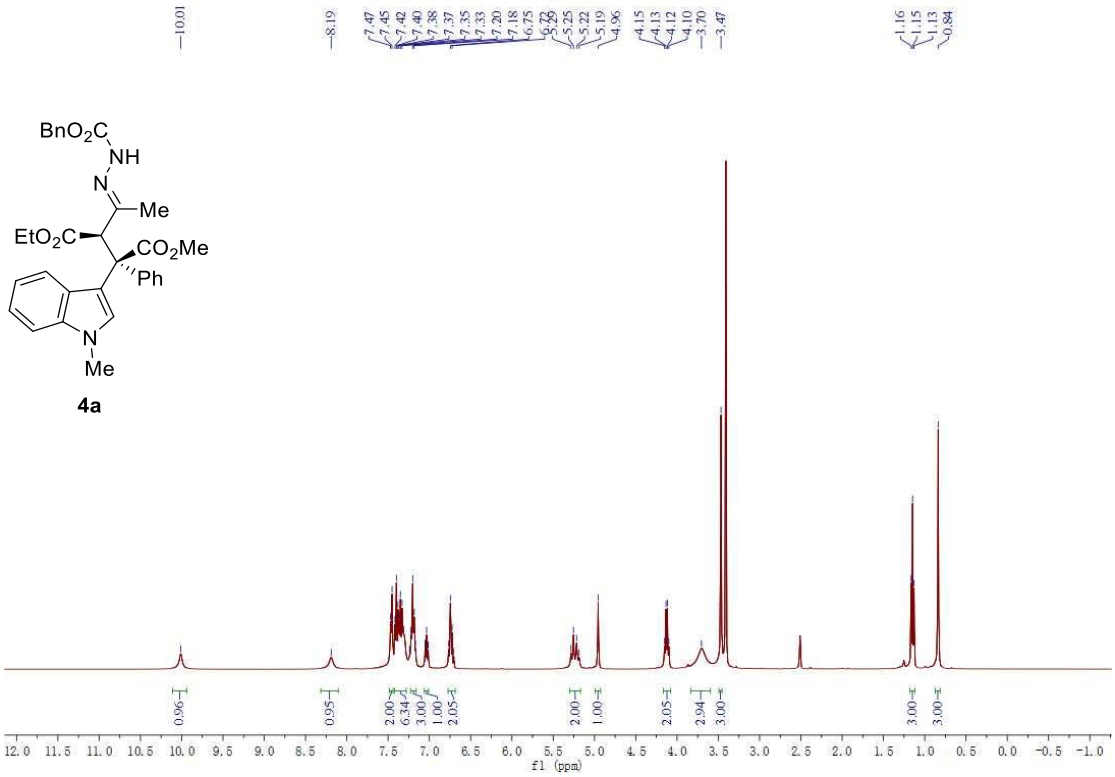
1. C.-Y. Guan, T.-J. Han, S.-K. Jia, Y.-Z. Hua and G.-J. Mei, *Green Synth. Catal.*, 2023, ***4***, 258.

2. F.-Y. Yang, T.-J. Han, S.-K. Jia, M.-C. Wang and G.-J. Mei, *Chem. Commun.*, 2023, ***59***, 3107.

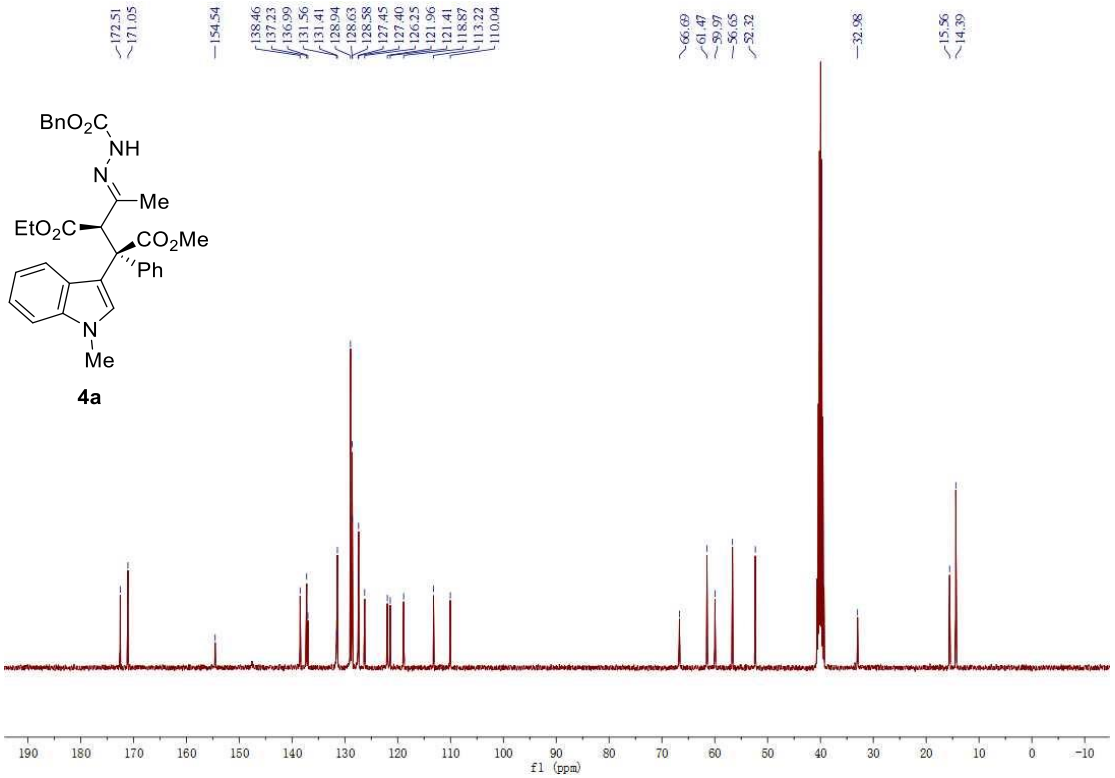
3. H. Qiu, M. Li, L. Jiang, F. Lv, L. Zan, C. Zhai, M. P. Doyle and W. Hu, *Nat. Chem.*, 2012, ***4***, 733.

NMR Spectra of compounds

^{1}H NMR (400 MHz, DMSO-d_6)



^{13}C NMR (101 MHz, DMSO-d_6)



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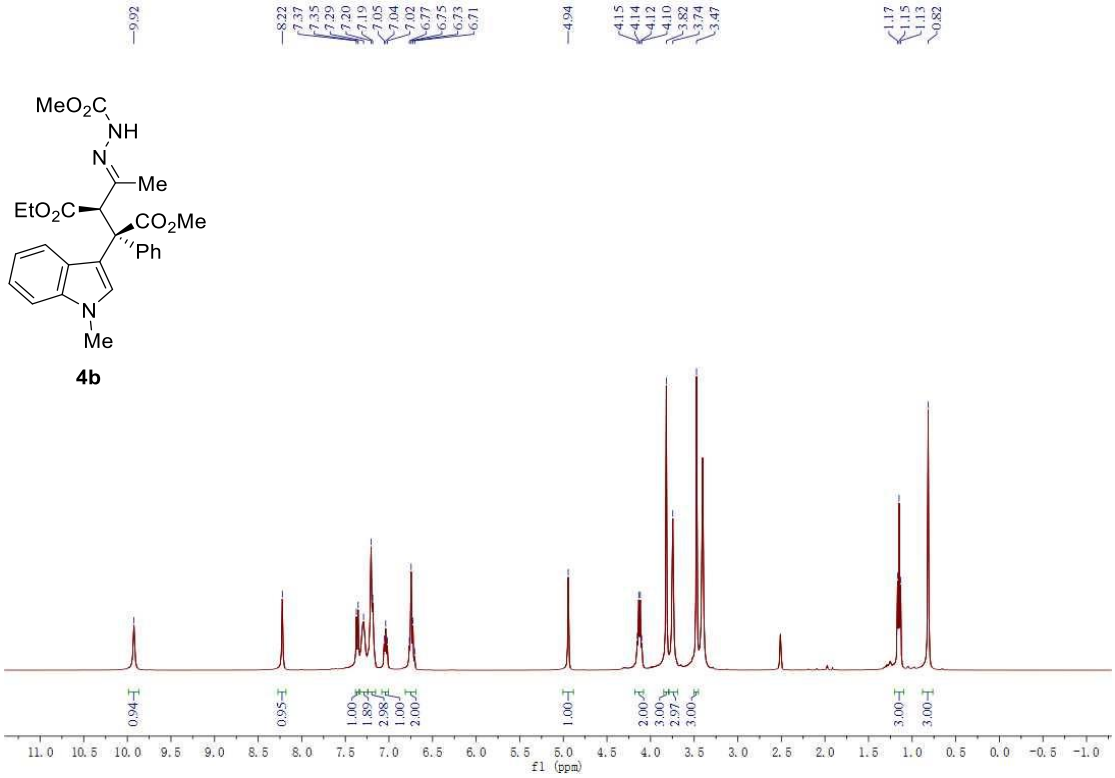

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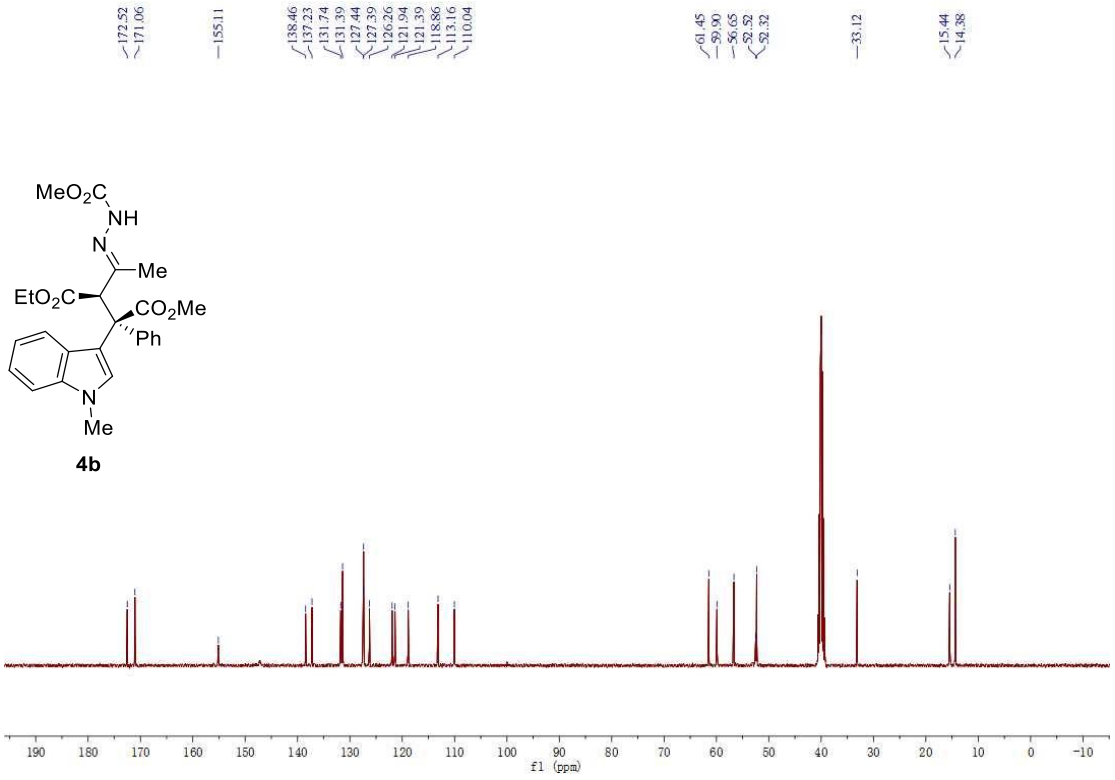

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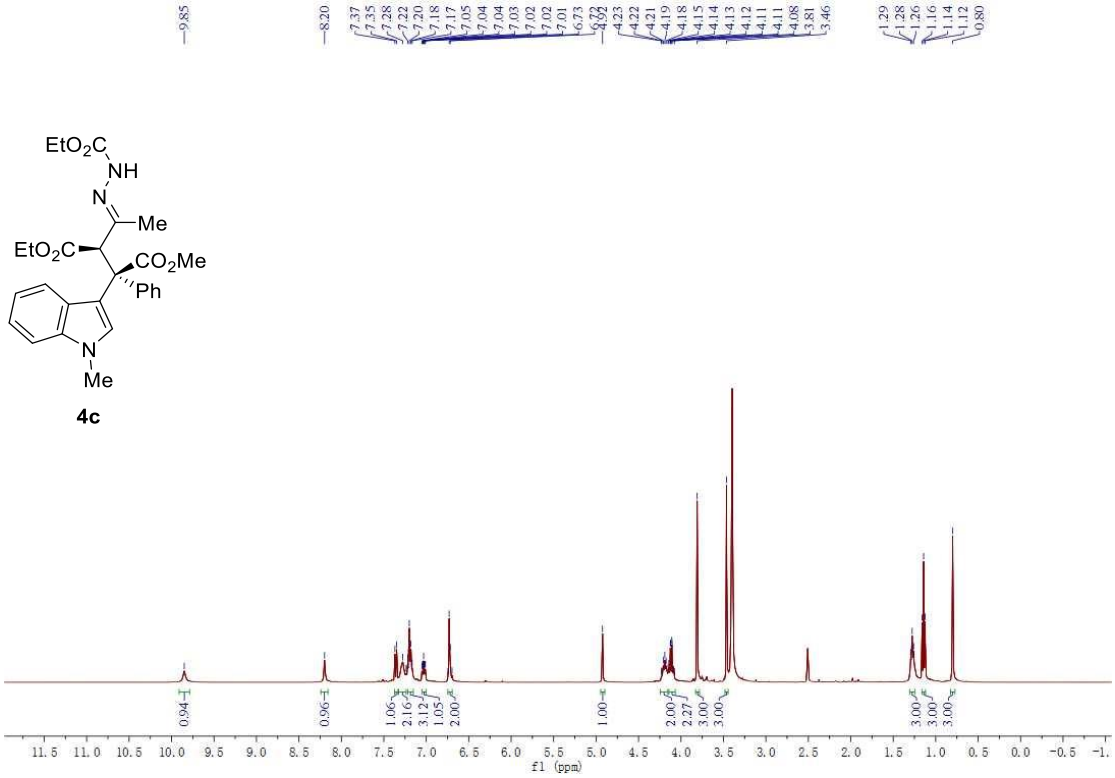

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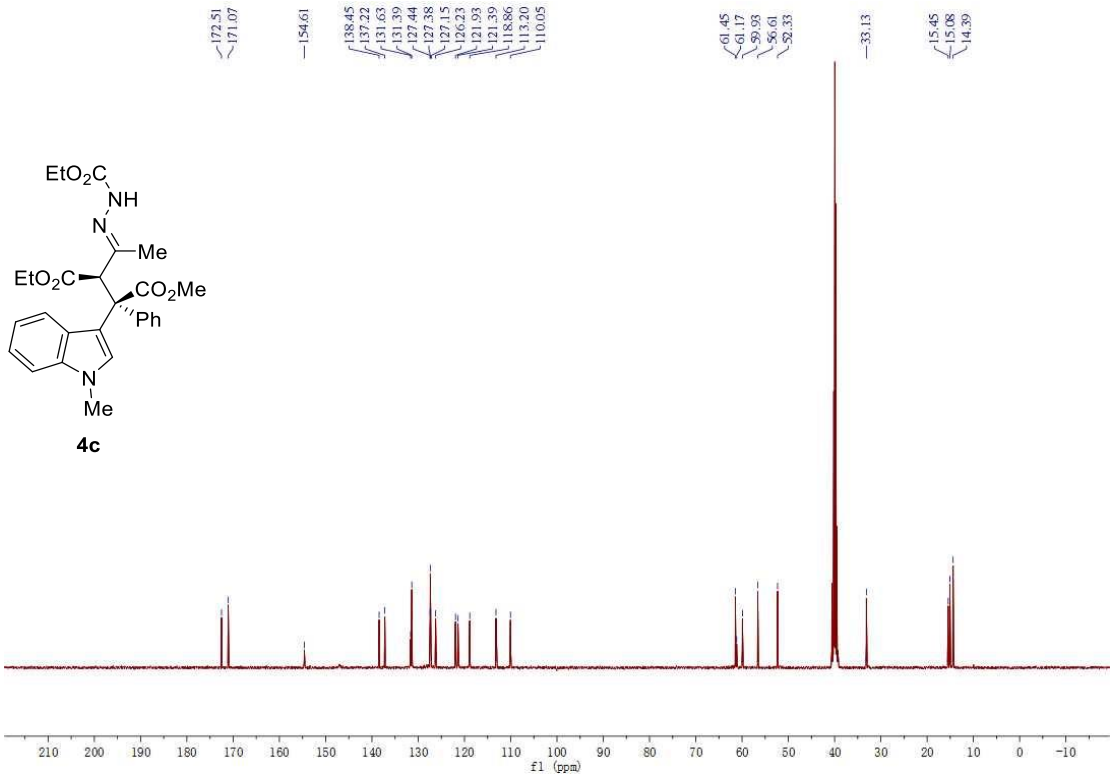

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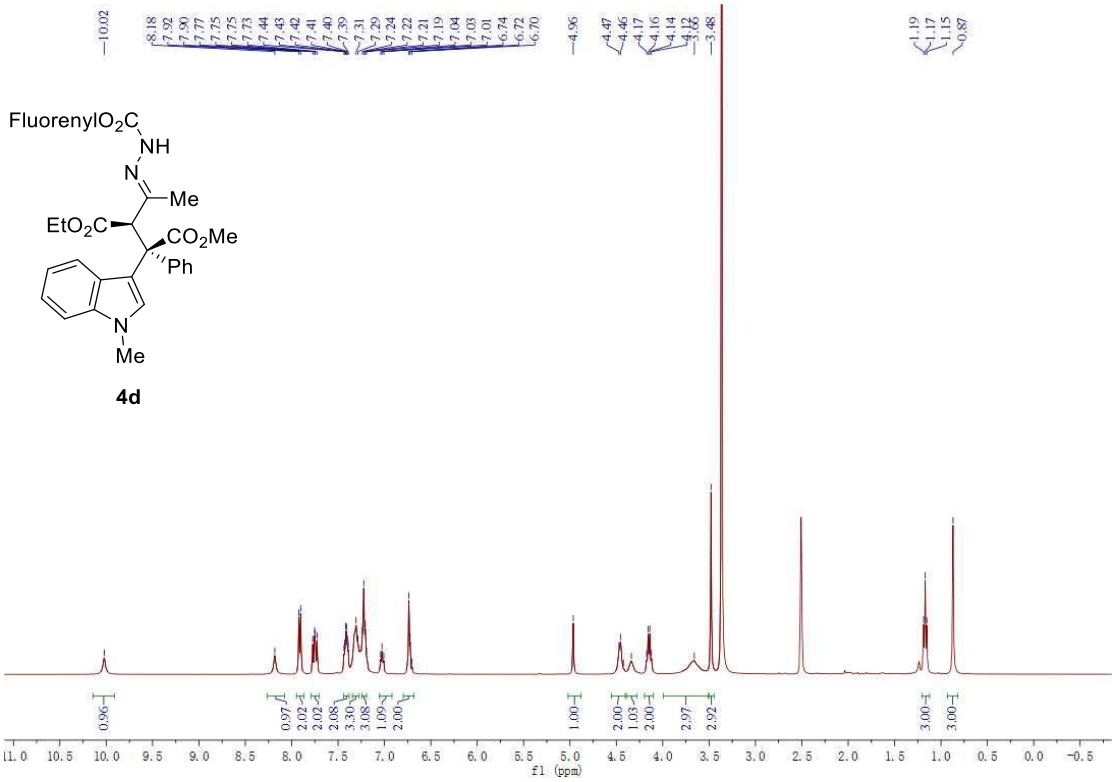

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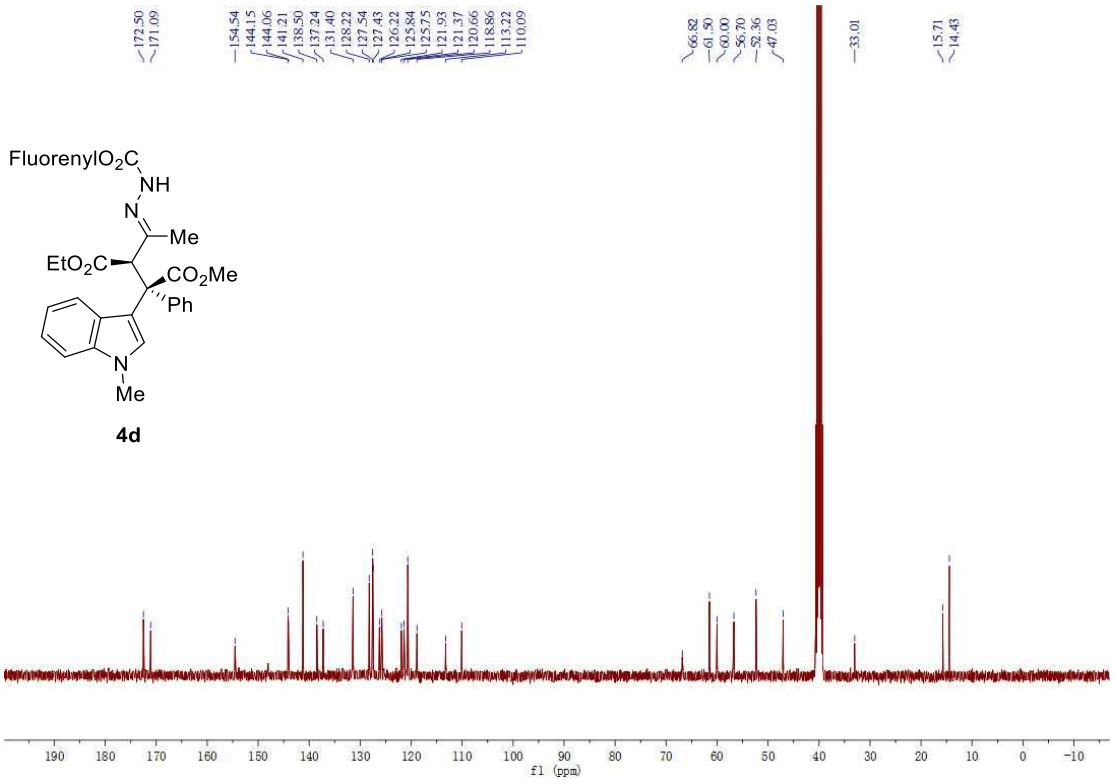

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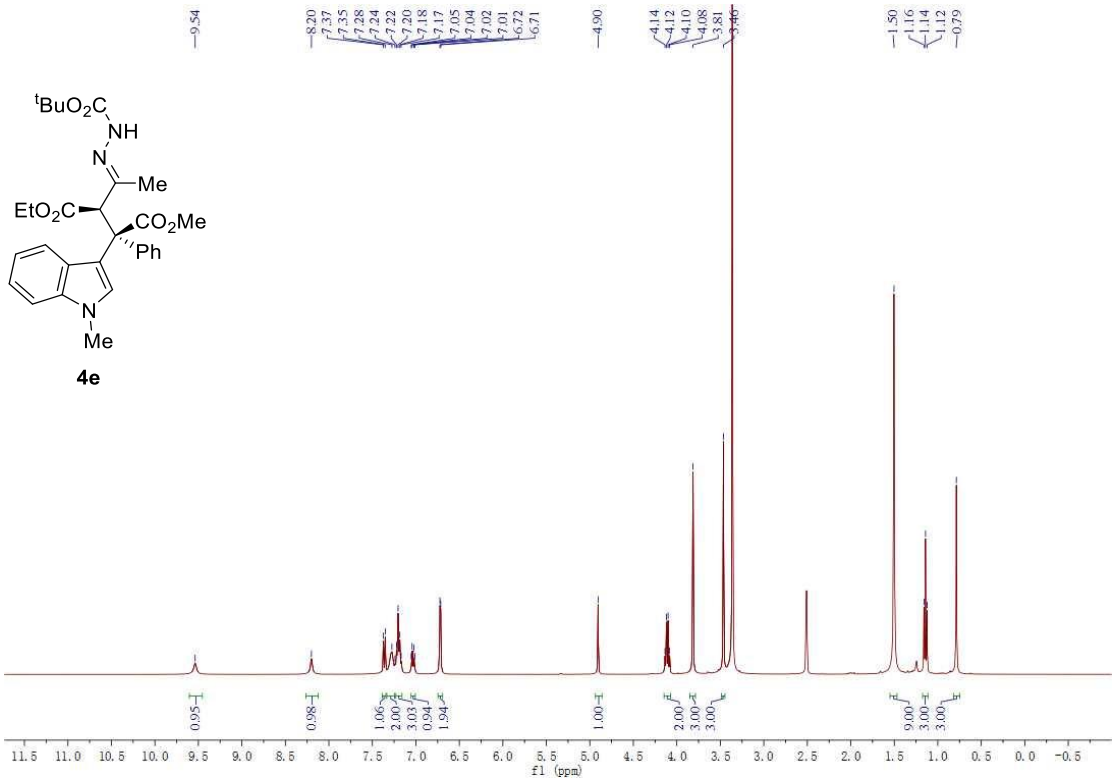
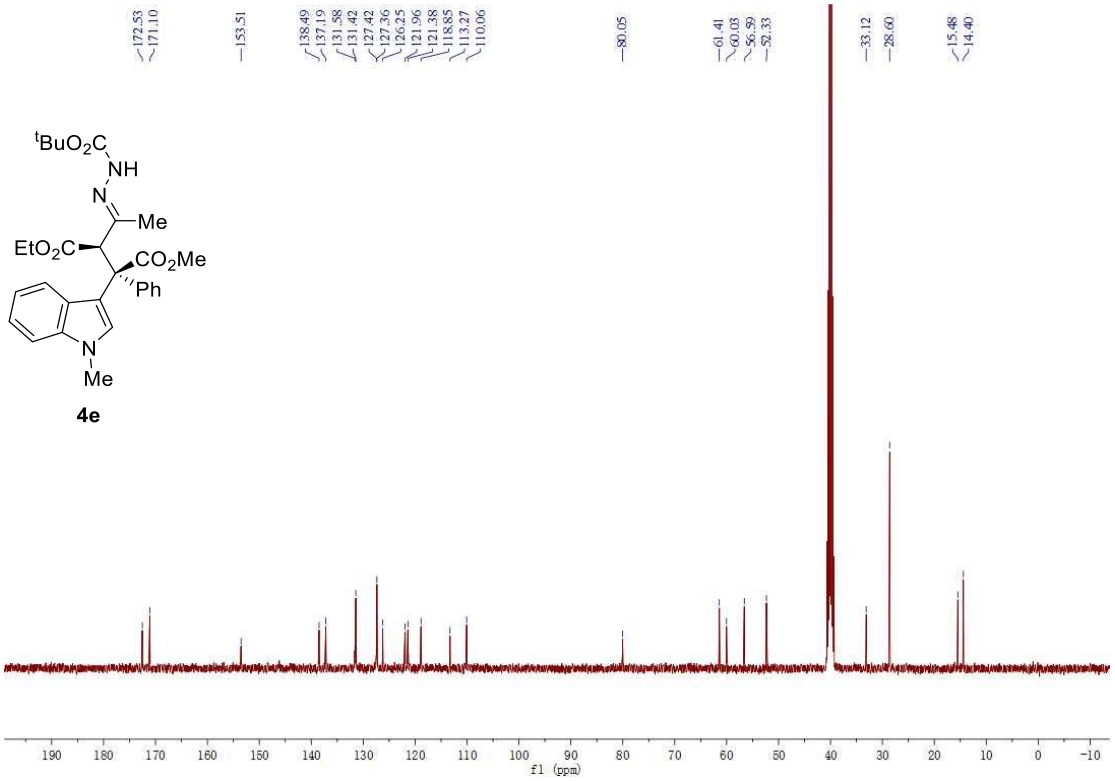


4e

^{13}C NMR (101 MHz, DMSO-d_6)



4e

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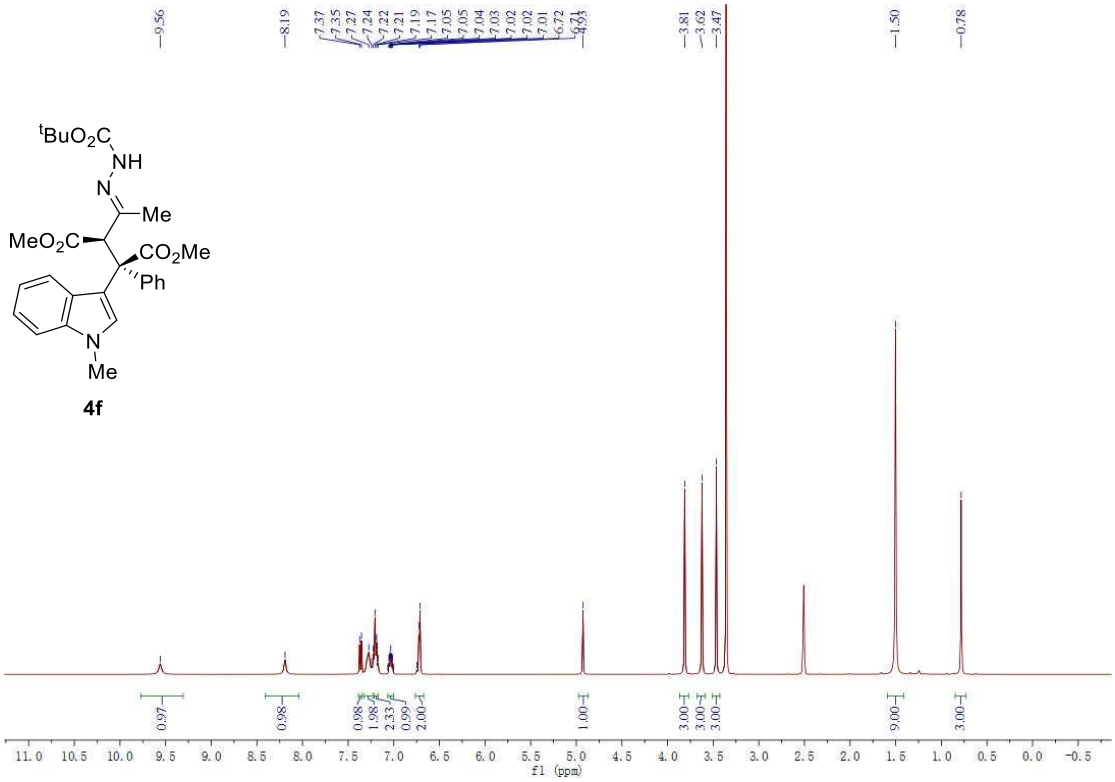

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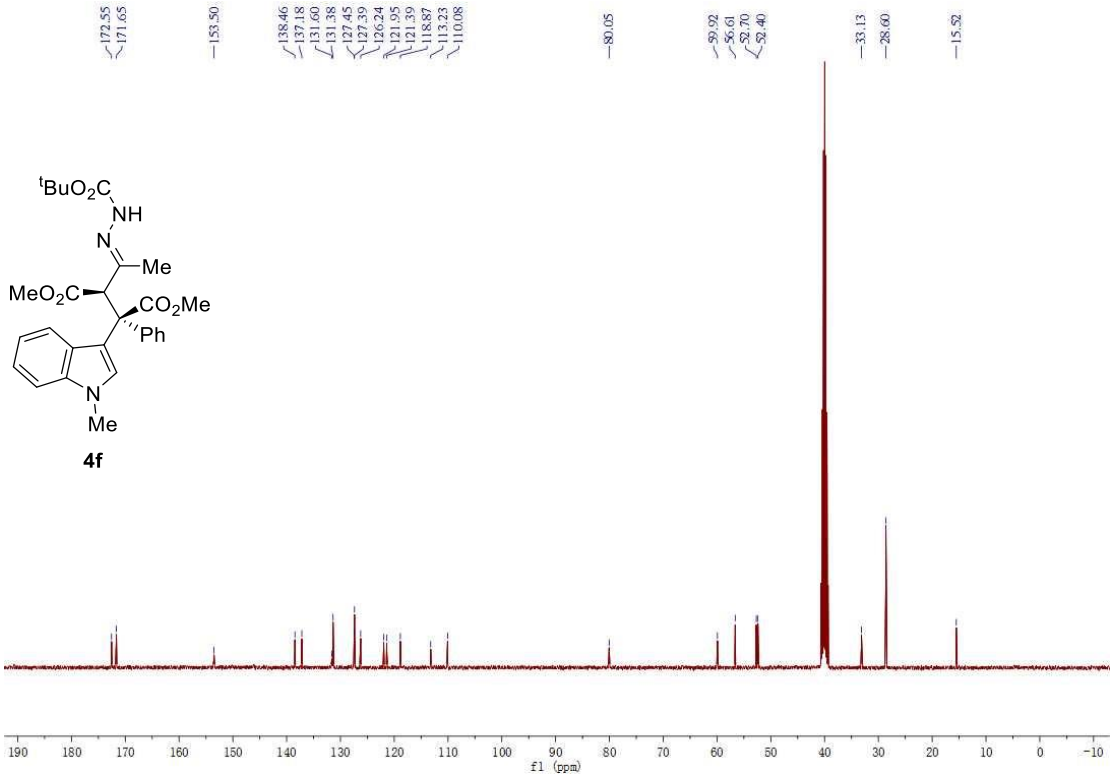

4f

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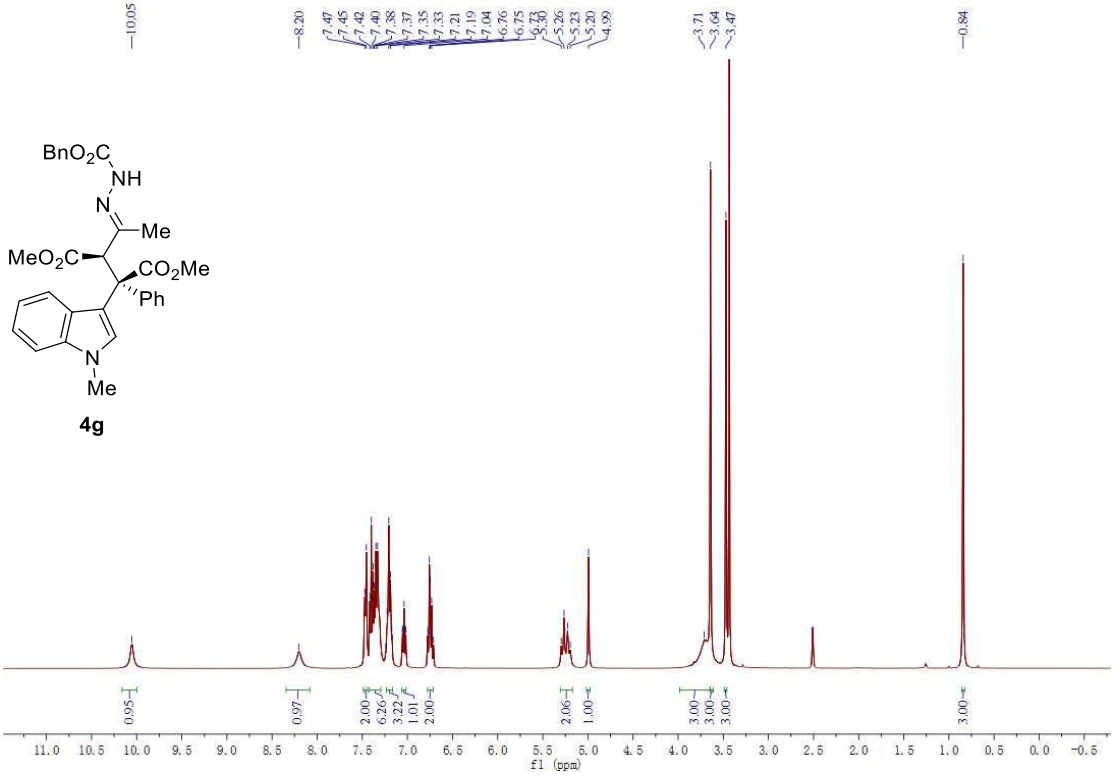

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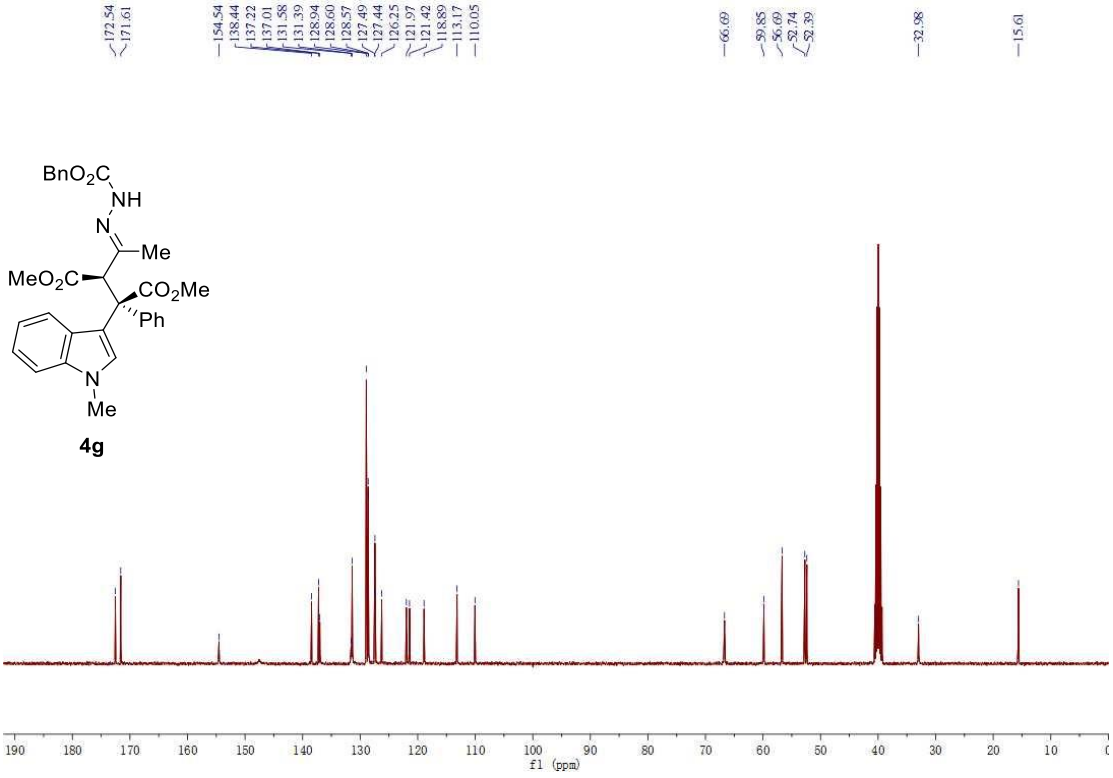

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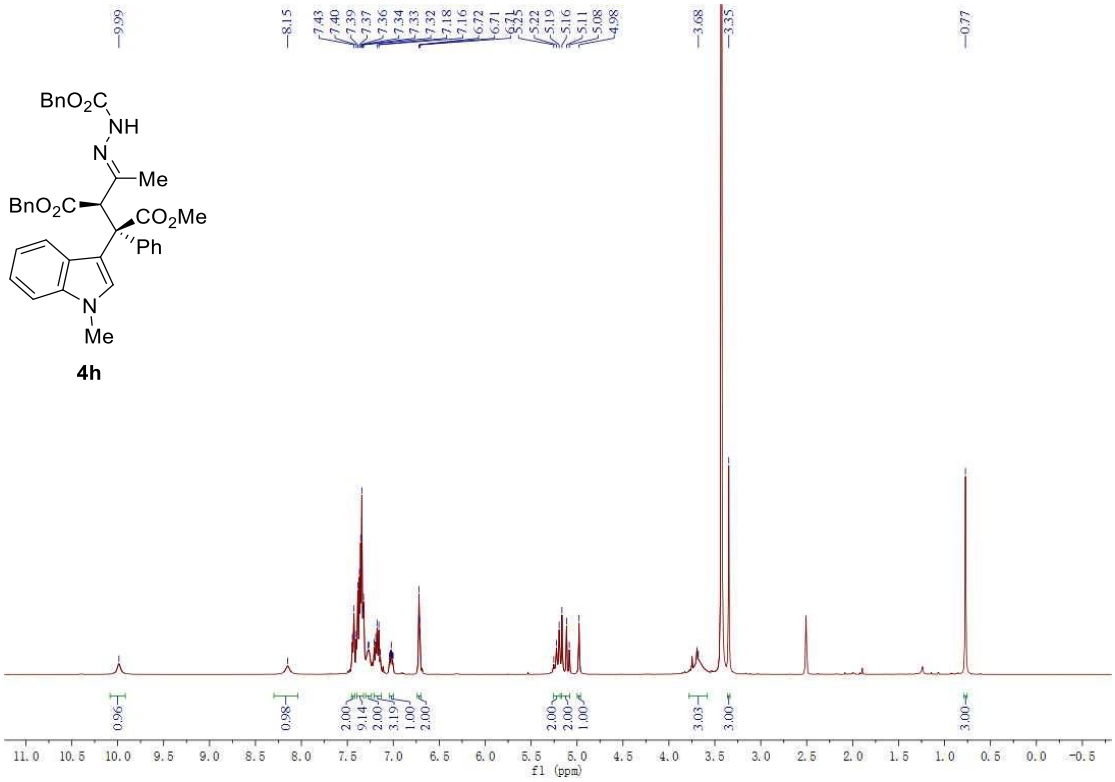

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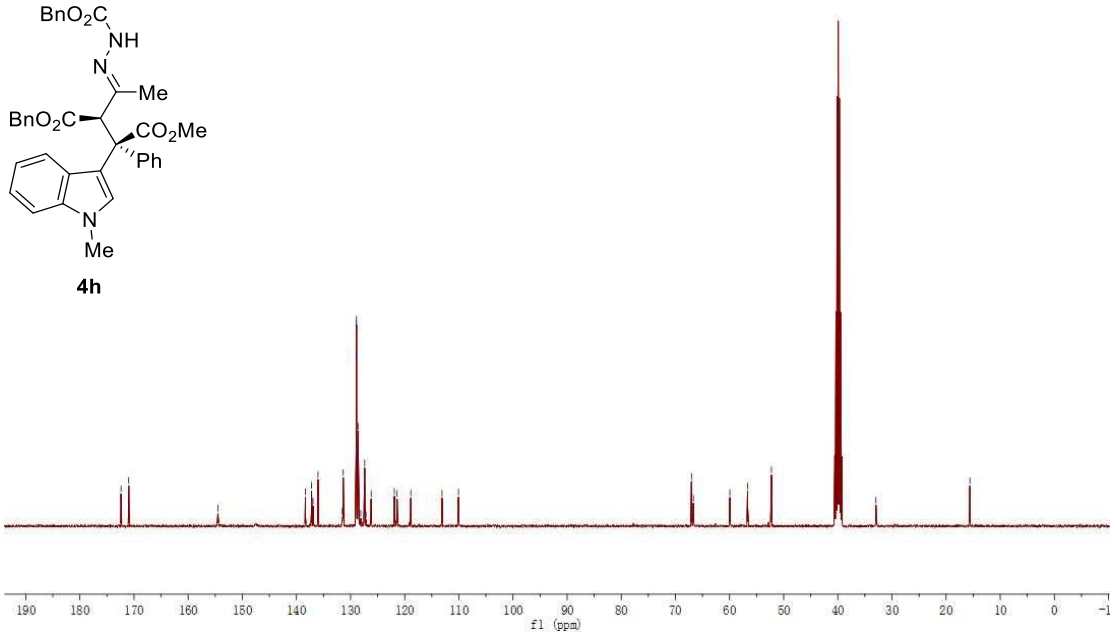

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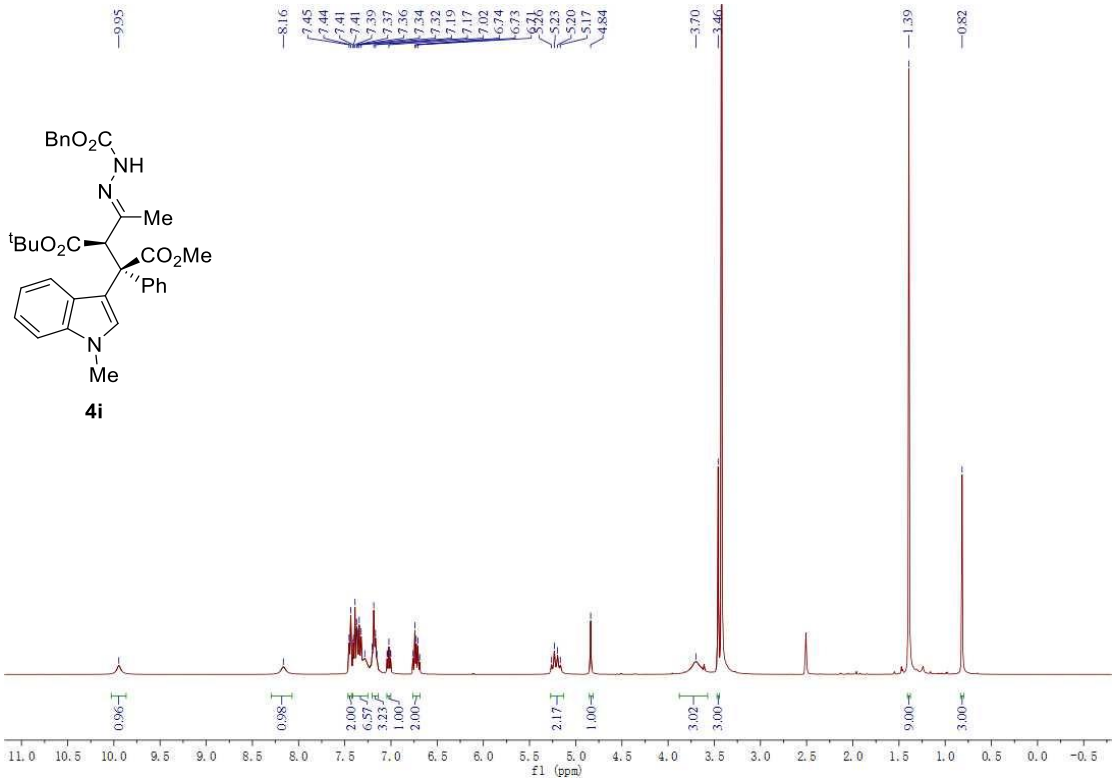

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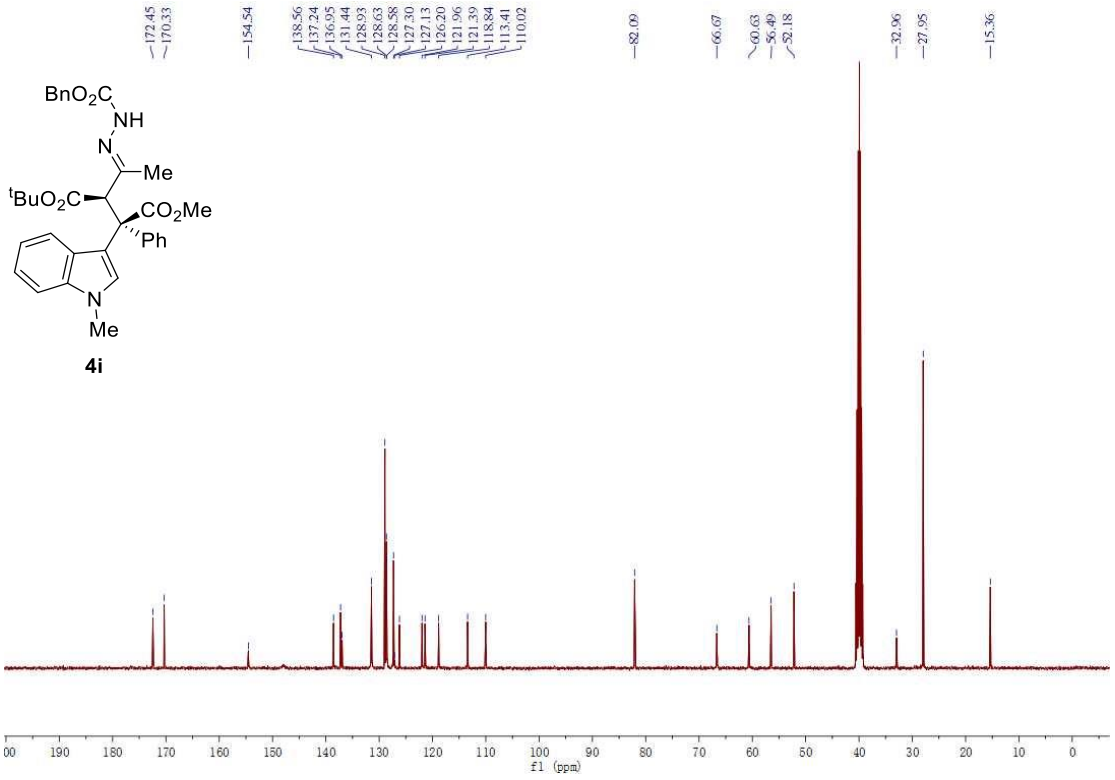

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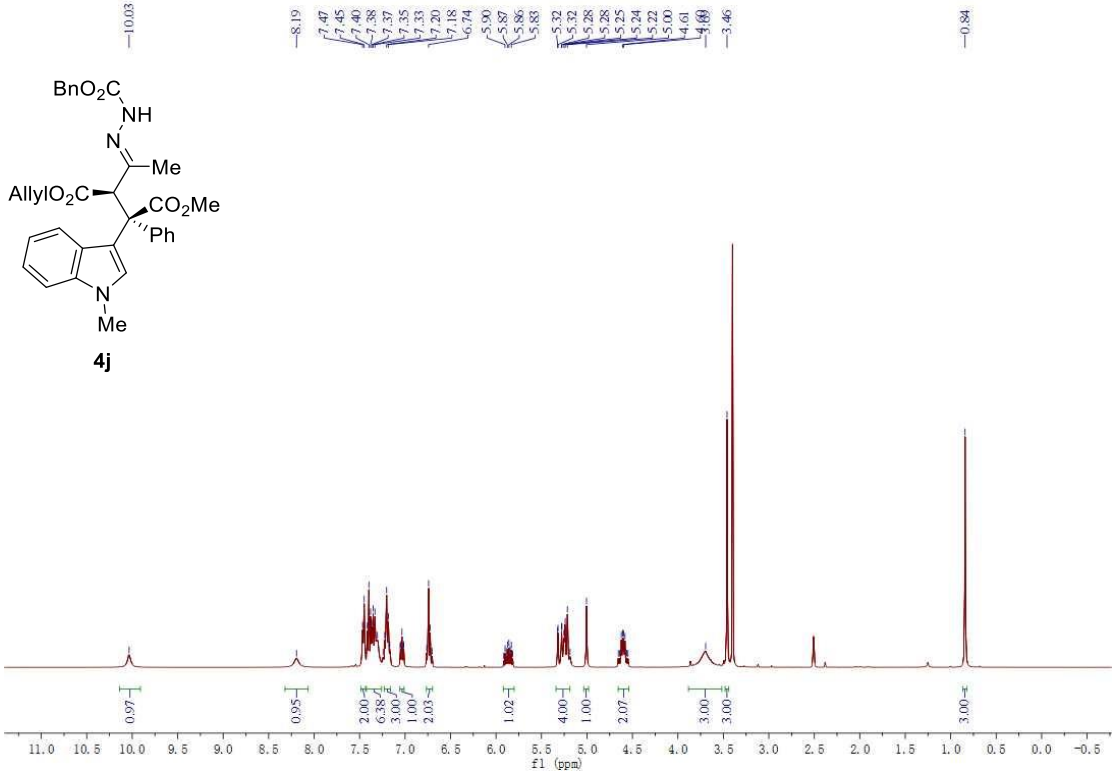

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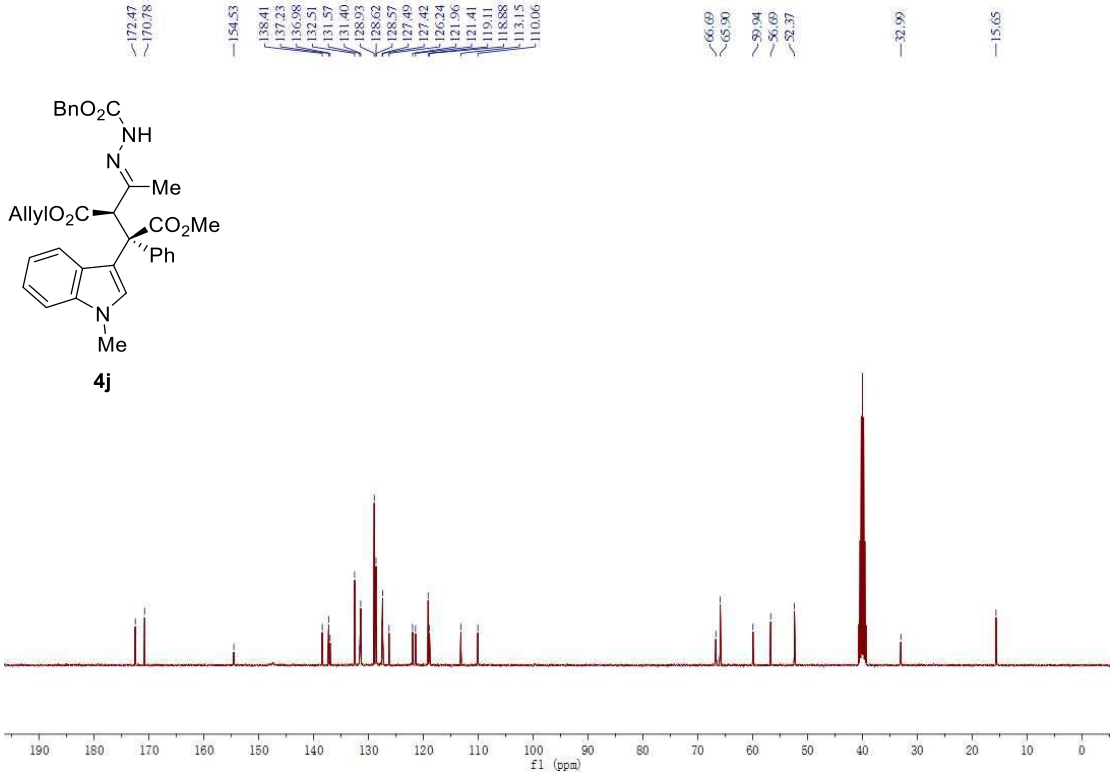

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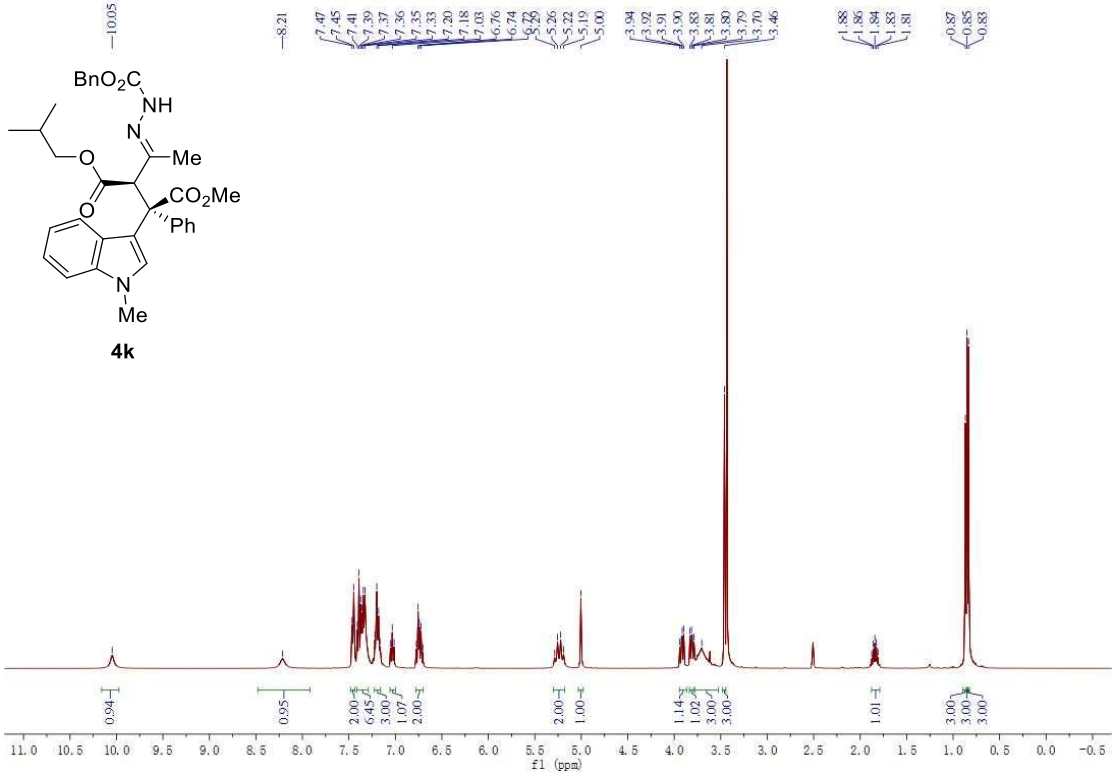

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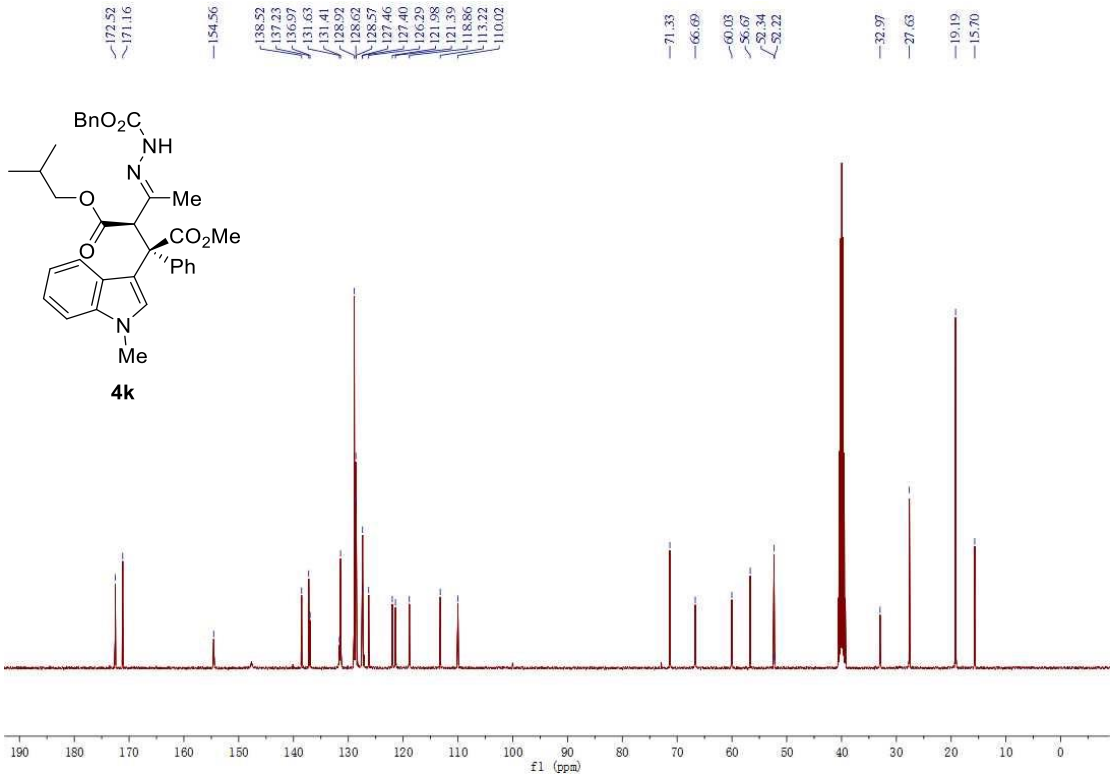

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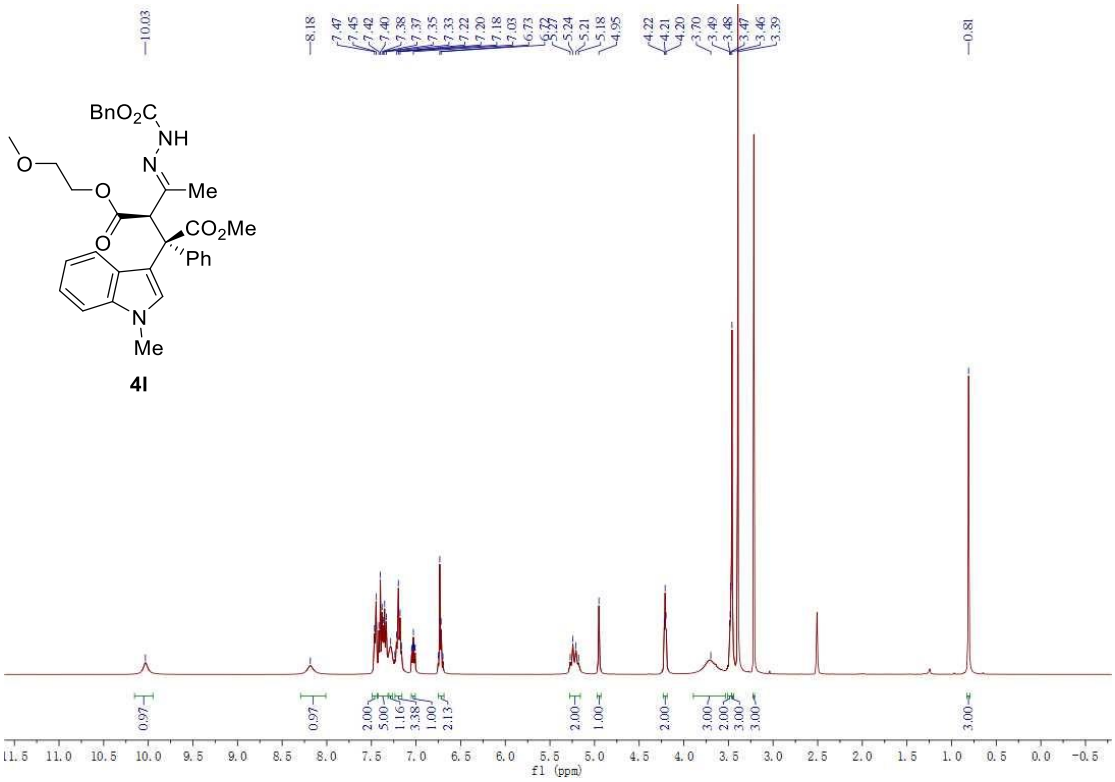

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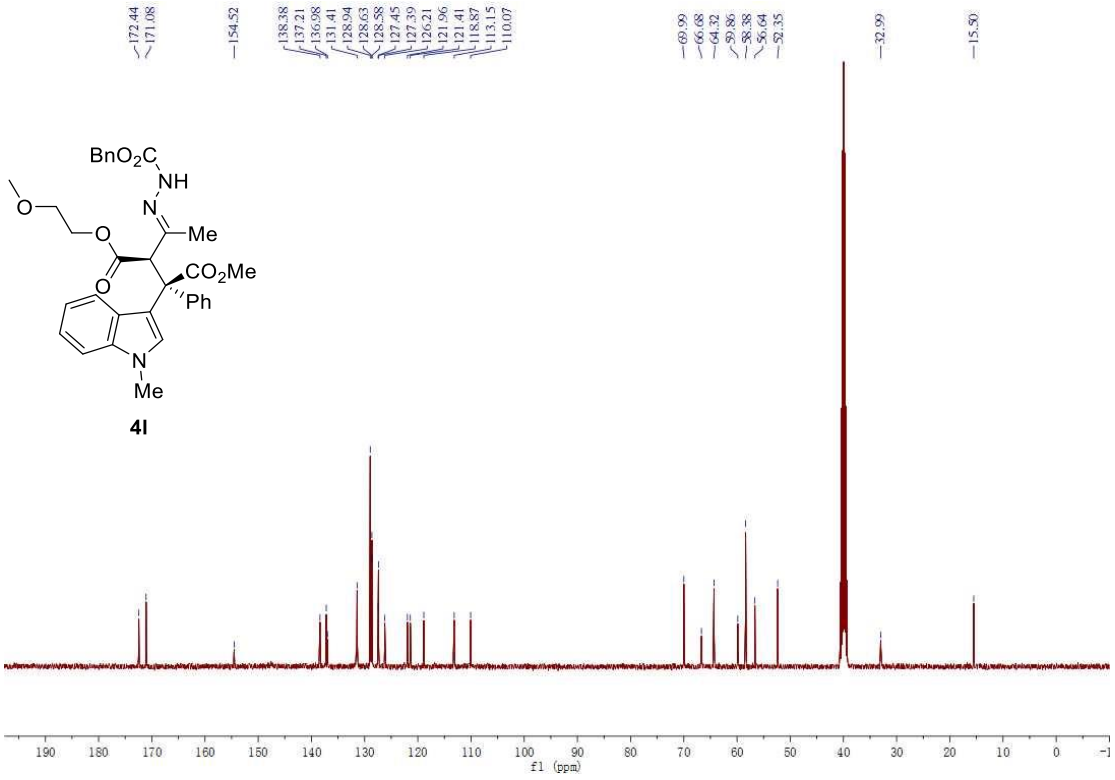

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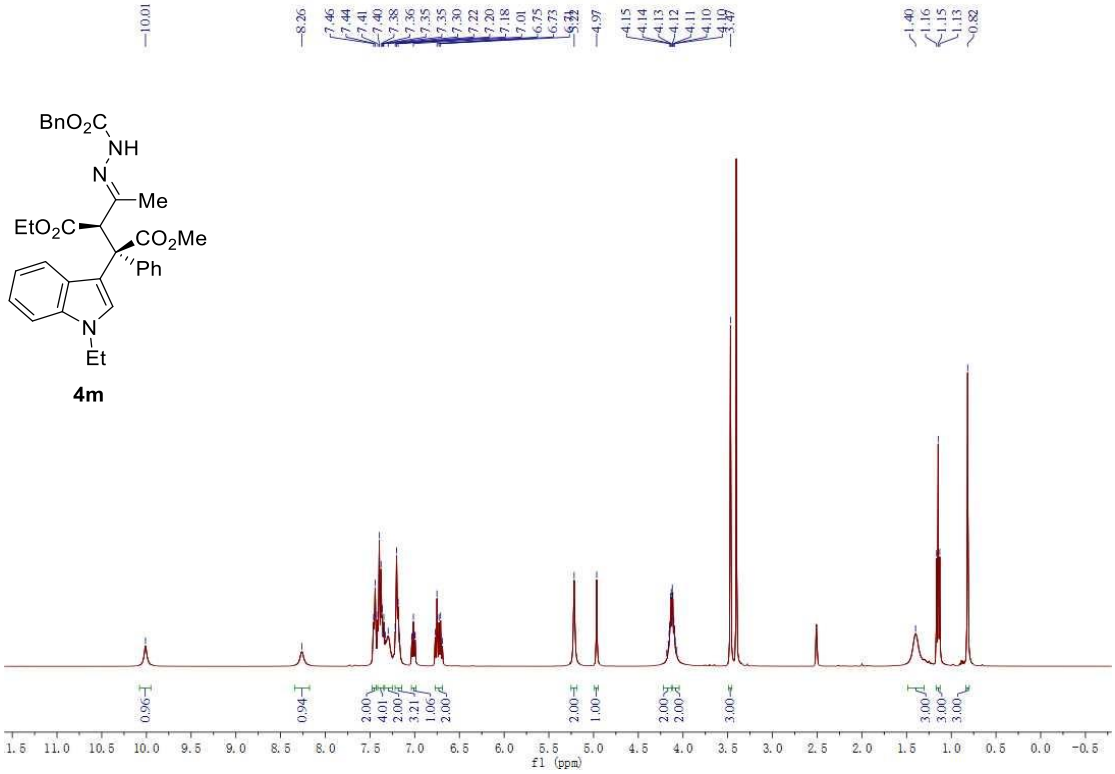

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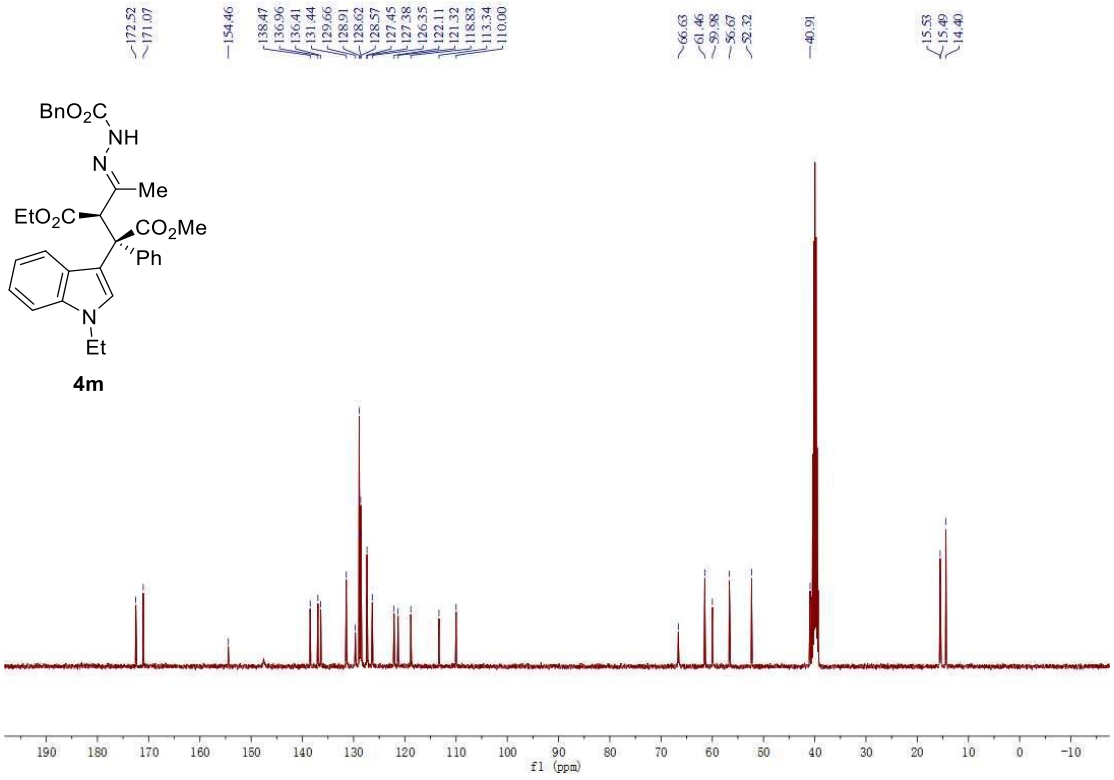

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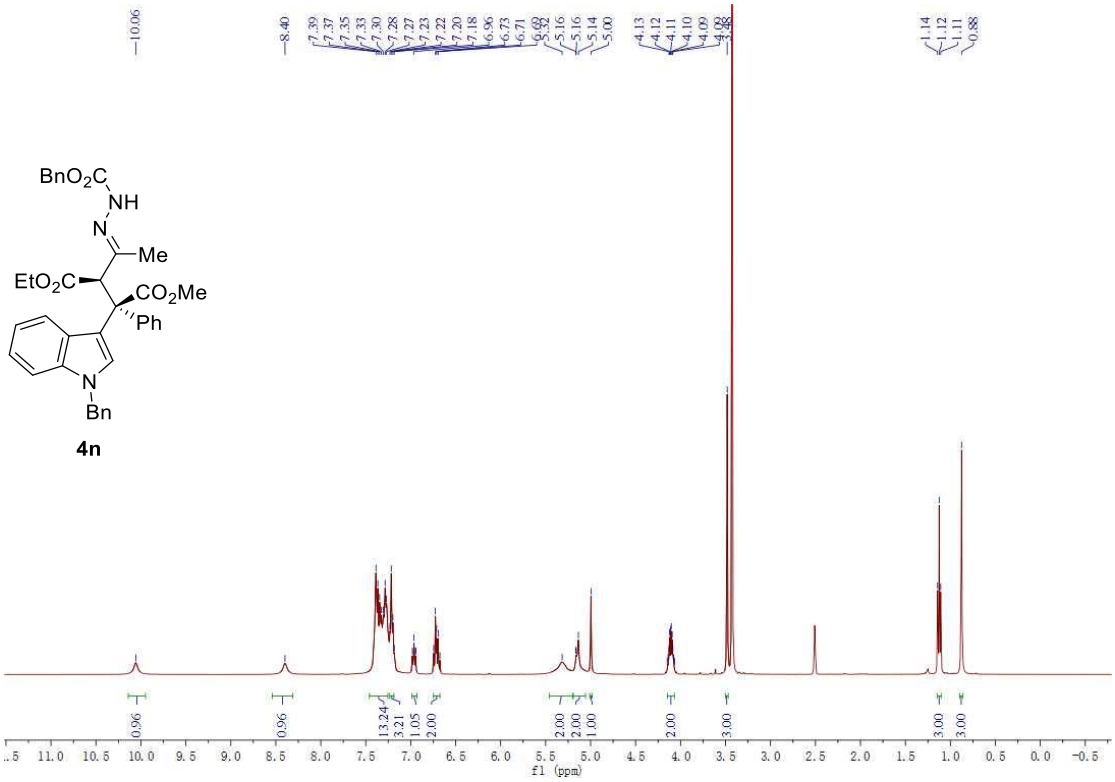

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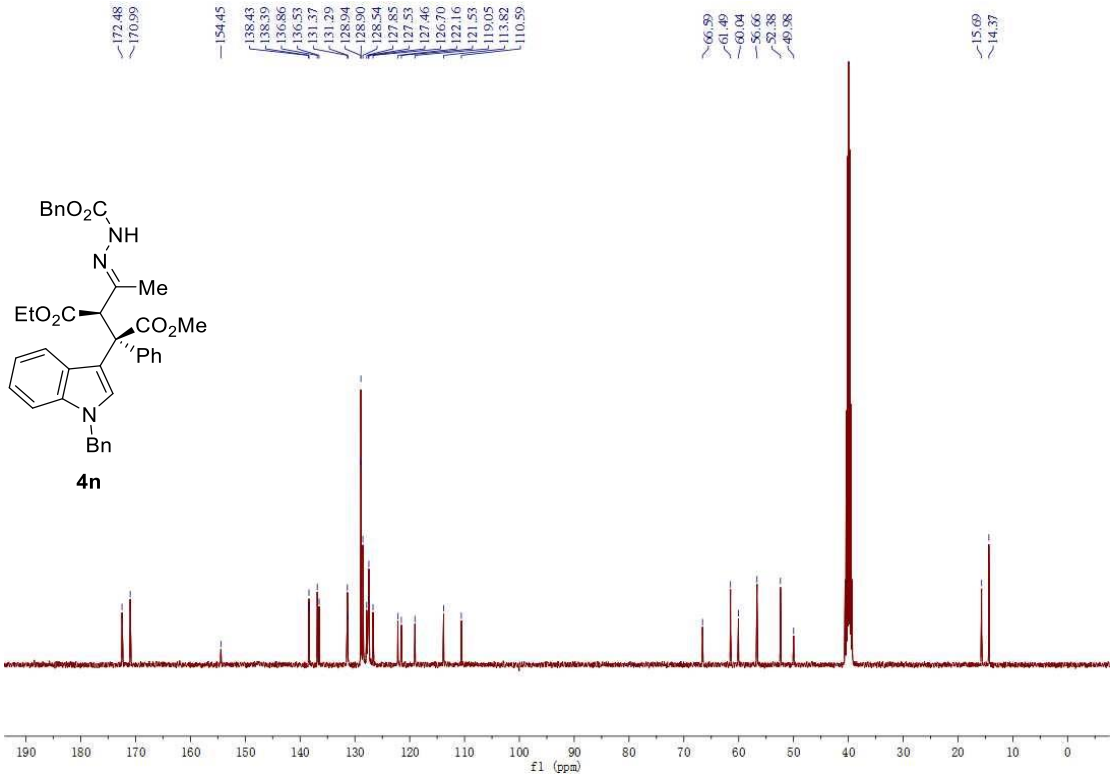

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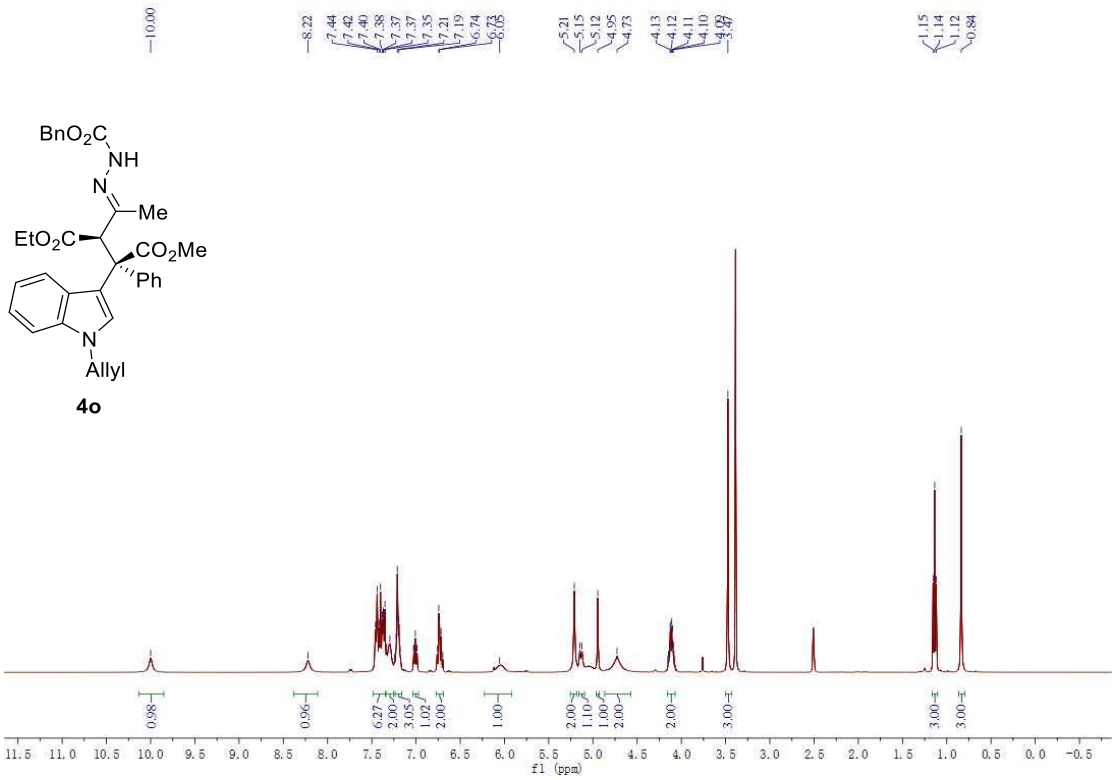

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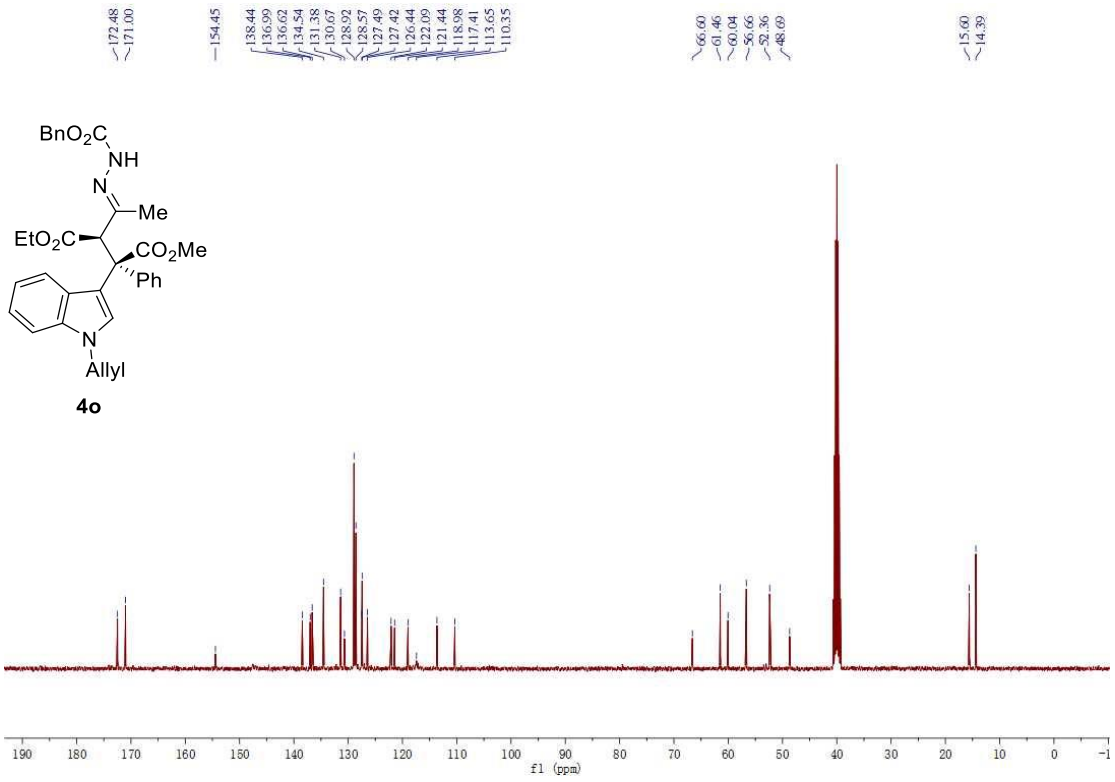

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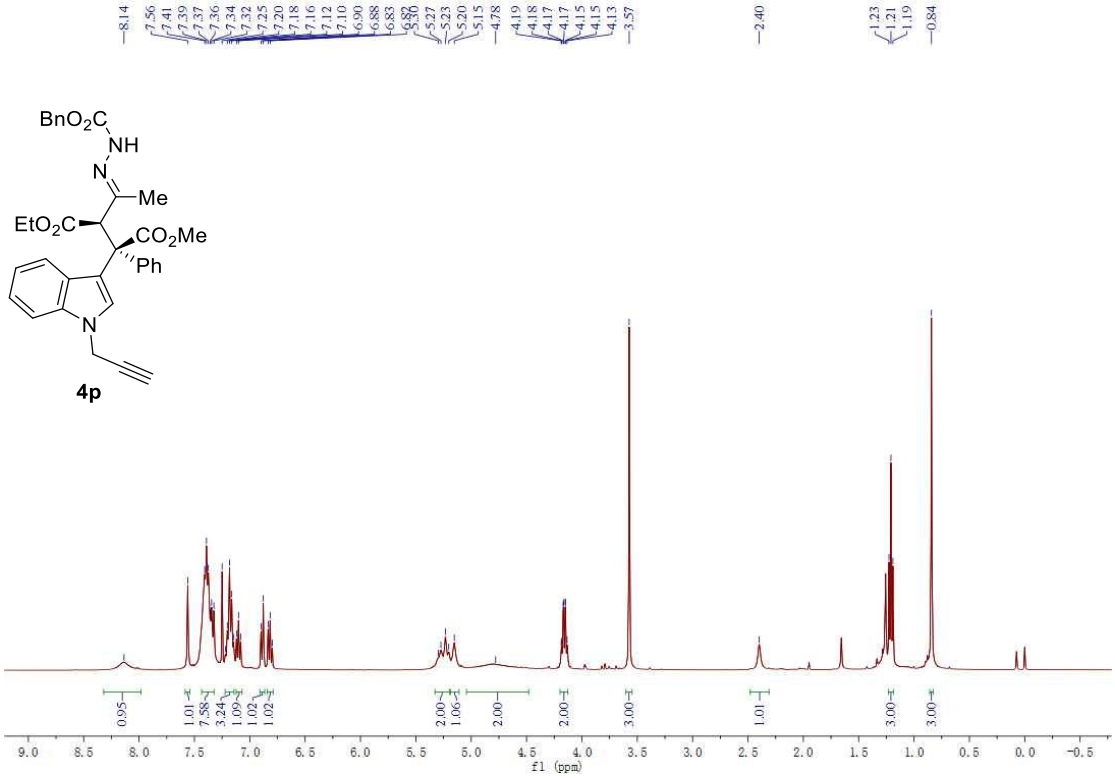

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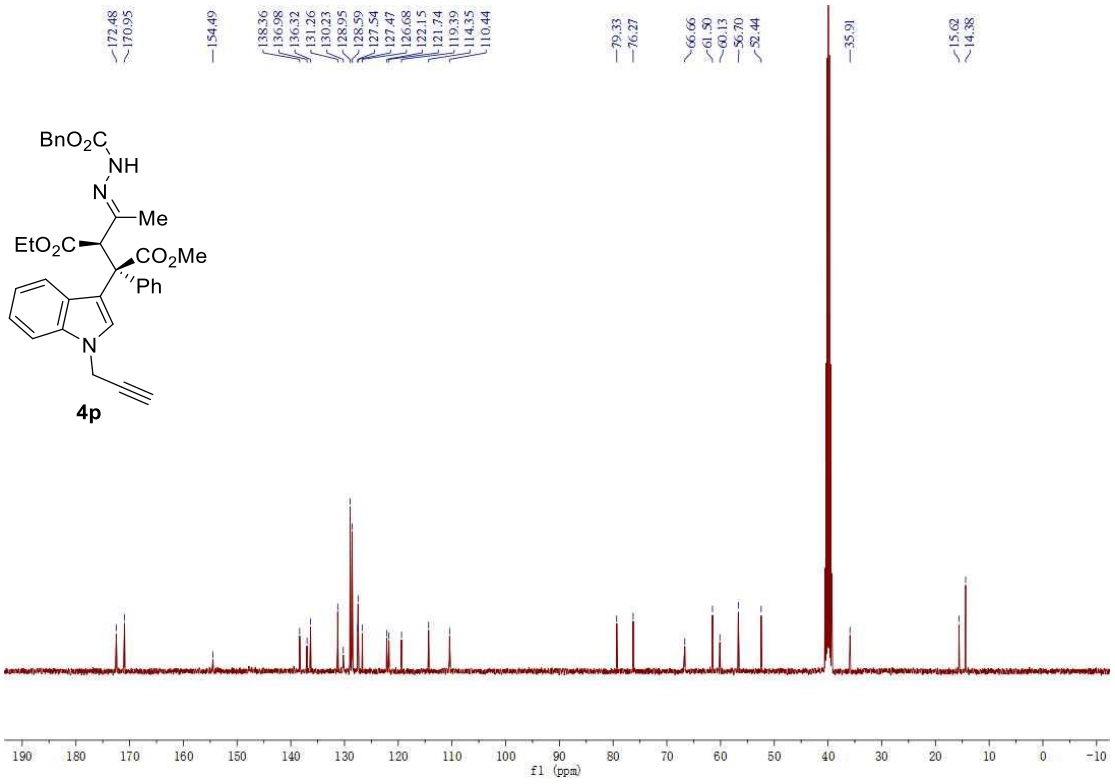

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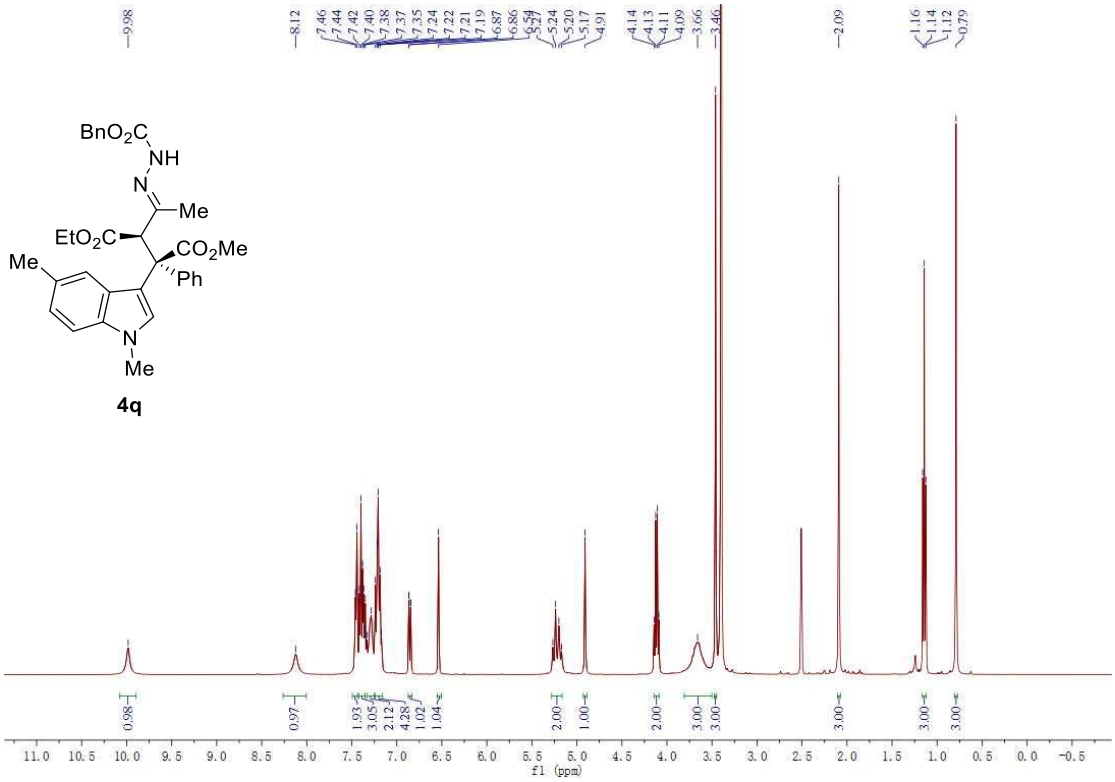

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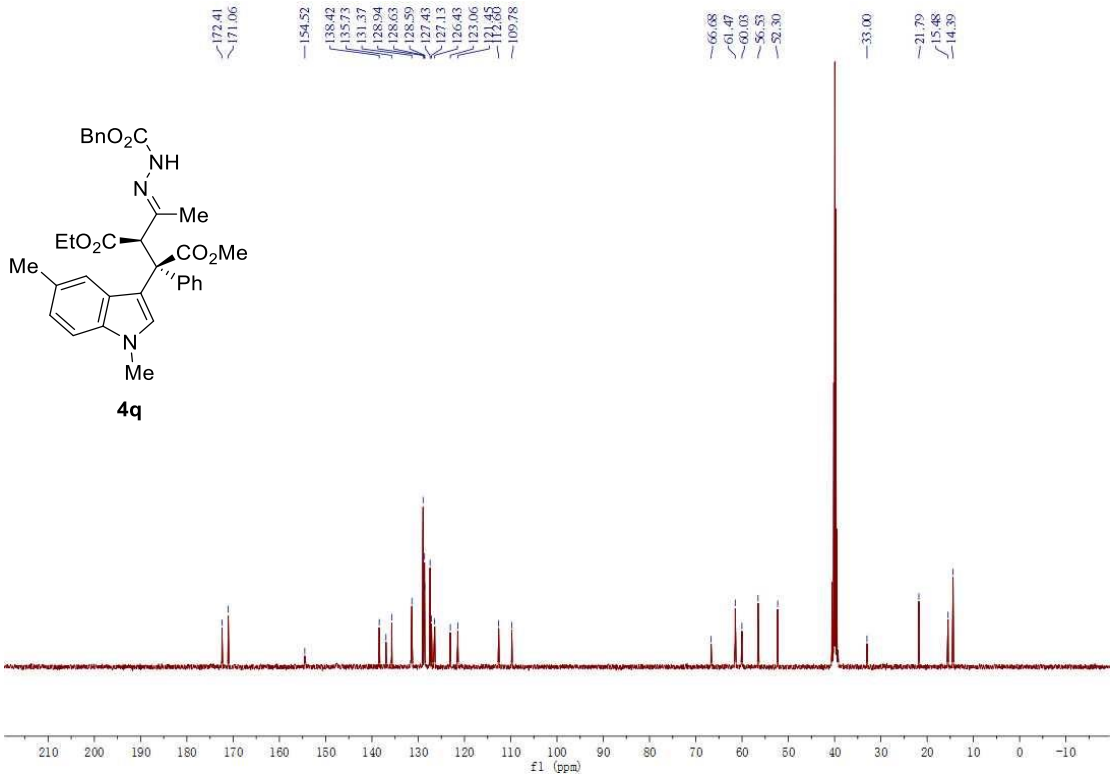

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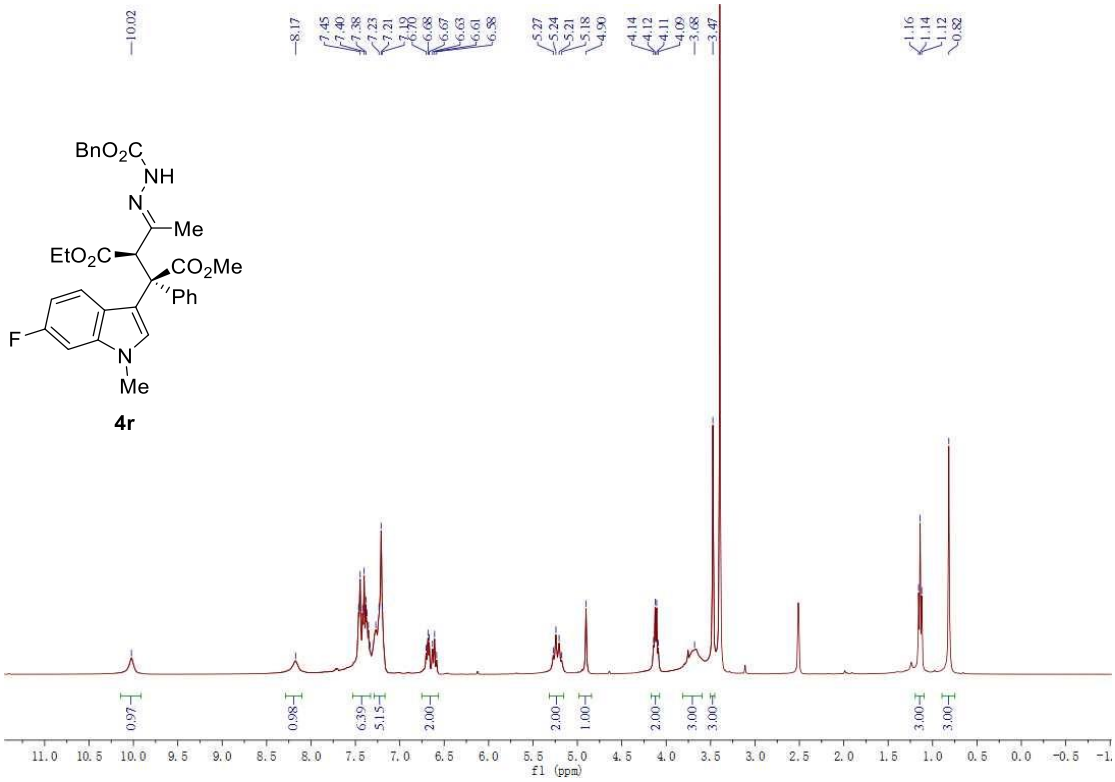

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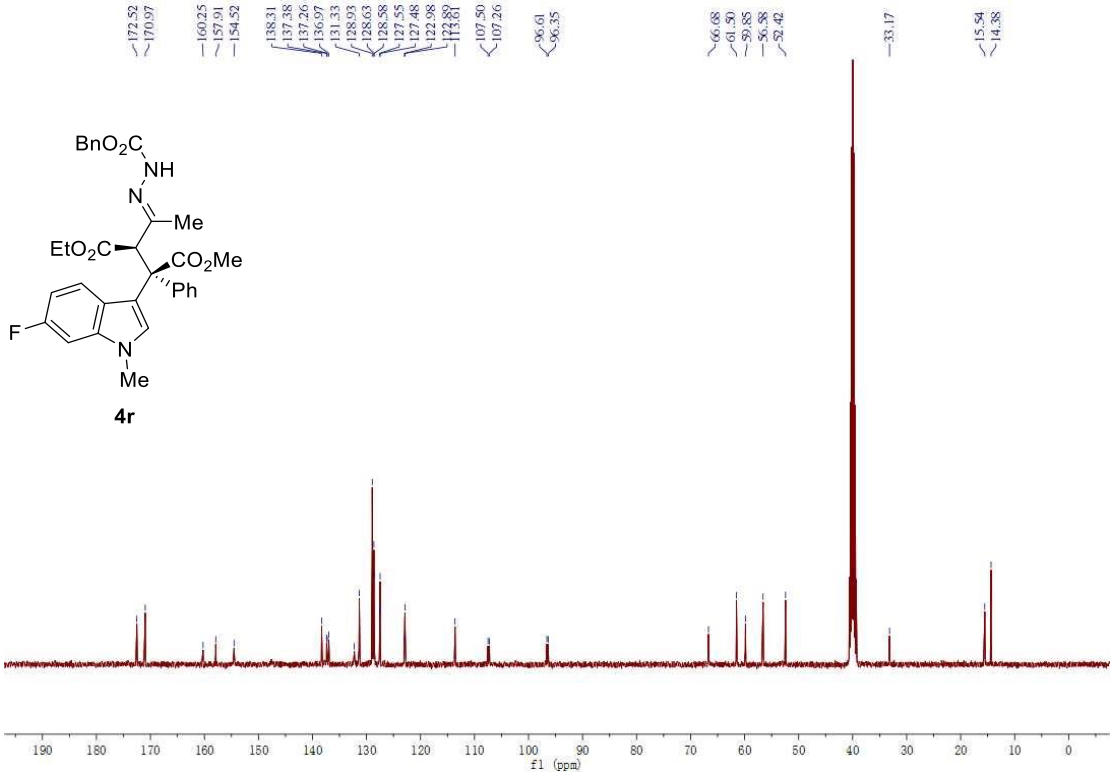

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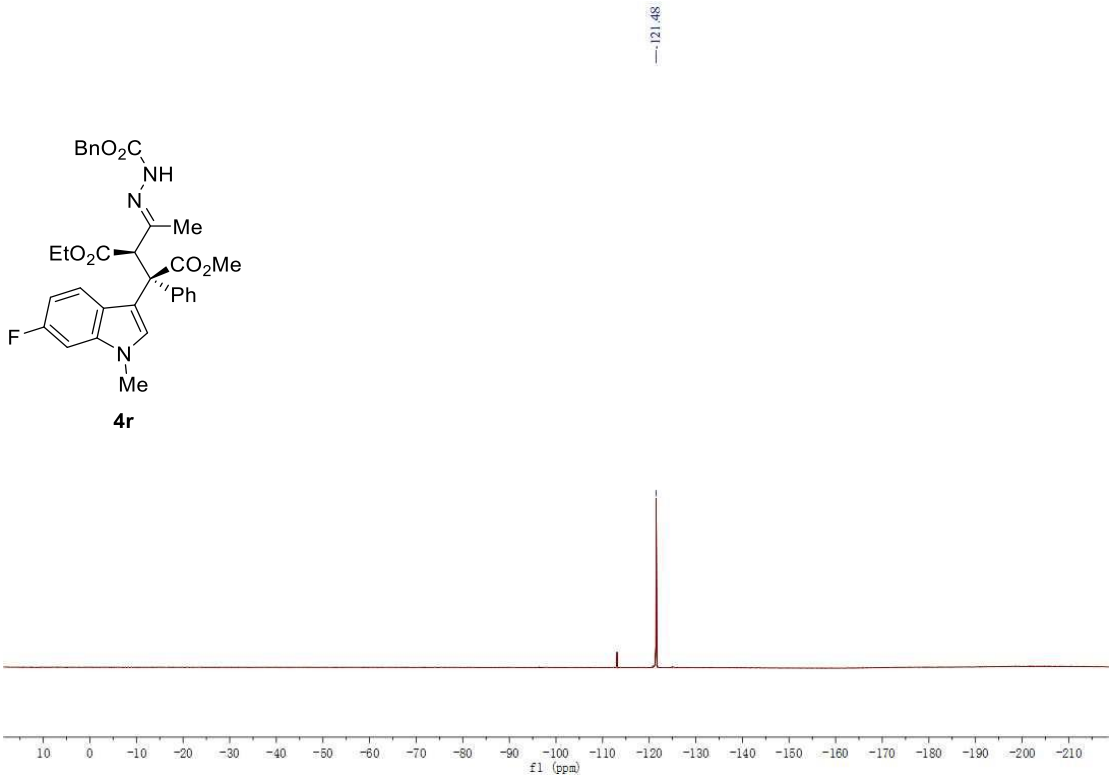

4r

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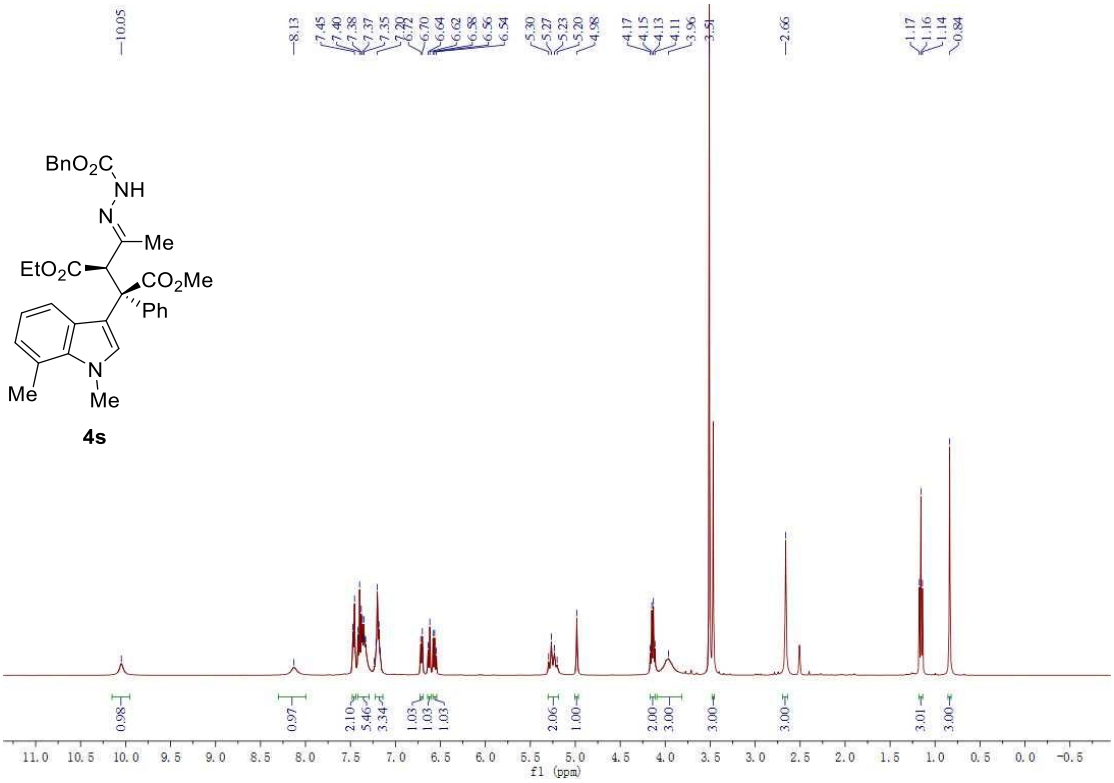

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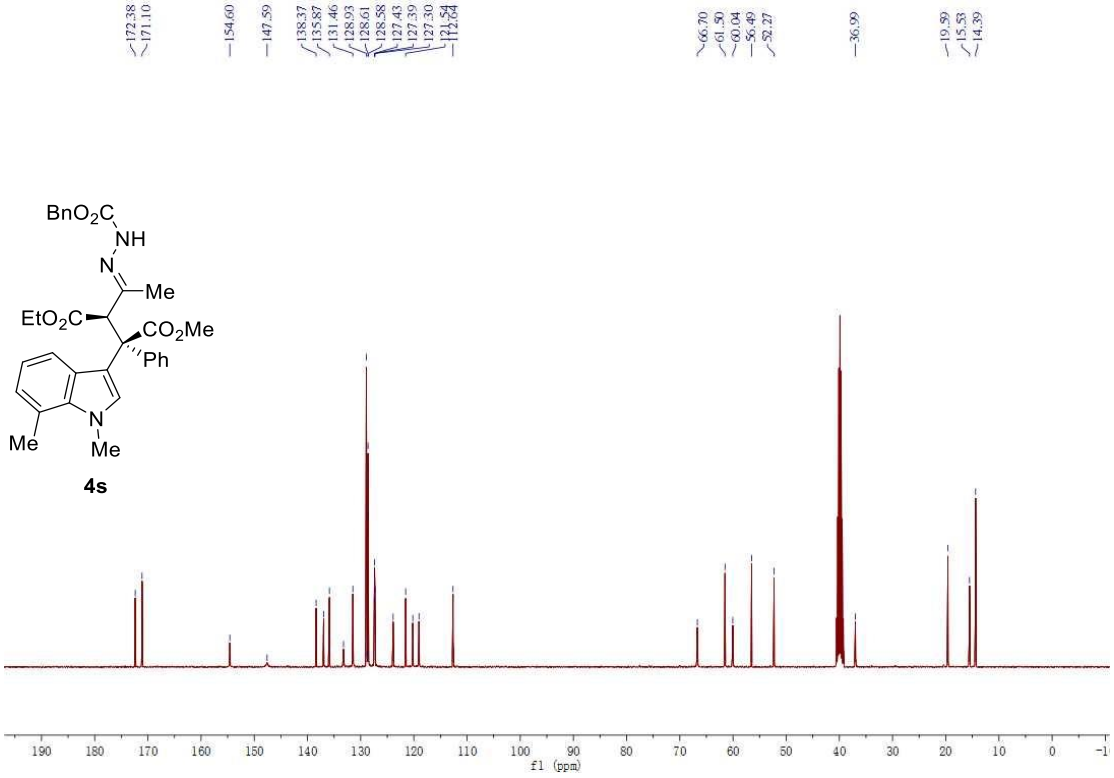

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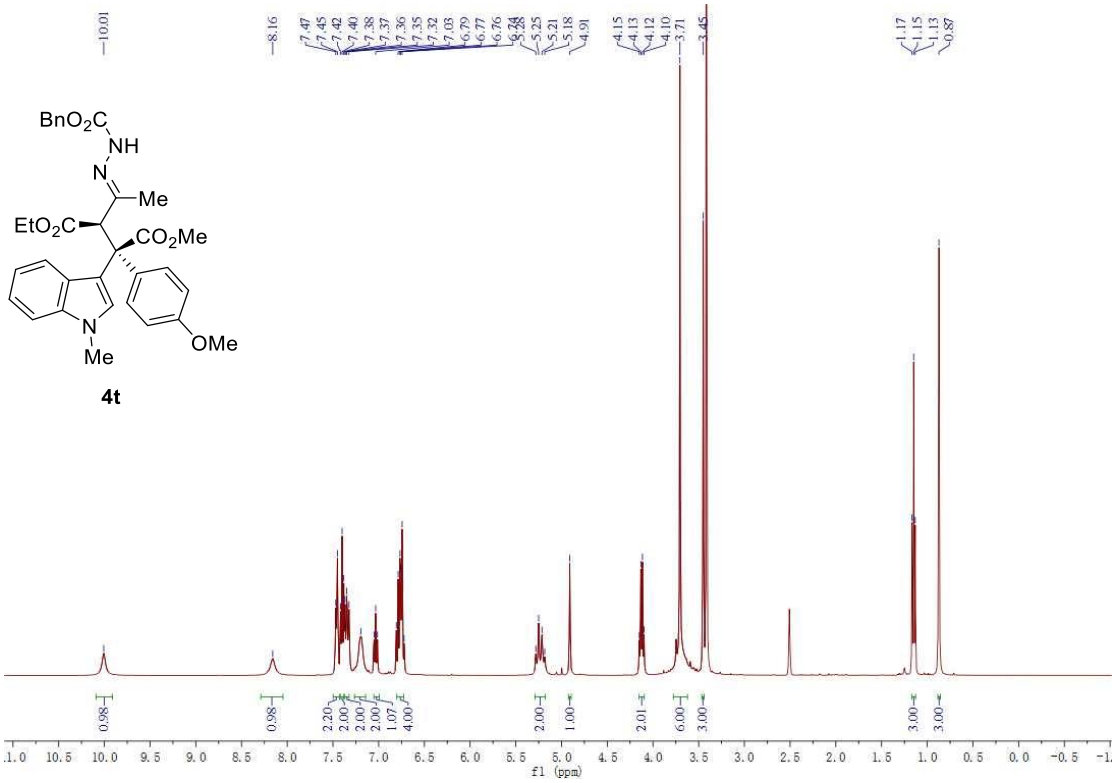

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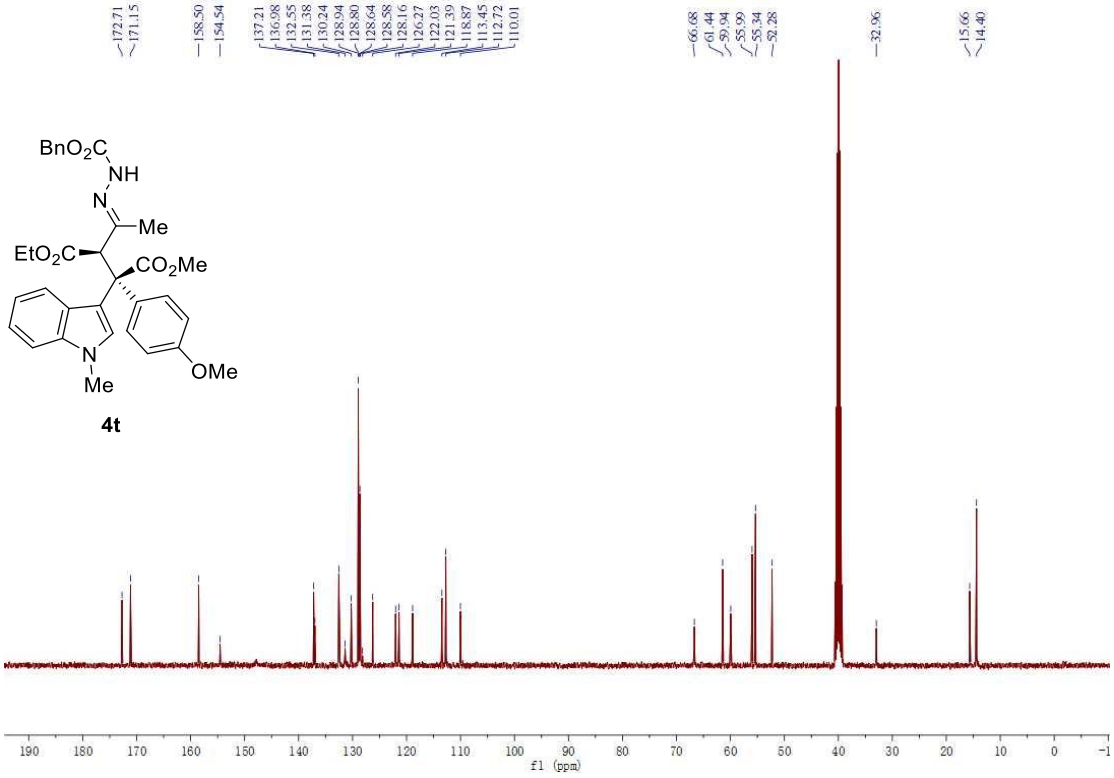

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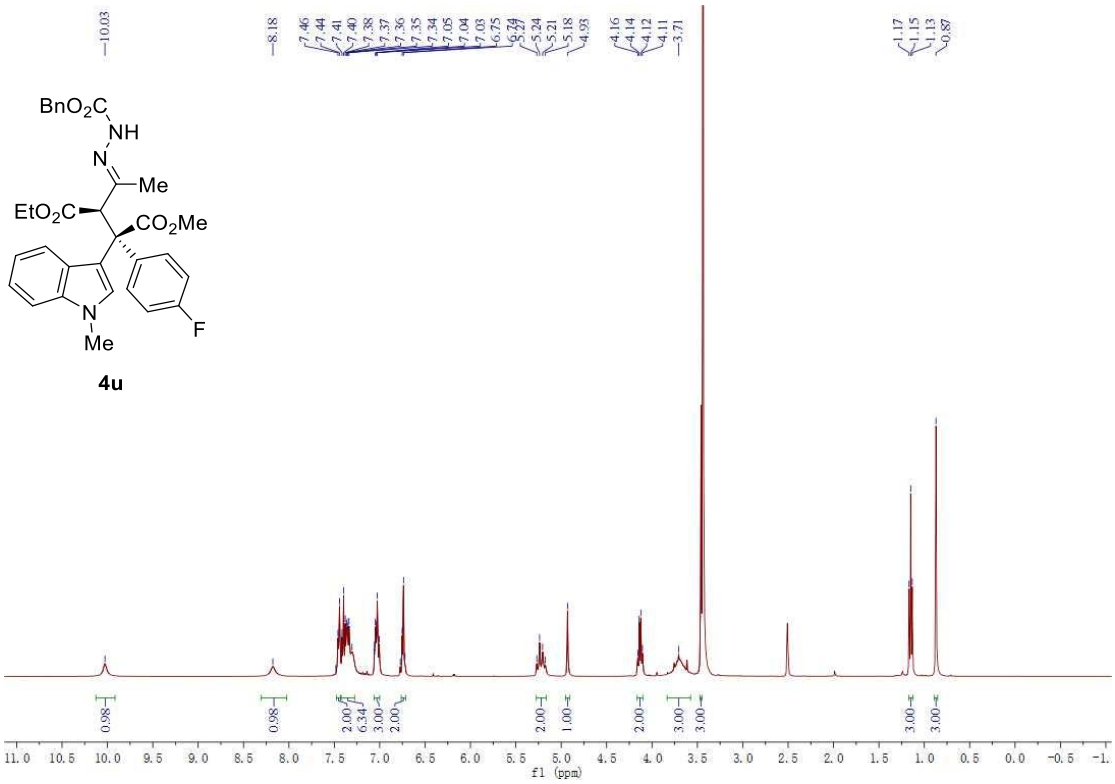

4u

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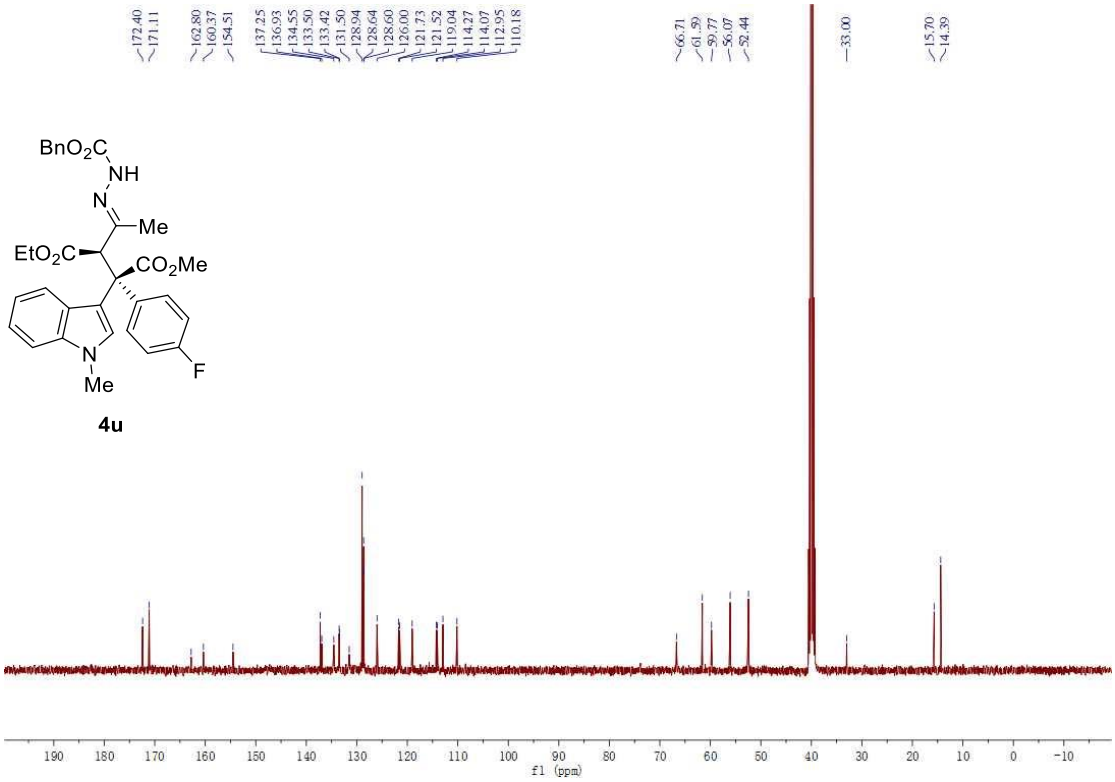

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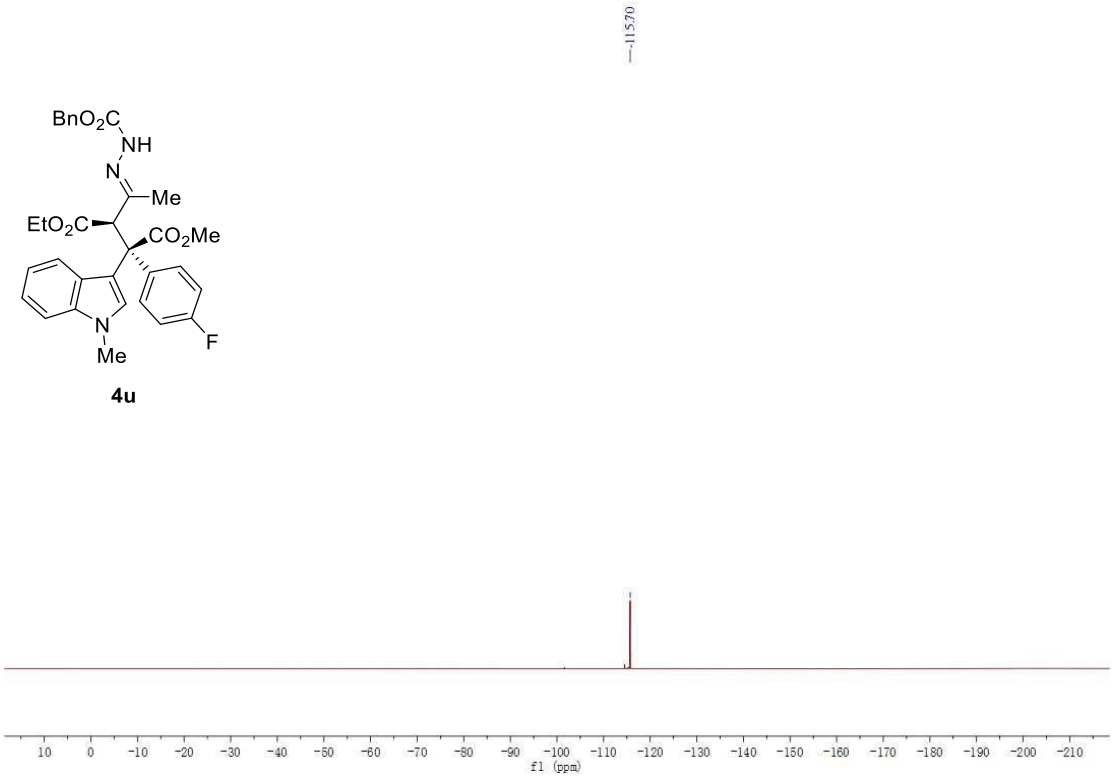

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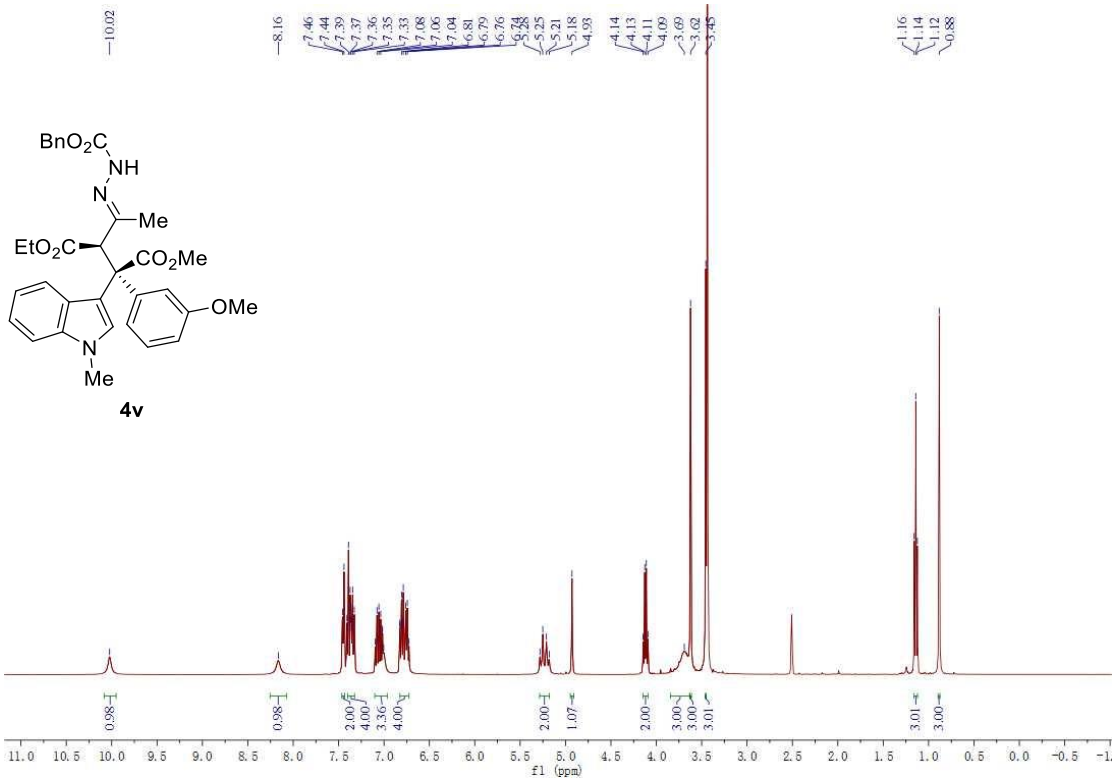

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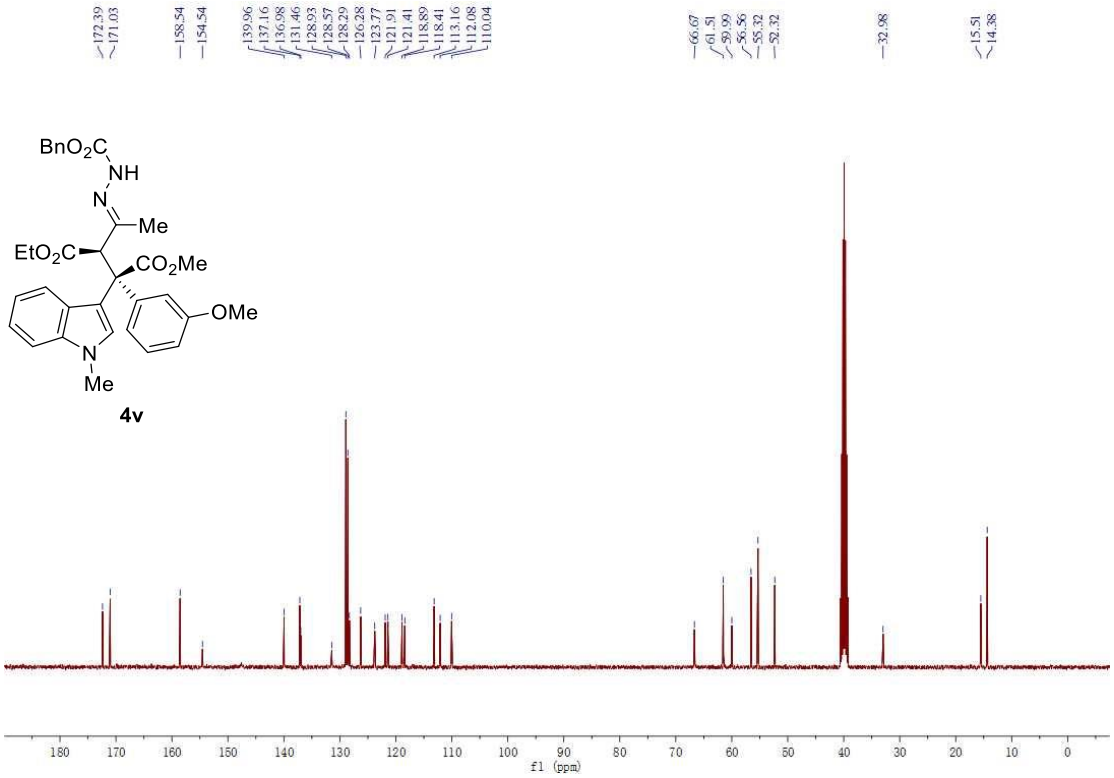

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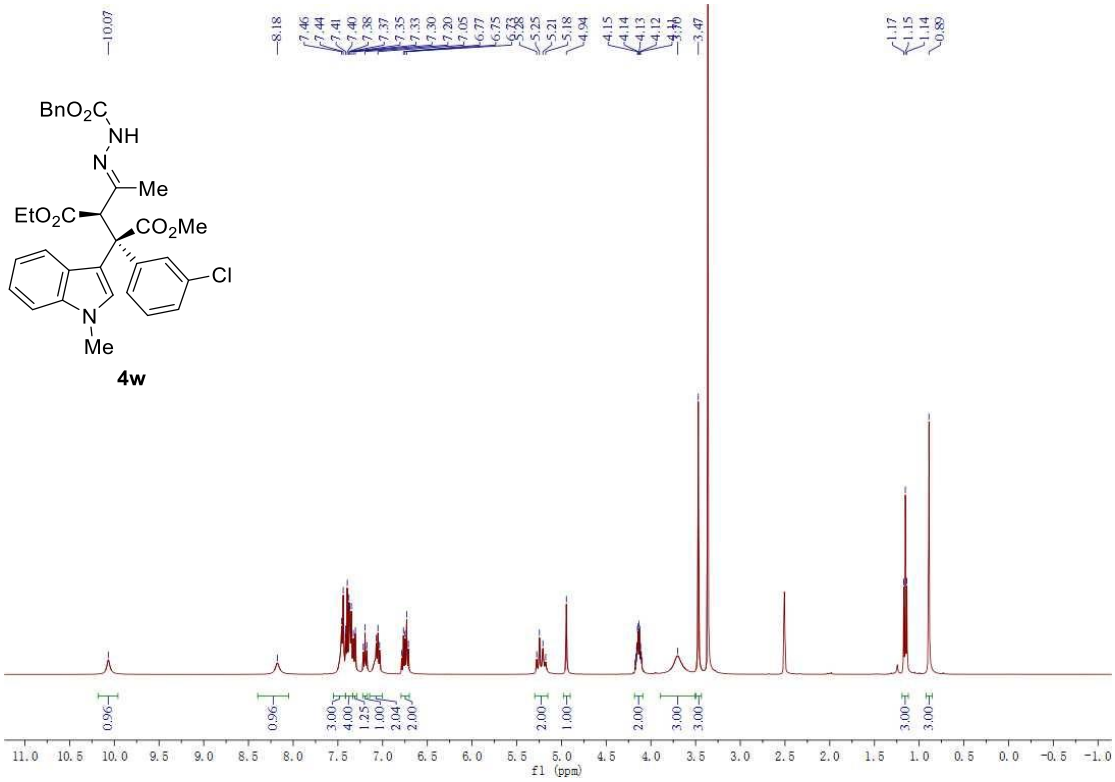

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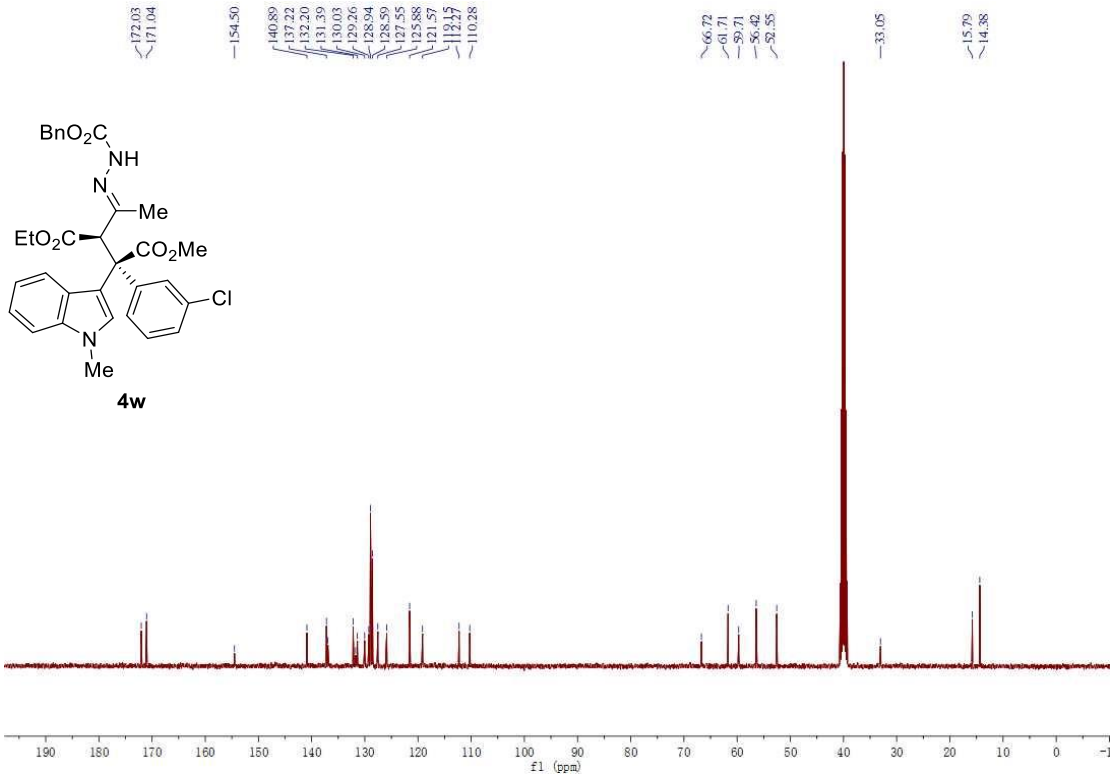

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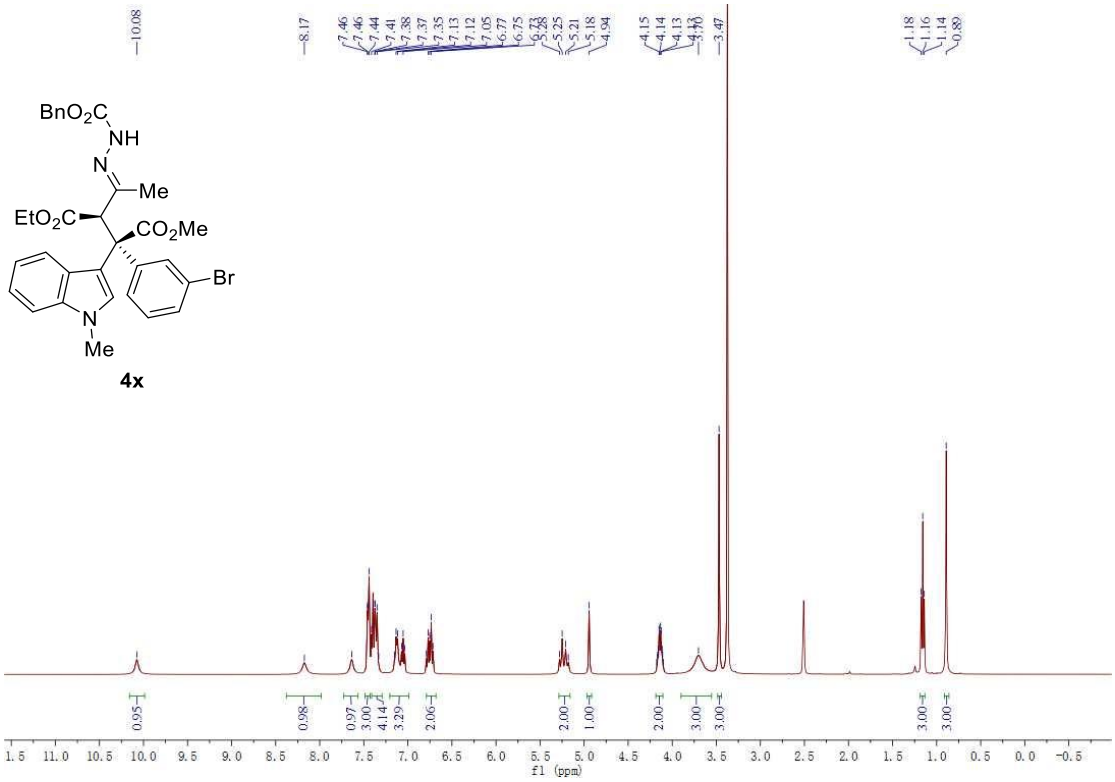
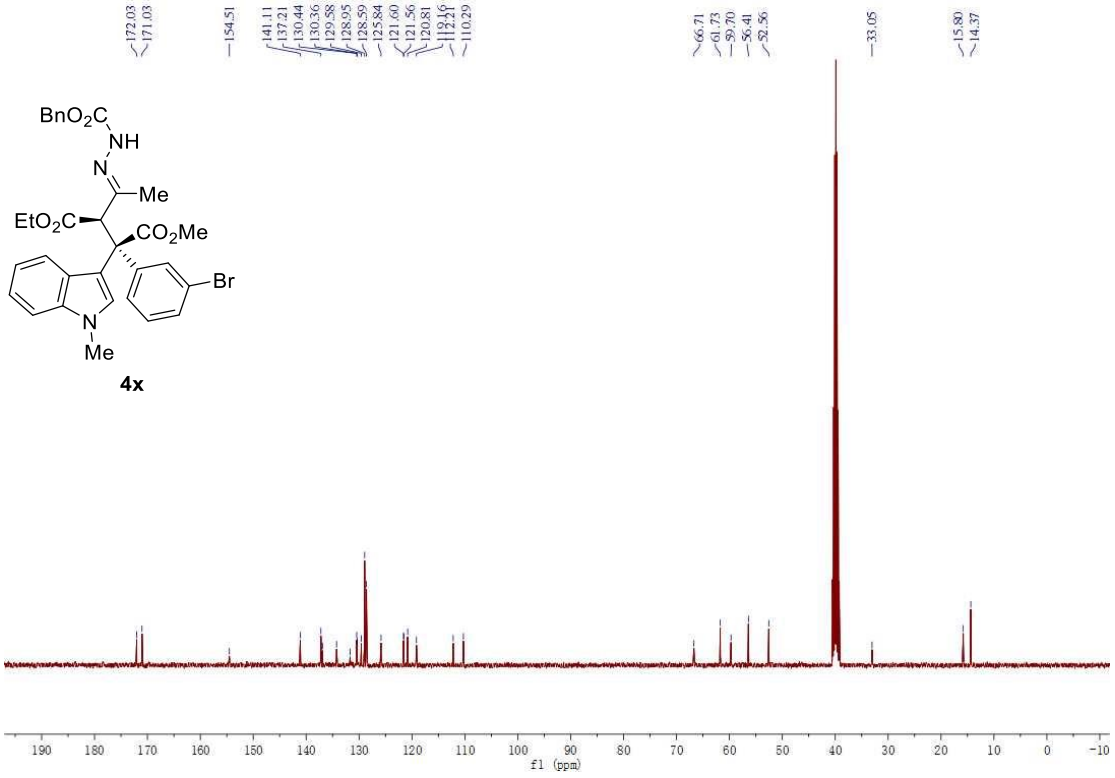
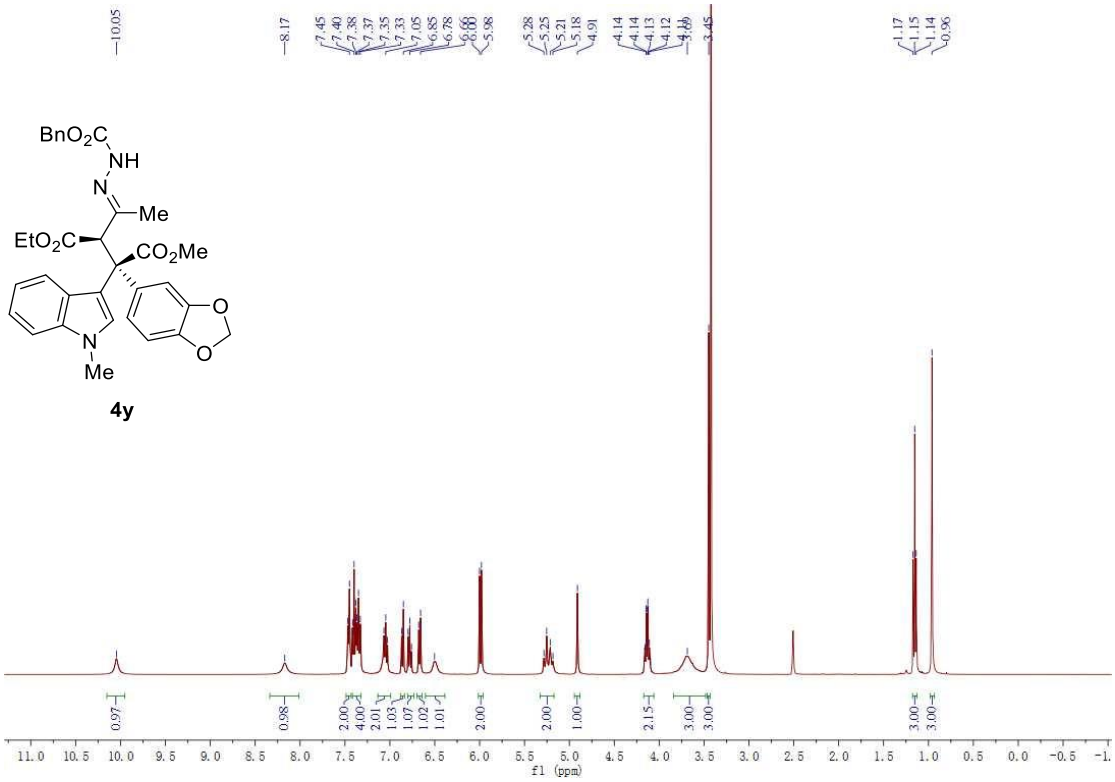


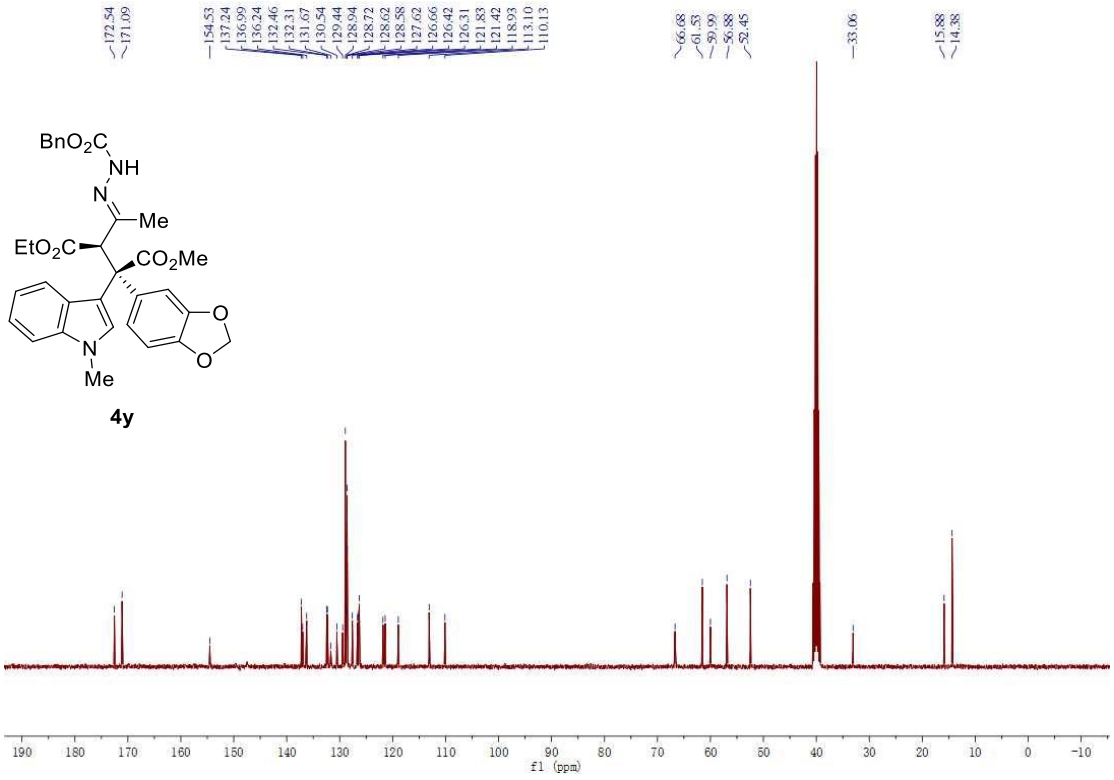
^{13}C NMR (101 MHz, DMSO-d_6)



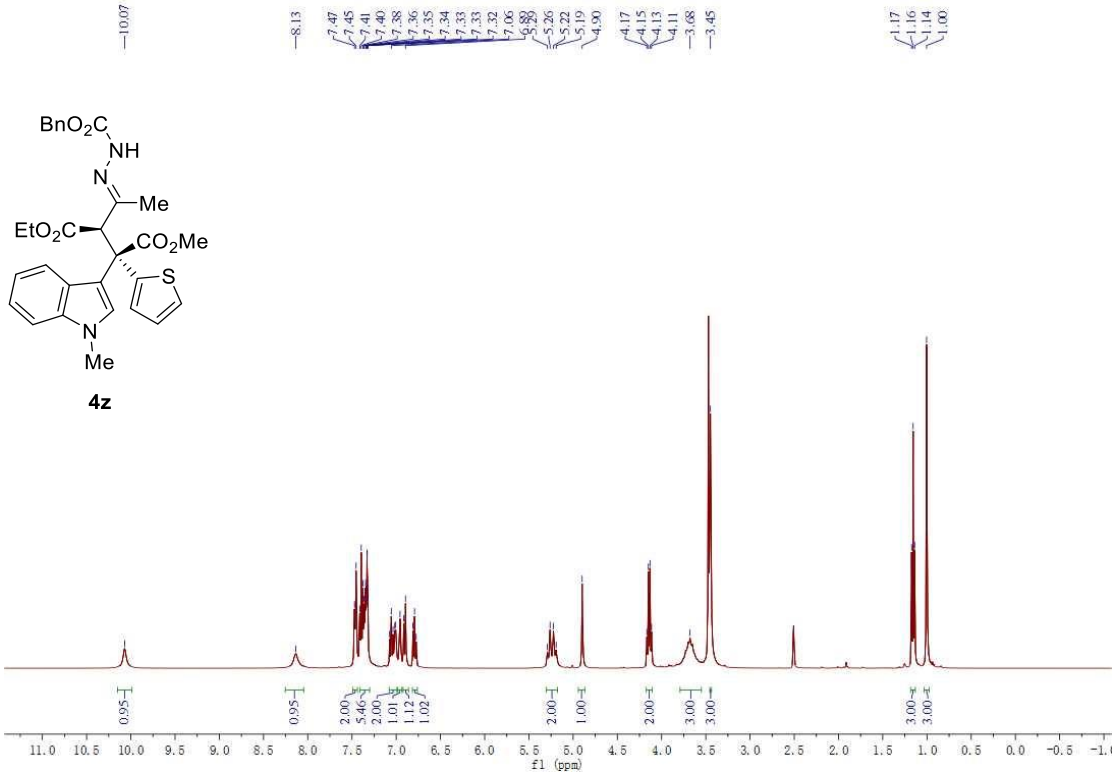
^{1}H NMR (400 MHz, DMSO-d_6)



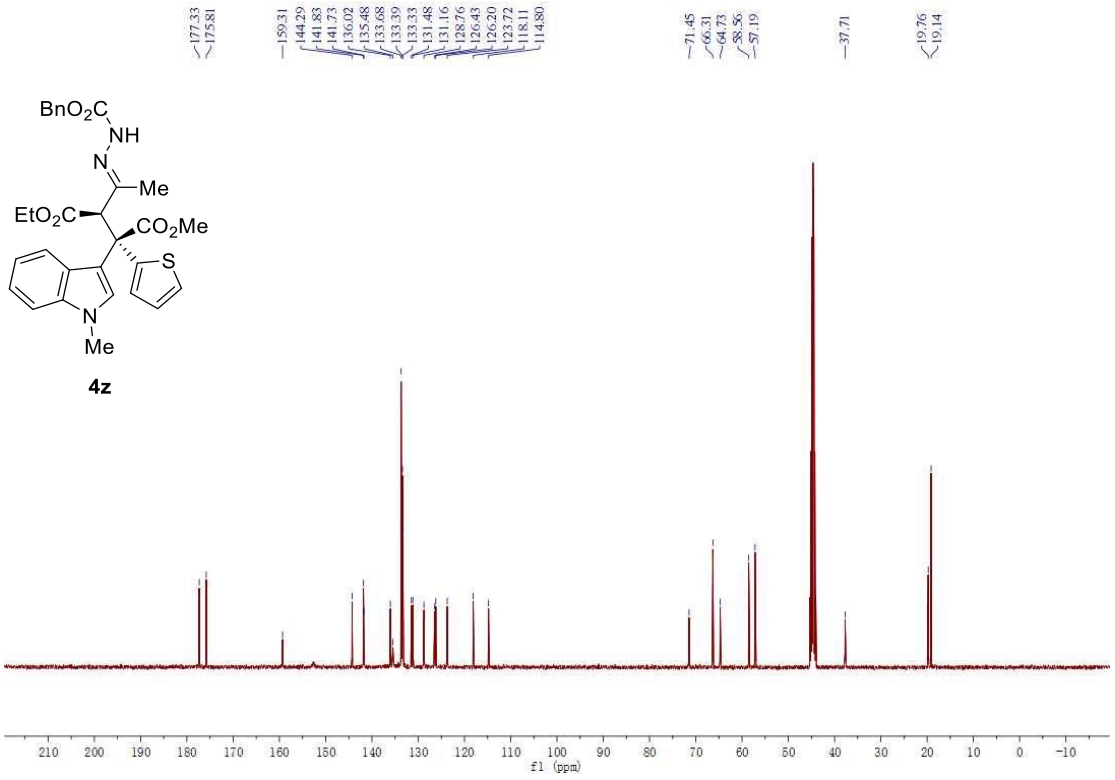
^{13}C NMR (101 MHz, DMSO-d_6)



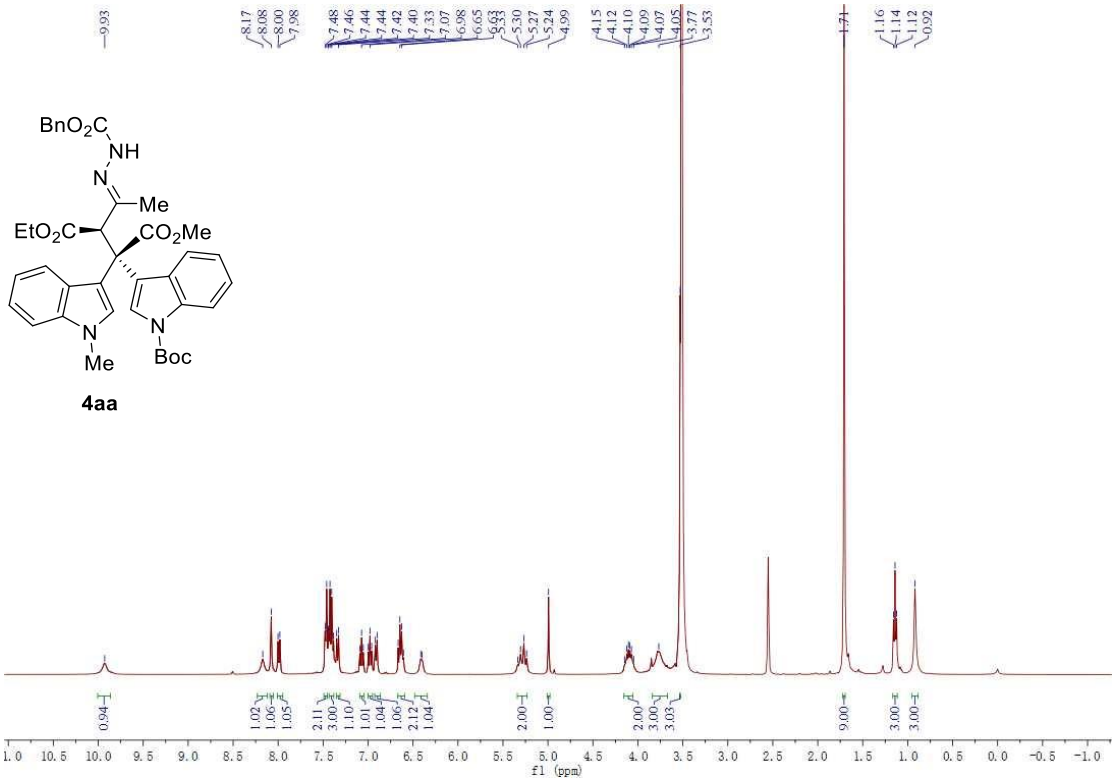
^{1}H NMR (400 MHz, DMSO-d_6)



^{13}C NMR (101 MHz, DMSO-d_6)

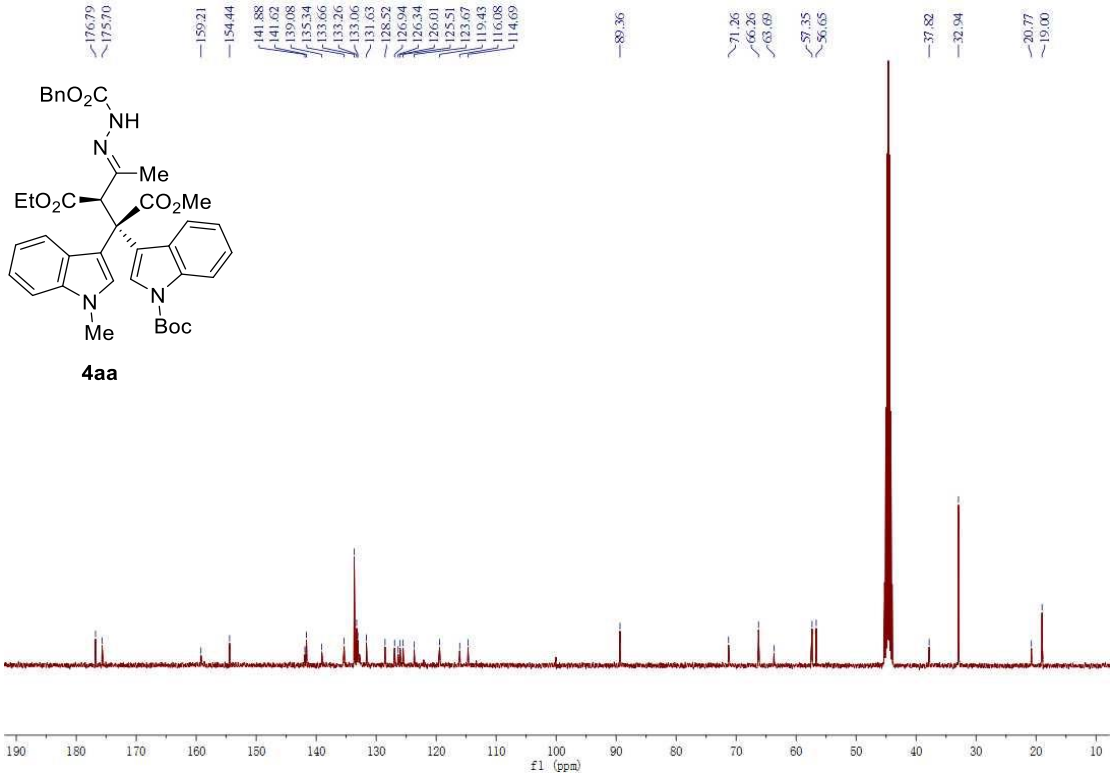


^{1}H NMR (400 MHz, DMSO-d_6)



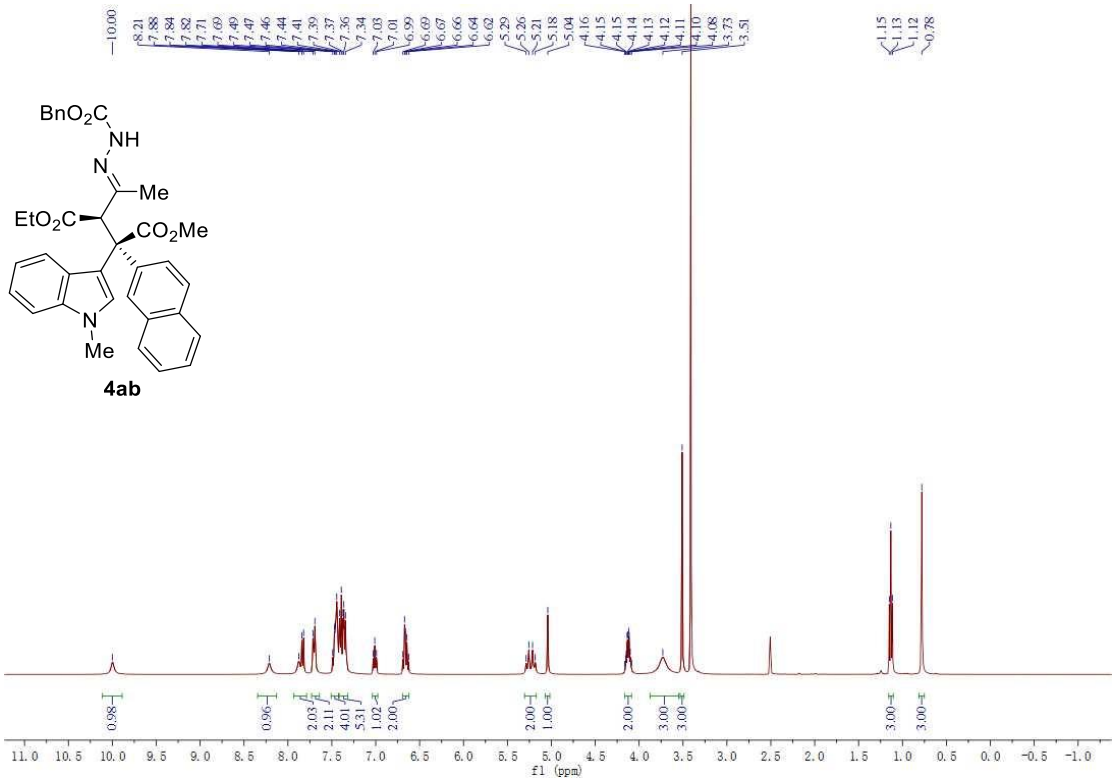
4aa

^{13}C NMR (101 MHz, DMSO-d_6)

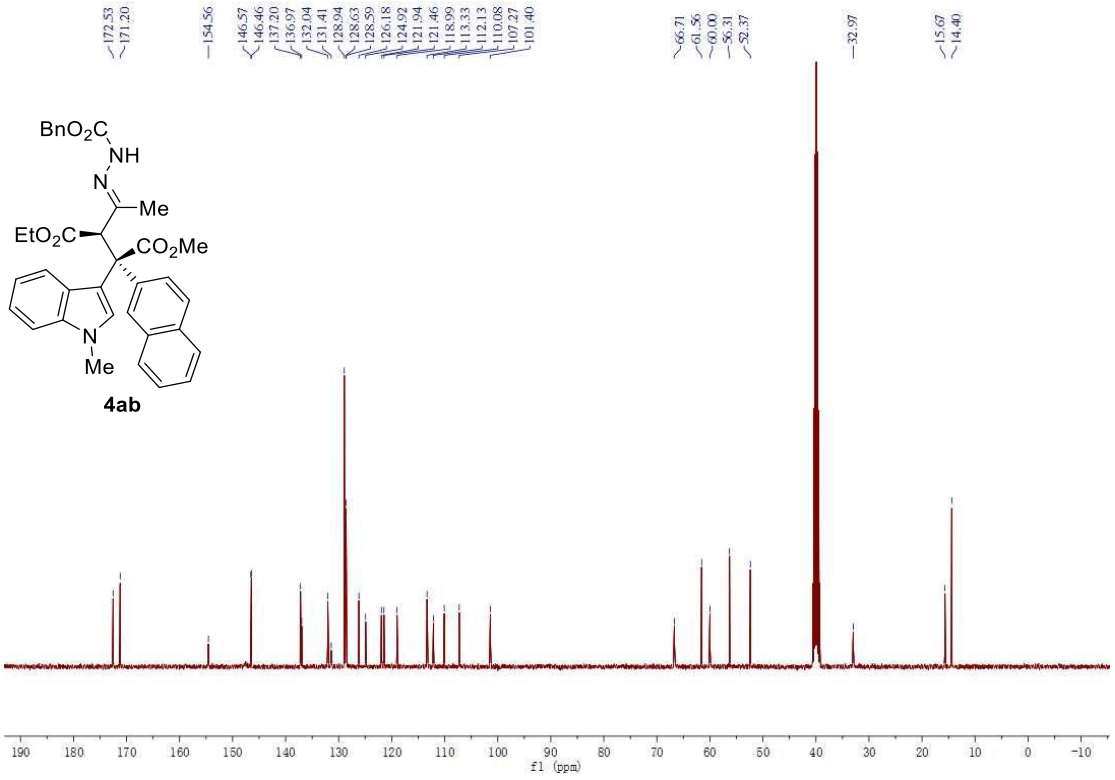


4aa

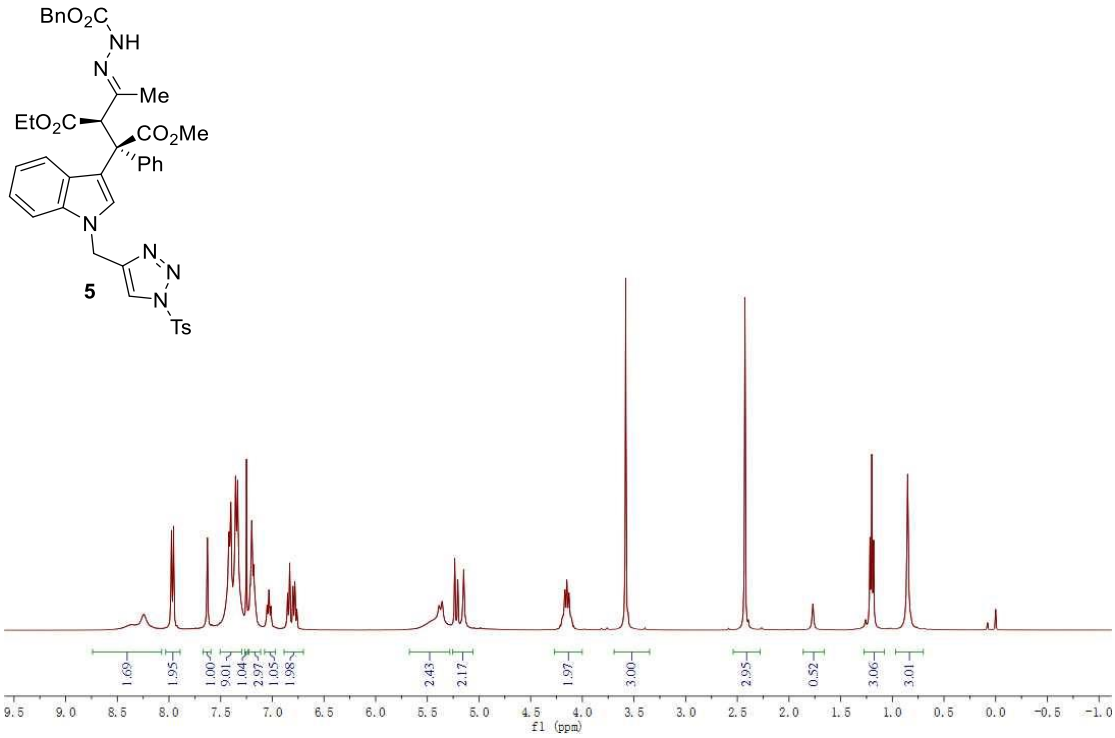
^{1}H NMR (400 MHz, DMSO-d_6)



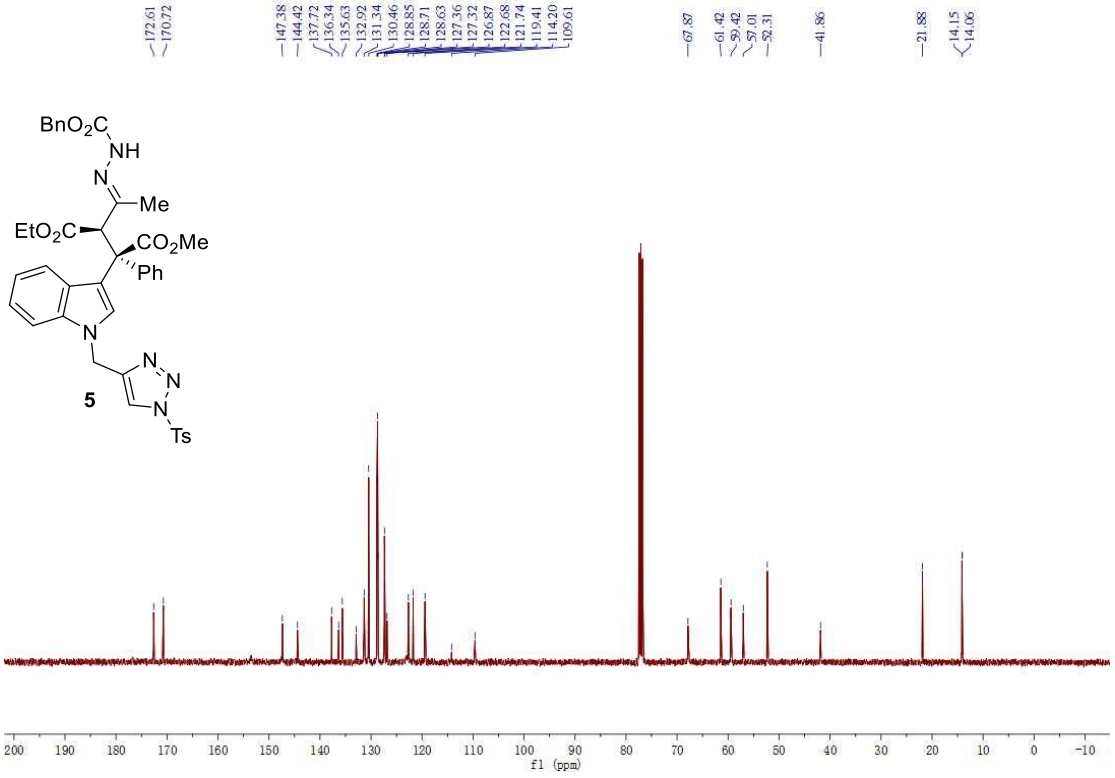
^{13}C NMR (101 MHz, DMSO-d_6)



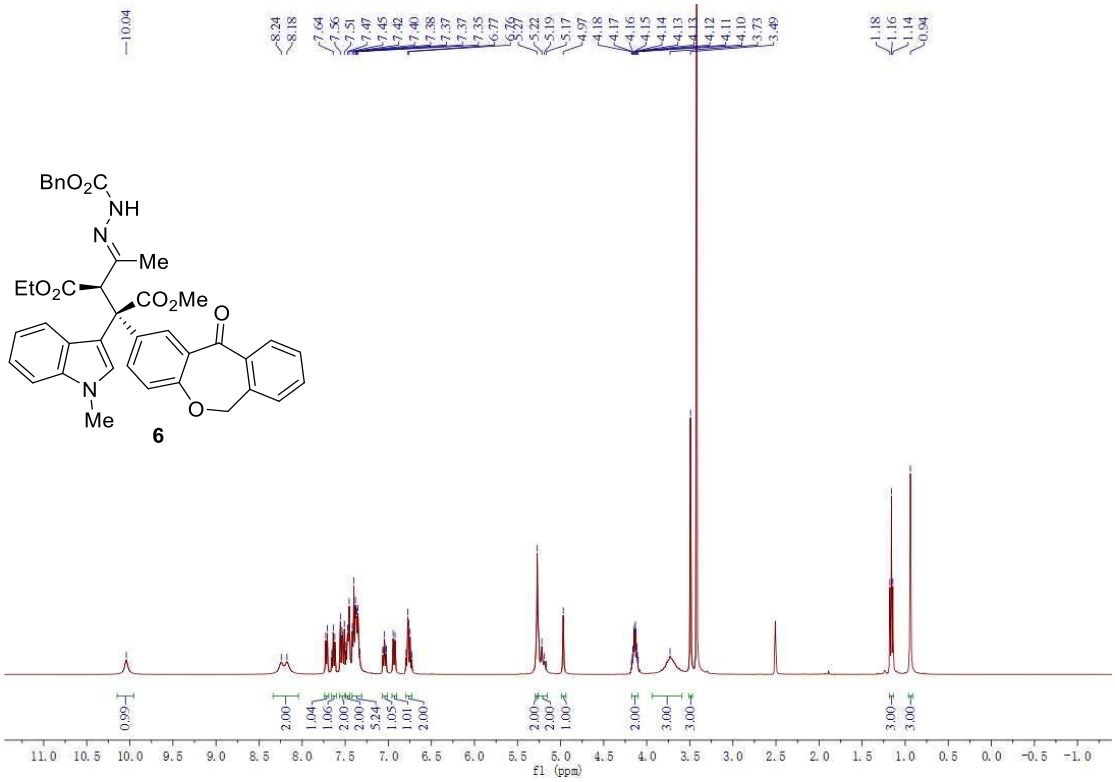
^{1}H NMR (400 MHz, $CDCl_3$)



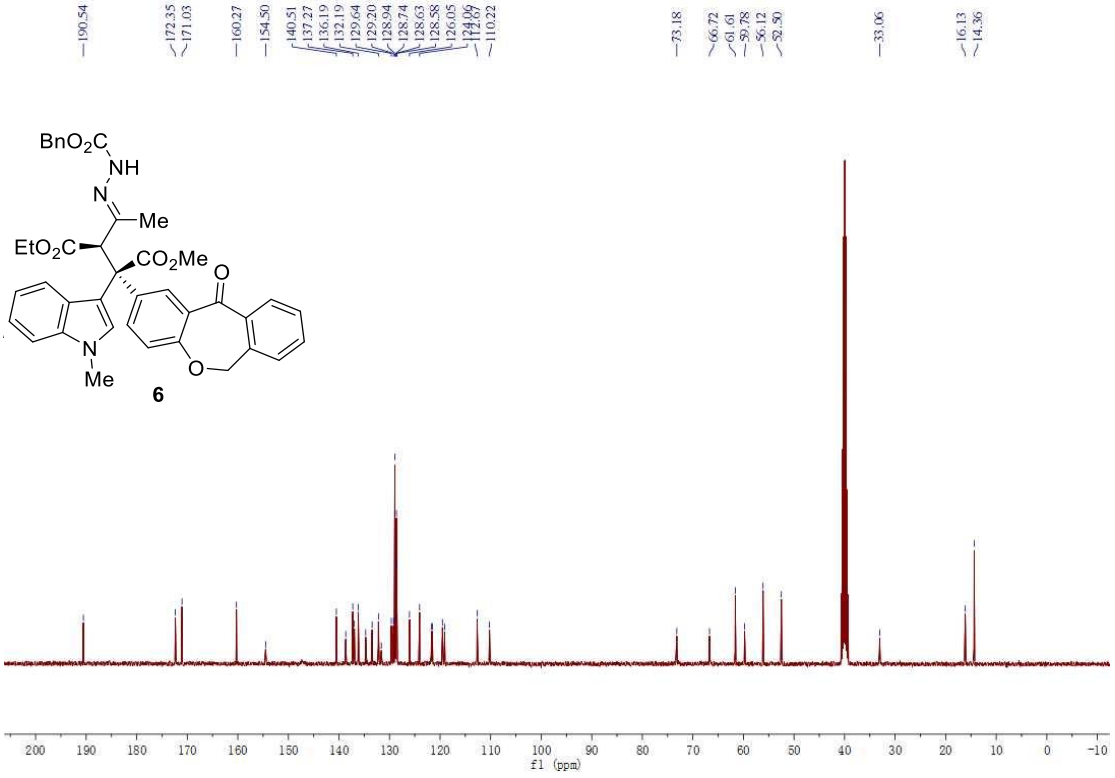
^{13}C NMR (101 MHz, $CDCl_3$)



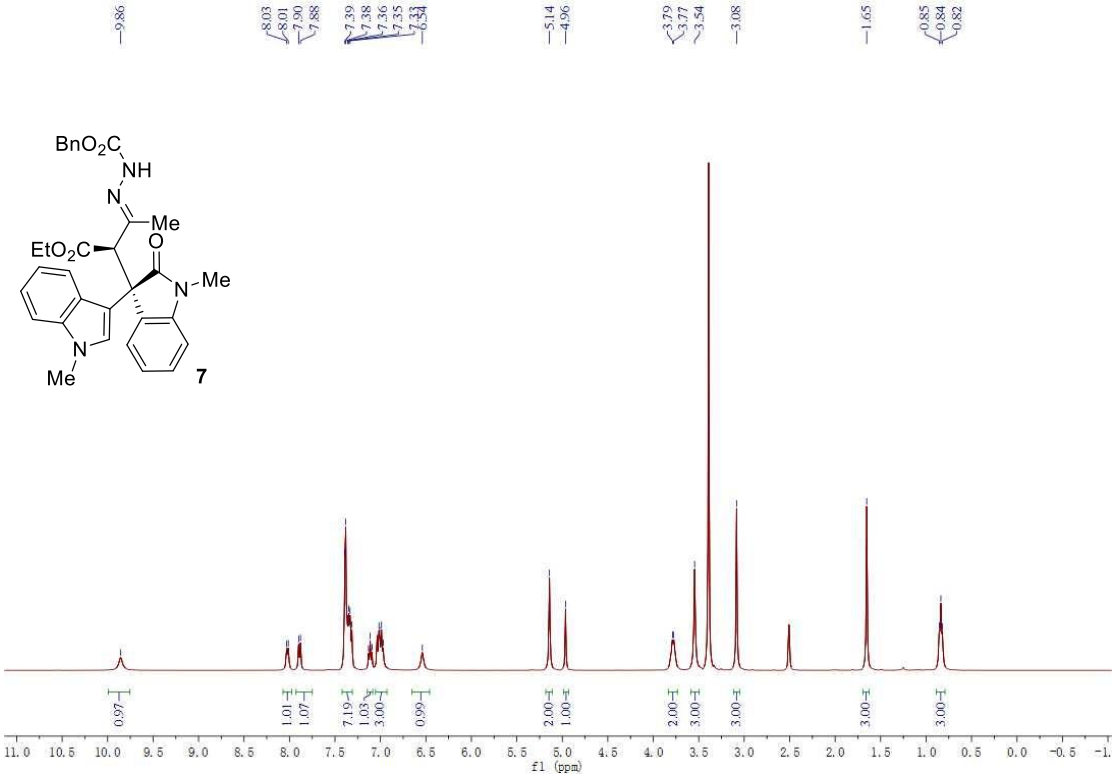
^{1}H NMR (400 MHz, DMSO-d_6)



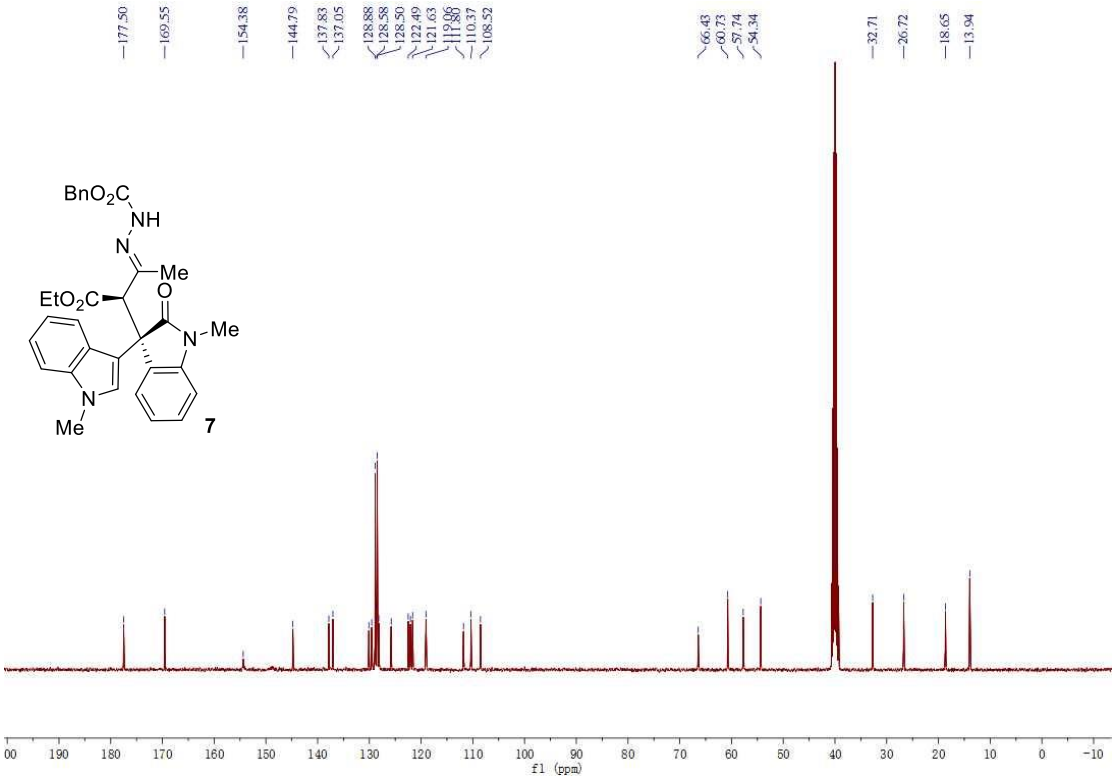
^{13}C NMR (101 MHz, DMSO-d_6)



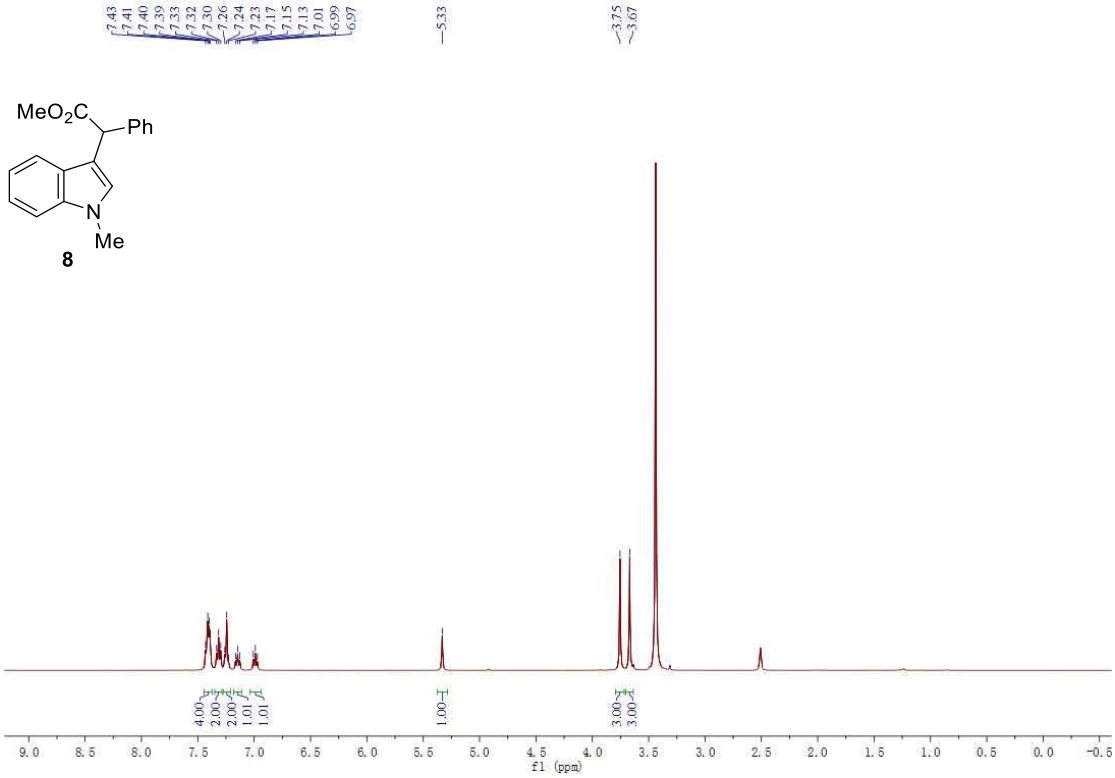
^{1}H NMR (400 MHz, DMSO-d_6)



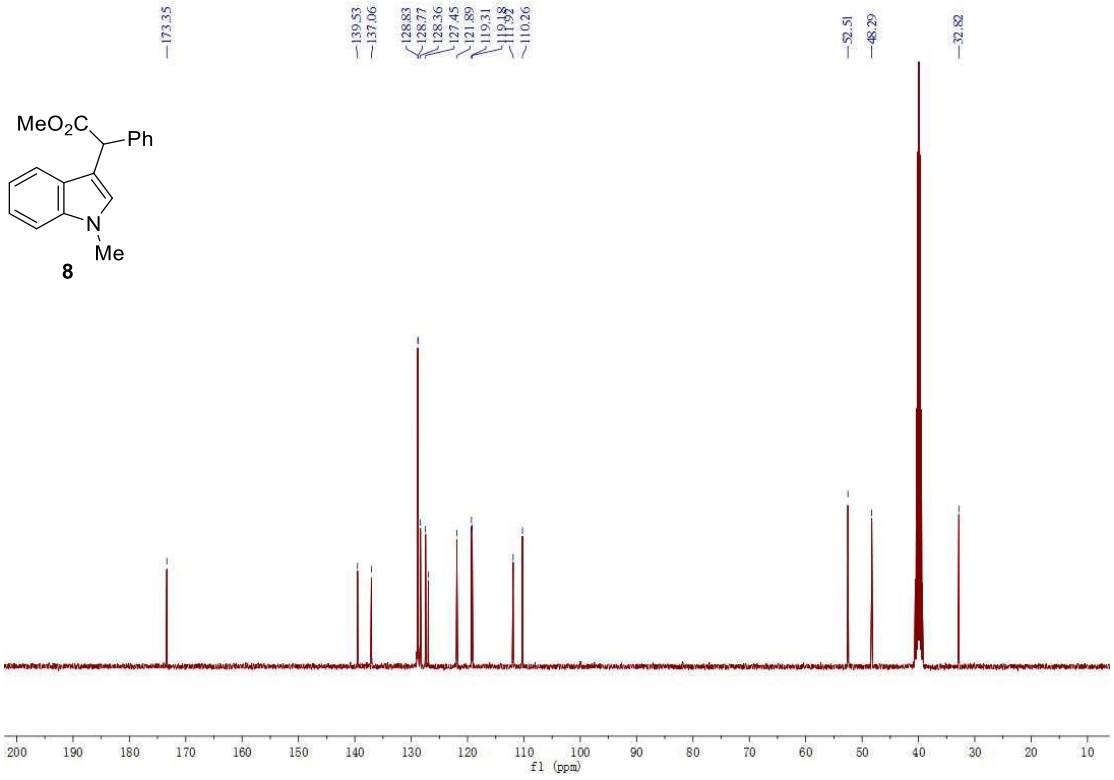
^{13}C NMR (101 MHz, DMSO-d_6)



^{1}H NMR (400 MHz, DMSO-d_6)

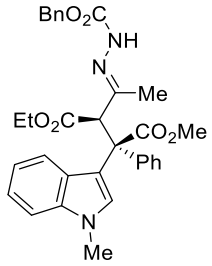


^{13}C NMR (101 MHz, DMSO-d_6)

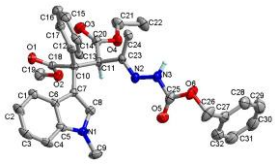


Single-crystal X-ray diffraction of 4a (CCDC: 2310471)

X-ray analysis was carried out using the single crystal which was grown in Hexane/isobutanol. The instrumentation used for the crystal measurement is Oxford Gemini E X-ray single-crystal diffractometer (ellipsoid contour at 30% probability level).



4a



X-ray of **4a**
CCDC (2310471)

checkCIF/PLATON report

Structure factors have been supplied for datablock(s) 202311315

THIS REPORT IS FOR GUIDANCE ONLY. IF USED AS PART OF A REVIEW PROCEDURE FOR PUBLICATION, IT SHOULD NOT REPLACE THE EXPERTISE OF AN EXPERIENCED CRYSTALLOGRAPHIC REFEREE.

No syntax errors found. CIF dictionary Interpreting this report

Datablock: 202311315

Bond precision: C-C = 0.0066 A Wavelength=1.54184

Cell: a=8.75449(18) b=16.6482(4) c=19.5357(4)
alpha=90 beta=90 gamma=90
Temperature: 293 K

	Calculated	Reported
Volume	2847.26(11)	2847.27(11)
Space group	P 21 21 21	P 21 21 21
Hall group	P 2ac 2ab	P 2ac 2ab
Moiety formula	C32 H33 N3 O6	C32 H33 N3 O6
Sum formula	C32 H33 N3 O6	C32 H33 N3 O6
Mr	555.61	555.61
Dx,g cm-3	1.296	1.296
Z	4	4
Mu (mm-1)	0.736	0.736
F000	1176.0	1176.0
F000'	1179.68	
h,k,lmax		10,20,23
Nref		5327
Tmin,Tmax	0.899,0.929	0.730,1.000
Tmin'	0.889	

Correction method= # Reported T Limits: Tmin=0.730 Tmax=1.000
AbsCorr = MULTI-SCAN

Data completeness= Theta(max)= 70.539

R(reflections)= 0.0601(4576) wR2(reflections)= 0.1723(5327)

S = 1.041 Npar= 366

The following ALERTS were generated. Each ALERT has the format
test-name_ALERT_alert-type_alert-level.
Click on the hyperlinks for more details of the test.

Alert level C

```
PLAT220_ALERT_2_C NonSolvent   Resd 1  C   Ueq(max)/Ueq(min) Range        3.1 Ratio
PLAT241_ALERT_2_C High   'MainMol' Ueq as Compared to Neighbors of        C26 Check
PLAT242_ALERT_2_C Low    'MainMol' Ueq as Compared to Neighbors of        C27 Check
PLAT245_ALERT_2_C U(iso) H3A       Smaller than U(eq) N3        by       0.019 Ang**2
PLAT340_ALERT_3_C Low Bond Precision on  C-C Bonds ...............     0.00655 Ang.
PLAT420_ALERT_2_C D-H Bond Without Acceptor  N3       --H3A      .      Please Check
```

Alert level G

```
PLAT003_ALERT_2_G Number of Uiso or Uij Restrained non-H Atoms ...          2 Report
PLAT177_ALERT_4_G The CIF-Embedded .res File Contains DELU Records          1 Report
PLAT186_ALERT_4_G The CIF-Embedded .res File Contains ISOR Records          1 Report
PLAT192_ALERT_3_G A Non-default DELU Restraint Value for First Par     0.0010 Report
PLAT192_ALERT_3_G A Non-default DELU Restraint Value for SecondPar     0.0010 Report
PLAT199_ALERT_1_G Reported _cell_measurement_temperature ..... (K)        293 Check
PLAT200_ALERT_1_G Reported   _diffrn_ambient_temperature ..... (K)        293 Check
PLAT860_ALERT_3_G Number of Least-Squares Restraints .............         13 Note
PLAT912_ALERT_4_G Missing # of FCF Reflections Above STh/L=  0.600         32 Note
PLAT941_ALERT_3_G Average HKL Measurement Multiplicity ...........        3.8 Low
PLAT978_ALERT_2_G Number C-C Bonds with Positive Residual Density.          2 Info
```

```
  0 ALERT level A = Most likely a serious problem - resolve or explain
  0 ALERT level B = A potentially serious problem, consider carefully
  6 ALERT level C = Check. Ensure it is not caused by an omission or oversight
 11 ALERT level G = General information/check it is not something unexpected

  2 ALERT type 1 CIF construction/syntax error, inconsistent or missing data
  7 ALERT type 2 Indicator that the structure model may be wrong or deficient
  5 ALERT type 3 Indicator that the structure quality may be low
  3 ALERT type 4 Improvement, methodology, query or suggestion
  0 ALERT type 5 Informative message, check
```

It is advisable to attempt to resolve as many as possible of the alerts in all categories. Often the minor alerts point to easily fixed oversights, errors and omissions in your CIF or refinement strategy, so attention to these fine details can be worthwhile. In order to resolve some of the more serious problems it may be necessary to carry out additional measurements or structure refinements. However, the purpose of your study may justify the reported deviations and the more serious of these should normally be commented upon in the discussion or experimental section of a paper or in the "special_details" fields of the CIF. checkCIF was carefully designed to identify outliers and unusual parameters, but every test has its limitations and alerts that are not important in a particular case may appear. Conversely, the absence of alerts does not guarantee there are no aspects of the results needing attention. It is up to the individual to critically assess their own results and, if necessary, seek expert advice.

Publication of your CIF in IUCr journals

A basic structural check has been run on your CIF. These basic checks will be run on all CIFs submitted for publication in IUCr journals (*Acta Crystallographica*, *Journal of Applied Crystallography*, *Journal of Synchrotron Radiation*); however, if you intend to submit to *Acta Crystallographica Section C* or *E* or *IUCrData*, you should make sure that full publication checks are run on the final version of your CIF prior to submission.

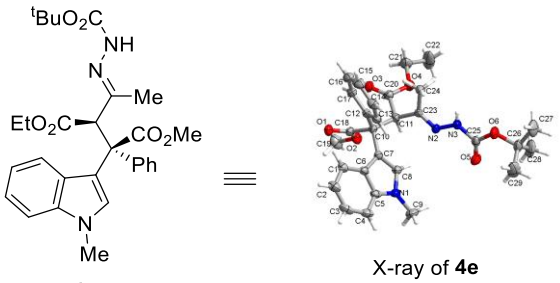
Publication of your CIF in other journals

Please refer to the *Notes for Authors* of the relevant journal for any special instructions relating to CIF submission.

PLATON version of 14/11/2023; check.def file version of 14/09/2023

Single-crystal X-ray diffraction of 4e (CCDC: 2310472)

X-ray analysis was carried out using the single crystal which was grown in Hexane/isobutanol. The instrumentation used for the crystal measurement is Oxford Gemini E X-ray single-crystal



diffractometer (ellipsoid contour at 30% probability level).

checkCIF/PLATON report

Structure factors have been supplied for datablock(s) 202311316

THIS REPORT IS FOR GUIDANCE ONLY. IF USED AS PART OF A REVIEW PROCEDURE FOR PUBLICATION, IT SHOULD NOT REPLACE THE EXPERTISE OF AN EXPERIENCED CRYSTALLOGRAPHIC REFEREE.

No syntax errors found. CIF dictionary Interpreting this report

Datablock: 202311316

Bond precision: C-C = 0.0061 A Wavelength=1.54184

Cell: a=12.7618(5) b=13.0621(6) c=13.4282(7)
alpha=113.796(5) beta=90.707(4) gamma=110.206(4)
Temperature: 293 K

	Calculated	Reported
Volume	1891.85(19)	1891.85(17)
Space group	P -1	P -1
Hall group	-P 1	-P 1
Moiety formula	C29 H35 N3 O6, 2(C H Cl3)	C29 H35 N3 O6, 2(C H Cl3)
Sum formula	C31 H37 Cl6 N3 O6	C31 H37 Cl6 N3 O6
Mr	760.34	760.33
Dx,g cm-3	1.335	1.335
Z	2	2
Mu (mm-1)	4.503	4.503
F000	788.0	788.0
F000'	794.24	
h,k,lmax		15,15,16
Nref		6667
Tmin,Tmax	0.520,0.637	0.712,1.000
Tmin'	0.443	

Correction method= # Reported T Limits: Tmin=0.712 Tmax=1.000
AbsCorr = MULTI-SCAN

Data completeness= Theta(max)= 67.078

R(reflections)= 0.0718(5111) wR2(reflections)= 0.2237(6667)

S = 1.073 Npar= 446

The following ALERTS were generated. Each ALERT has the format
test-name_ALERT_alert-type_alert-level.
Click on the hyperlinks for more details of the test.

Alert level C

```
PLAT220_ALERT_2_C NonSolvent   Resd 1  C   Ueq(max)/Ueq(min) Range         3.6 Ratio
PLAT222_ALERT_3_C NonSolvent Resd 1  H   Uiso(max)/Uiso(min) Range         4.5 Ratio
PLAT242_ALERT_2_C Low    'MainMol' Ueq as Compared to Neighbors of         C21 Check
PLAT242_ALERT_2_C Low    'MainMol' Ueq as Compared to Neighbors of         C26 Check
PLAT244_ALERT_4_C Low    'Solvent' Ueq as Compared to Neighbors of         C31 Check
PLAT260_ALERT_2_C Large Average Ueq of Residue Including      Cl1A       0.104 Check
PLAT260_ALERT_2_C Large Average Ueq of Residue Including       C14       0.159 Check
PLAT340_ALERT_3_C Low Bond Precision on  C-C Bonds ...............     0.00608 Ang.
PLAT420_ALERT_2_C D-H Bond Without Acceptor  N3       --H3       .      Please Check
PLAT906_ALERT_3_C Large K Value in the Analysis of Variance ......       3.238 Check
PLAT911_ALERT_3_C Missing FCF Refl Between Thmin & STh/L=    0.597          80 Report
               13-12  2,  -8 13  2,  13-12  3,  -7 12  3,   2 -4  4,  -6 10  4,
               -7 11  4,  -6 11  4,  -5 11  4,  -8 12  4,  -7 12  4,  -6 12  4,
               -5 12  4,  -3 12  4,   2-15  5, -14  6  5,  -7 10  5,  -6 10  5,
               -5 10  5,  -4 10  5,  -8 11  5,  -7 11  5,  -6 11  5,   1-14  6,
                2-14  6,  -7  9  6,  -6  9  6,  -8 10  6,  -7 10  6,  -6 10  6,
               -5 10  6,  -4 10  6,   3-15  7,   4-15  7,   5-15  7,   3-14  7,
                4-14  7,   3-13  7,   4-13  7,   4-12  7,  -8  9  7,  -7  9  7,
               -6  9  7,  -6 10  7,   3-15  8,   4-15  8,   5-15  8,   6-15  8,
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                6-14  8,   2-13  8,   3-13  8,   4-13  8,   5-13  8,   3-12  8,
                4-12  8,  -7  9  8,  -6  9  8,   2-15  9,   3-15  9,   4-15  9,
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                5-14 10,   3-13 10,
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Alert level G

```
PLAT072_ALERT_2_G SHELXL First  Parameter in WGHT  Unusually Large        0.11 Report
PLAT152_ALERT_1_G The Supplied and Calc. Volume s.u. Differ by ...           2 Units
PLAT171_ALERT_4_G The CIF-Embedded .res File Contains EADP Records           6 Report
PLAT199_ALERT_1_G Reported _cell_measurement_temperature ..... (K)         293 Check
PLAT200_ALERT_1_G Reported   _diffrn_ambient_temperature ..... (K)         293 Check
PLAT231_ALERT_4_G Hirshfeld Test (Solvent)   Cl3A      --C30      .        5.7 s.u.
PLAT231_ALERT_4_G Hirshfeld Test (Solvent)   Cl4A      --C31      .       20.7 s.u.
PLAT231_ALERT_4_G Hirshfeld Test (Solvent)   Cl5       --C31      .        6.5 s.u.
PLAT302_ALERT_4_G Anion/Solvent/Minor-Residue Disorder (Resd  2  )          75% Note
PLAT302_ALERT_4_G Anion/Solvent/Minor-Residue Disorder (Resd  3  )          75% Note
PLAT432_ALERT_2_G Short Inter X...Y Contact  Cl5A      ..C5       .        3.23 Ang.
                                                 1-x,-y,1-z  =      2_656 Check
PLAT779_ALERT_4_G Suspect or Irrelevant (Bond) Angle(s) in CIF ...       44.50 Deg.
              C30  -CL1  -CL2     1_555   1_555   1_555 ......     #  131 Check
PLAT909_ALERT_3_G Percentage of I>2sig(I) Data at Theta(Max) Still          56% Note
PLAT933_ALERT_2_G Number of HKL-OMIT Records in Embedded .res File           1 Note
                2 -4  4,
PLAT941_ALERT_3_G Average HKL Measurement Multiplicity ...........          4.0 Low
PLAT978_ALERT_2_G Number C-C Bonds with Positive Residual Density.           2 Info
```

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```
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```

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PLATON version of 14/11/2023; check.def file version of 14/09/2023