

# Supporting Information

## AQUEOUS SYNTHESIS OF (R\*, R\*)-BIS (SPIROPYRAZOLONE)- CYCLOPROPANES THROUGH IODINE-PROMOTED CYCLIZATION OF ALDEHYDES AND PYRAZOLIN-5-ONES

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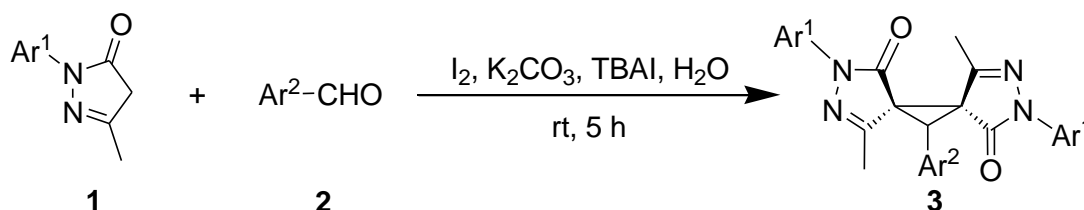
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## 1. General Information

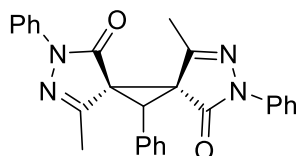
All reagents were obtained from commercial sources and used without further purification. NMR spectra were recorded on a 500 MHz NMR spectrometer (500 MHz for  $^1\text{H}$  NMR and 125 MHz for  $^{13}\text{C}$  NMR).  $^1\text{H}$  NMR chemical shifts were determined relative to internal TMS at  $\delta$  0.0 ppm.  $^{13}\text{C}$  NMR chemical shifts were determined relative to  $\text{CDCl}_3$  at  $\delta$  77.16 ppm. Data for  $^1\text{H}$  NMR and  $^{13}\text{C}$  NMR are reported as follows: chemical shift ( $\delta$ , ppm) and multiplicity (s = singlet, d = doublet, t = triplet and m = multiplet). All melting points were determined on a XT-4 binocular microscope melting point apparatus. High-resolution mass spectra (HRMS) were measured with ESI-TOF in the positive mode.

## 2. Procedure for the Synthesis of 3



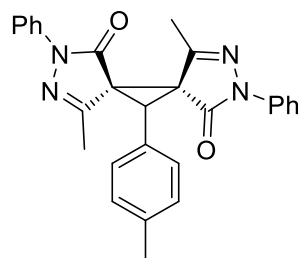
In a 25 mL of glass tube, a mixture containing pyrazolone **1** (1.0 mmol), benzaldehyde **2** (0.5 mmol),  $\text{I}_2$  (152.3 mg, 0.6 mmol),  $\text{K}_2\text{CO}_3$  (69.0 mg, 0.5 mmol), TBAI (73.8 mg, 0.2 mmol), and deionized water (8 mL) was vigorously stirred under air atmosphere at room temperature for 5 hours. After completion of the reaction (monitored by TLC), the reaction mixture was washed with aqueous  $\text{Na}_2\text{S}_2\text{O}_3$  (5 wt%). The resulted solid was filtered, washed with water followed by an ice-cold ethanol/water solution (v/v 1:2), and dried to afford the corresponding product bispyrazolone cyclopropane **3**, which can be directly used for NMR analysis. Samples for melting point determination were obtained by recrystallization from ethanol.

## 3. Characterization Data for 3

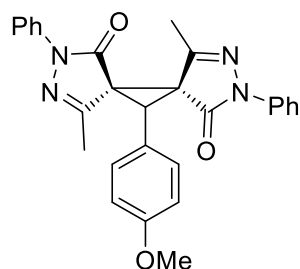


**(5R\*,6R\*)-4,10-Dimethyl-2,8,11-triphenyl-2,3,8,9-tetraazadispiro[4.0.4.1]undeca-3,9-diene-1,7-dione (3a)**. White solid, 94% yield, mp 166–168 °C (Lit. [1] 166–168 °C);  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.93 (d,  $J = 8.0$  Hz, 2H), 7.88 (d,  $J = 8.0$  Hz, 2H), 7.44 (t,  $J = 7.9$  Hz, 2H), 7.42–7.35 (m, 5H), 7.25–7.17 (m, 4H), 4.45 (s, 1H), 2.53 (s, 3H), 2.08 (s, 3H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  167.8, 165.6, 156.1, 155.4, 138.0,

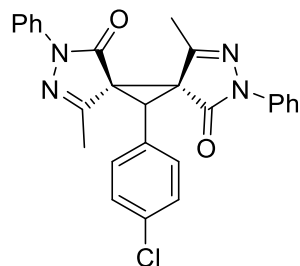
137.9, 130.0 (2C), 129.1 (2C), 129.0 (2C), 128.9, 128.7 (2C), 128.1, 125.7, 125.6, 119.1 (4C), 51.4, 50.4, 43.2, 20.4, 18.5.



**(5R\*,6R\*)-4,10-Dimethyl-2,8-diphenyl-11-(*p*-tolyl)-2,3,8,9-tetraazadispiro[4.0.4.1]undeca-3,9-diene-1,7-dione (3b).** Light yellow solid, 90% yield, mp 145–146 °C (Lit. [2] 146–147 °C); <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.93 (d, *J* = 8.6 Hz, 2H), 7.89 (d, *J* = 8.6 Hz, 2H), 7.43 (t, *J* = 8.0 Hz, 2H), 7.39 (t, *J* = 8.0 Hz, 2H), 7.25–7.19 (m, 2H), 7.17 (d, *J* = 7.7 Hz, 2H), 7.07 (d, *J* = 7.9 Hz, 2H), 4.41 (s, 1H), 2.52 (s, 3H), 2.36 (s, 3H), 2.09 (s, 3H); <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) δ 167.8, 165.7, 156.1, 155.5, 138.7, 138.0, 137.9, 129.9 (2C), 129.4 (2C), 129.1 (2C), 129.0 (2C), 125.6, 125.5, 124.9, 119.1 (2C), 119.0 (2C), 51.5, 50.4, 43.2, 21.4, 20.4, 18.5.

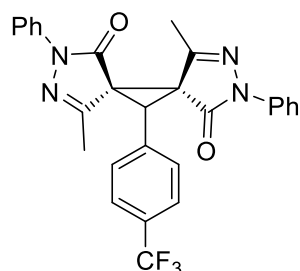


**(5R\*,6R\*)-11-(4-Methoxyphenyl)-4,10-dimethyl-2,8-diphenyl-2,3,8,9-tetraazadispiro[4.0.4.1]undeca-3,9-diene-1,7-dione (3c).** Yellow solid, 87% yield, mp 164–166 °C (Lit. [2] 164–166 °C); <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.92 (d, *J* = 7.8 Hz, 2H), 7.89 (d, *J* = 7.8 Hz, 2H), 7.43 (t, *J* = 7.8 Hz, 2H), 7.40 (t, *J* = 8.4 Hz, 2H), 7.24–7.17 (m, 2H), 7.11 (d, *J* = 8.4 Hz, 2H), 6.89 (d, *J* = 8.7 Hz, 2H), 4.39 (s, 1H), 3.80 (s, 3H), 2.52 (s, 3H), 2.09 (s, 3H); <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) δ 167.8, 165.7, 159.8, 156.2, 155.4, 138.0, 137.9, 131.2 (2C), 129.1 (2C), 129.0 (2C), 125.6, 125.5, 119.8, 119.1 (4C), 114.1 (2C), 55.4, 51.6, 50.5, 42.8, 20.4, 18.5.

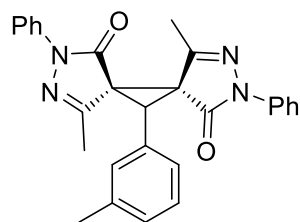


**(5R\*,6R\*)-11-(4-Chlorophenyl)-4,10-dimethyl-2,8-diphenyl-2,3,8,9-tetraazadispiro[4.0.4.1]undeca-3,9-diene-1,7-dione (3d).** Light yellow solid, 96% yield, mp 143–144 °C; <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.91 (d, *J* = 8.2 Hz, 2H), 7.87 (d, *J* = 8.2 Hz, 2H), 7.44 (t, *J* = 7.9 Hz, 2H), 7.40 (t, *J* = 8.2 Hz, 2H), 7.36 (d, *J* = 8.2 Hz, 2H), 7.26–7.19 (m, 2H), 7.14 (d, *J* = 8.1 Hz, 2H), 4.37 (s, 1H), 2.52 (s, 3H), 2.09 (s, 3H);

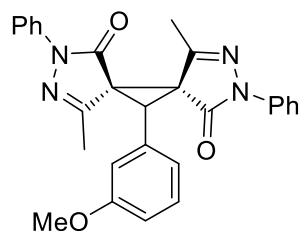
$^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  167.6, 165.5, 155.9, 154.9, 137.84, 137.77, 134.9, 131.4 (2C), 129.14 (2C), 129.07 (2C), 129.0 (2C), 126.7, 125.8, 125.7, 119.09 (2C), 119.07 (2C), 51.2, 50.1, 42.3, 20.4, 18.5; HRMS (ESI-TOF) calcd for  $\text{C}_{27}\text{H}_{22}^{35}\text{ClN}_4\text{O}_2$   $[\text{M} + \text{H}]^+$  469.1431, found 469.1440.



**(5R\*,6R\*)-4,10-Dimethyl-2,8-diphenyl-11-(4-(trifluoromethyl)phenyl)-2,3,8,9-tetraazadispiro[4.0.4.1]undeca-3,9-diene-1,7-dione (3e).** White solid, 95% yield, mp 154–156 °C (Lit. [3] 154–156 °C);  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.93 (d,  $J = 8.1$  Hz, 2H), 7.86 (d,  $J = 8.1$  Hz, 2H), 7.64 (d,  $J = 8.1$  Hz, 2H), 7.44 (t,  $J = 8.0$  Hz, 2H), 7.41 (t,  $J = 8.0$  Hz, 2H), 7.33 (d,  $J = 8.0$  Hz, 2H), 7.26–7.19 (m, 2H), 4.42 (s, 1H), 2.53 (s, 3H), 2.08 (s, 3H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  167.4, 165.4, 155.8, 154.7, 137.8, 137.7, 132.3, 131.1 (q,  $J = 32.6$  Hz), 130.5 (2C), 129.2 (2C), 129.1 (2C), 125.9, 125.8, 125.7 (q,  $J = 3.7$  Hz, 2C), 123.8 (q,  $J = 272.3$  Hz), 119.1 (4C), 51.0, 49.9, 42.2, 20.4, 18.5.

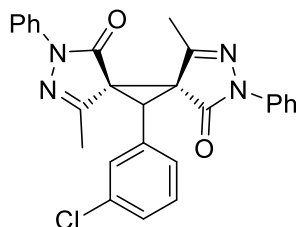


**(5R\*,6R\*)-4,10-Dimethyl-2,8-diphenyl-11-(*m*-tolyl)-2,3,8,9-tetraazadispiro[4.0.4.1]undeca-3,9-diene-1,7-dione (3f).** Light yellow solid, 88% yield, mp 145–147 °C;  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.94 (d,  $J = 7.8$  Hz, 2H), 7.89 (d,  $J = 7.9$  Hz, 2H), 7.43 (t,  $J = 8.0$  Hz, 2H), 7.39 (t,  $J = 8.0$  Hz, 2H), 7.27–7.15 (m, 4H), 6.99 (s, 1H), 6.98 (d,  $J = 6.9$  Hz, 1H), 4.41 (s, 1H), 2.52 (s, 3H), 2.33 (s, 3H), 2.11 (s, 3H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  167.8, 165.6, 156.0, 155.4, 138.4, 138.0, 137.9, 130.5, 129.6, 129.1 (2C), 129.0 (2C), 128.6, 128.0, 127.0, 125.6, 125.5, 119.02 (2C), 119.00 (2C), 51.3, 50.4, 43.3, 21.5, 20.4, 18.4; HRMS (ESI-TOF) calcd for  $\text{C}_{28}\text{H}_{25}\text{N}_4\text{O}_2$   $[\text{M} + \text{H}]^+$  449.1978, found 449.2001.

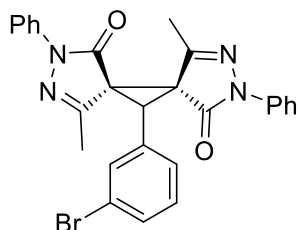


**(5R\*,6R\*)-11-(3-Methoxyphenyl)-4,10-dimethyl-2,8-diphenyl-2,3,8,9-tetraazadispiro[4.0.4.1]undeca-3,9-diene-1,7-dione (3g).** Yellow solid, 86% yield, mp 125–127 °C (Lit. [4] 126–127 °C);  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.93 (d,  $J = 8.1$  Hz, 2H), 7.88

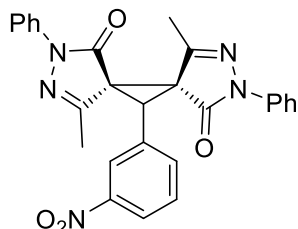
(d,  $J = 8.1$  Hz, 2H), 7.43 (t,  $J = 7.9$  Hz, 2H), 7.39 (t,  $J = 7.9$  Hz, 2H), 7.28 (t,  $J = 8.0$  Hz, 1H), 7.25–7.17 (m, 2H), 6.90 (dd,  $J = 8.3, 2.5$  Hz, 1H), 6.78 (d,  $J = 7.6$  Hz, 1H), 6.72 (s, 1H), 4.41 (s, 1H), 3.77 (s, 3H), 2.52 (s, 3H), 2.13 (s, 3H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  167.8, 165.5, 159.7, 156.0, 155.3, 138.0, 137.9, 129.8, 129.5, 129.1 (2C), 129.0 (2C), 125.7, 125.5, 122.2, 119.1 (4C), 115.8, 114.1, 55.5, 51.4, 50.4, 43.1, 20.4, 18.4.



**(5R\*,6R\*)-11-(3-Chlorophenyl)-4,10-dimethyl-2,8-diphenyl-2,3,8,9-tetraazadispiro[4.0.4.1]undeca-3,9-diene-1,7-dione (3h).** Light yellow solid, 92% yield, mp 157–158 °C (Lit. [4] 158–159 °C);  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.92 (d,  $J = 8.1$  Hz, 2H), 7.87 (d,  $J = 8.2$  Hz, 2H), 7.43 (t,  $J = 7.9$  Hz, 2H), 7.39 (t,  $J = 7.9$  Hz, 2H), 7.35 (d,  $J = 8.0$  Hz, 1H), 7.29 (t,  $J = 7.8$  Hz, 1H), 7.24–7.17 (m, 3H), 7.07 (d,  $J = 7.6$  Hz, 1H), 4.36 (s, 1H), 2.50 (s, 3H), 2.11 (s, 3H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  167.4, 165.3, 155.7, 154.7, 137.8, 137.7, 134.5, 130.1, 130.0, 129.9, 129.1 (2C), 129.04, 129.01 (2C), 128.2, 125.7, 125.6, 119.0 (4C), 50.9, 50.0, 42.2, 20.4, 18.4.

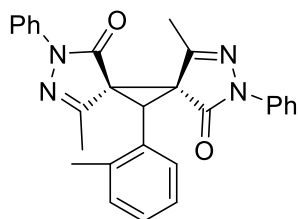


**(5R\*,6R\*)-11-(3-Bromophenyl)-4,10-dimethyl-2,8-diphenyl-2,3,8,9-tetraazadispiro[4.0.4.1]undeca-3,9-diene-1,7-dione (3i).** Light yellow solid, 90% yield, mp 152–153 °C (Lit. [2] 154–155 °C);  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.92 (d,  $J = 8.2$  Hz, 2H), 7.87 (d,  $J = 8.2$  Hz, 2H), 7.51 (d,  $J = 8.0$  Hz, 1H), 7.44 (t,  $J = 8.0$  Hz, 2H), 7.40 (t,  $J = 8.0$  Hz, 2H), 7.35 (s, 1H), 7.26–7.19 (m, 3H), 7.13 (d,  $J = 7.7$  Hz, 1H), 4.38 (s, 1H), 2.51 (s, 3H), 2.12 (s, 3H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  167.5, 165.3, 155.8, 154.8, 137.8, 137.7, 132.9, 132.0, 130.4, 130.2, 129.1 (2C), 129.0 (2C), 128.7, 125.8, 125.7, 122.6, 119.1 (4C), 50.9, 50.0, 42.1, 20.4, 18.5.

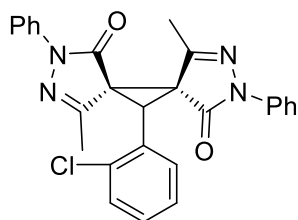


**(5R\*,6R\*)-4,10-Dimethyl-11-(3-nitrophenyl)-2,8-diphenyl-2,3,8,9-tetraazadispiro[4.0.4.1]undeca-3,9-diene-1,7-dione (3j).** Yellow solid, 93% yield, mp 183–185 °C (Lit. [3] 183–185 °C);  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  8.25–8.21 (m, 1H), 8.08 (s, 1H), 7.94–7.90 (m, 2H), 7.85–7.81 (m, 2H), 7.58–7.52 (m, 2H), 7.44 (t,  $J = 8.0$  Hz, 2H),

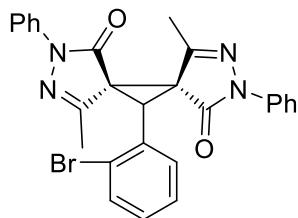
7.39 (t,  $J = 8.0$  Hz, 2H), 7.26–7.19 (m, 2H), 4.43 (s, 1H), 2.52 (s, 3H), 2.07 (s, 3H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  167.1, 165.2, 155.6, 154.1, 148.2, 137.6, 136.1, 130.5, 129.7, 129.1 (2C), 129.0 (2C), 125.9, 125.8, 125.1, 123.8, 119.1 (2C), 119.0 (2C), 50.7, 49.7, 41.6, 20.4, 18.4.



**(5R\*,6R\*)-4,10-Dimethyl-2,8-diphenyl-11-(*o*-tolyl)-2,3,8,9-tetraazadispiro[4.0.4.1]undeca-3,9-diene-1,7-dione (3k).** White solid, 87% yield, mp 176–178 °C (Lit. [1] 177–178 °C);  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.93 (d,  $J = 8.2$  Hz, 2H), 7.87 (d,  $J = 8.2$  Hz, 2H), 7.43 (t,  $J = 7.8$  Hz, 2H), 7.39 (t,  $J = 7.8$  Hz, 2H), 7.30 (t,  $J = 7.4$  Hz, 1H), 7.25–7.17 (m, 4H), 7.12 (d,  $J = 7.6$  Hz, 1H), 4.25 (s, 1H), 2.55 (s, 3H), 2.09 (s, 6H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  167.7, 165.7, 156.0, 155.7, 138.0, 137.9, 137.6, 130.7, 130.4, 129.10 (2C), 129.06, 129.0 (2C), 126.7, 125.9, 125.7, 125.6, 119.15 (2C), 119.13 (2C), 51.5, 50.7, 42.8, 20.2, 19.5, 18.4.

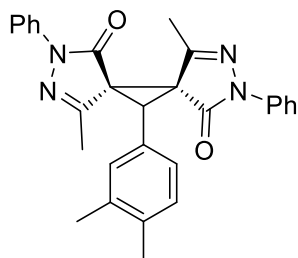


**(5R\*,6R\*)-11-(2-Chlorophenyl)-4,10-dimethyl-2,8-diphenyl-2,3,8,9-tetraazadispiro[4.0.4.1]undeca-3,9-diene-1,7-dione (3l).** Light yellow solid, 90% yield, mp 169–171 °C (Lit. [4] 168–170 °C);  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.93 (d,  $J = 8.0$  Hz, 2H), 7.83 (d,  $J = 8.0$  Hz, 2H), 7.47–7.42 (m, 3H), 7.39 (t,  $J = 7.9$  Hz, 2H), 7.35 (t,  $J = 7.6$  Hz, 1H), 7.30 (t,  $J = 7.4$  Hz, 1H), 7.26–7.18 (m, 3H), 4.24 (s, 1H), 2.53 (s, 3H), 2.14 (s, 3H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  167.5, 165.6, 155.9, 155.1, 137.9, 137.8, 135.3, 131.8, 130.3, 129.9, 129.1 (2C), 129.0 (2C), 126.8, 126.6, 125.7, 125.6, 119.3 (2C), 119.1 (2C), 50.9, 50.5, 41.8, 20.3, 18.4.

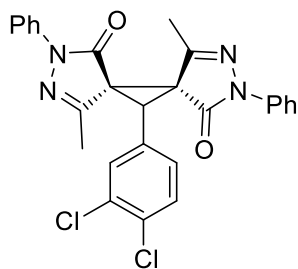


**(5R\*,6R\*)-11-(2-Bromophenyl)-4,10-dimethyl-2,8-diphenyl-2,3,8,9-tetraazadispiro[4.0.4.1]undeca-3,9-diene-1,7-dione (3m).** Light yellow solid, 89% yield, mp 154–155 °C (Lit. [4] 154–155 °C);  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.95–7.92 (m, 2H), 7.85–7.82 (m, 2H), 7.62 (dd,  $J = 7.9, 1.0$  Hz, 1H), 7.46–7.42 (m, 2H), 7.41–7.37 (m, 2H), 7.36–7.32 (m, 1H), 7.29–7.25 (m, 1H), 7.24–7.18 (m, 3H), 4.22 (s, 1H), 2.54 (s, 3H), 2.15 (s, 3H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  167.5, 165.3, 155.8, 154.8, 137.8,

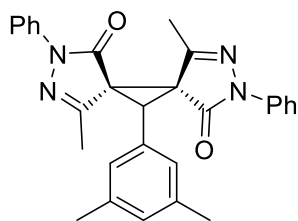
137.7, 132.9, 132.0, 130.4, 130.2, 129.1 (2C), 129.0 (2C), 128.7, 125.8, 125.7, 122.6, 119.08 (2C), 119.07 (2C), 51.0, 50.0, 42.1, 20.4, 18.5.



**(5R\*,6R\*)-11-(3,4-Dimethylphenyl)-4,10-dimethyl-2,8-diphenyl-2,3,8,9-tetraazadi spiro[4.0.4.1]undeca-3,9-diene-1,7-dione (3n).** Light yellow solid, 86% yield, mp 176–178 °C; <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.93 (d, *J* = 7.8 Hz, 2H), 7.89 (d, *J* = 7.8 Hz, 2H), 7.42 (t, *J* = 8.0 Hz, 2H), 7.39 (t, *J* = 8.0 Hz, 2H), 7.23–7.16 (m, 2H), 7.12 (d, *J* = 7.7 Hz, 1H), 6.93 (s, 1H), 6.91 (d, *J* = 7.7 Hz, 1H), 4.39 (s, 1H), 2.51 (s, 3H), 2.26 (s, 3H), 2.24 (s, 3H), 2.12 (s, 3H); <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) δ 167.9, 165.6, 156.1, 155.5, 138.1, 137.9, 137.3, 137.0, 131.0, 129.9, 129.1 (2C), 129.0 (2C), 127.3, 125.6, 125.4, 125.3, 119.1 (2C), 119.0 (2C), 51.4, 50.5, 43.3, 20.4, 19.8, 19.7, 18.4; HRMS (ESI-TOF) calcd for C<sub>29</sub>H<sub>27</sub>N<sub>4</sub>O<sub>2</sub> [M + H]<sup>+</sup> 463.2134, found 463.2128.

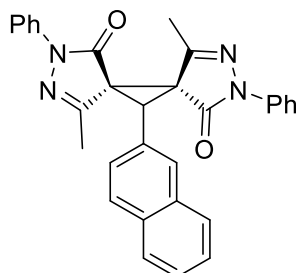


**(5R\*,6R\*)-11-(3,4-Dichlorophenyl)-4,10-dimethyl-2,8-diphenyl-2,3,8,9-tetraazadi spiro[4.0.4.1]undeca-3,9-diene-1,7-dione (3o).** Light yellow solid, 94% yield, mp 156–157 °C; <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.93–7.90 (m, 2H), 7.88–7.84 (m, 2H), 7.46–7.38 (m, 5H), 7.31–7.29 (m, 1H), 7.25–7.19 (m, 2H), 7.05–7.02 (m, 1H), 4.31 (s, 1H), 2.49 (s, 3H), 2.12 (s, 3H); <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) δ 167.3, 165.2, 155.6, 154.4, 137.8, 137.7, 133.2, 132.9, 131.9, 130.7, 129.3, 129.12 (2C), 129.06 (2C), 128.5, 125.8, 125.7, 119.0 (4C), 50.8, 49.9, 41.5, 20.4, 18.4; HRMS (ESI-TOF) calcd for C<sub>27</sub>H<sub>21</sub><sup>35</sup>Cl<sub>2</sub>N<sub>4</sub>O<sub>2</sub> [M + H]<sup>+</sup> 503.1042, found 503.1053.

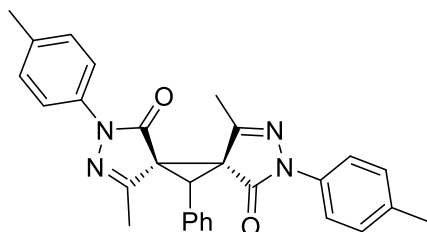


**(5R\*,6R\*)-11-(3,5-Dimethylphenyl)-4,10-dimethyl-2,8-diphenyl-2,3,8,9-tetraazadi spiro[4.0.4.1]undeca-3,9-diene-1,7-dione (3p).** White solid, 91% yield, mp 142–144 °C; <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.94 (d, *J* = 8.2 Hz, 2H), 7.89 (d, *J* = 8.2 Hz, 2H), 7.43 (t, *J* = 7.9 Hz, 2H), 7.39 (t, *J* = 8.0 Hz, 2H), 7.24–7.17 (m, 2H), 6.99 (s, 1H), 6.79 (s, 2H), 4.38 (s, 1H), 2.51 (s, 3H), 2.29 (s, 6H), 2.13 (s, 3H); <sup>13</sup>C NMR (125

MHz, CDCl<sub>3</sub>)  $\delta$  167.9, 165.6, 156.1, 155.5, 138.3 (2C), 138.1, 137.9, 130.5, 129.1 (2C), 129.0 (2C), 127.9, 127.6 (2C), 125.6, 125.4, 119.05 (2C), 119.01 (2C), 51.4, 50.5, 43.4, 21.4 (2C), 20.4, 18.4; HRMS (ESI-TOF) calcd for C<sub>29</sub>H<sub>27</sub>N<sub>4</sub>O<sub>2</sub> [M + H]<sup>+</sup> 463.2134, found 463.2158.



**(5R\*,6R\*)-4,10-Dimethyl-11-(naphthalen-2-yl)-2,8-diphenyl-2,3,8,9-tetraazadispiro[4.0.4.1]undeca-3,9-diene-1,7-dione (3q).** White solid, 76% yield, mp 160–162 °C; <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>)  $\delta$  7.96 (d, *J* = 7.8 Hz, 2H), 7.90 (d, *J* = 7.8 Hz, 2H), 7.83 (d, *J* = 8.6 Hz, 2H), 7.80–7.77 (m, 1H), 7.67 (s, 1H), 7.52–7.47 (m, 2H), 7.45 (t, *J* = 8.0 Hz, 2H), 7.39 (t, *J* = 8.0 Hz, 2H), 7.23 (t, *J* = 7.0 Hz, 2H), 7.19 (t, *J* = 7.4 Hz, 1H), 4.58 (s, 1H), 2.56 (s, 3H), 2.07 (s, 3H); <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>)  $\delta$  167.8, 165.6, 156.0, 155.3, 138.0, 137.9, 133.2, 133.0, 129.4, 129.1 (2C), 129.0 (2C), 128.6, 128.0, 127.9, 127.1, 126.8, 126.7, 125.7, 125.5, 125.4, 119.1 (2C), 119.0 (2C), 51.4, 50.4, 43.4, 20.4, 18.5; HRMS (ESI-TOF) calcd for C<sub>31</sub>H<sub>25</sub>N<sub>4</sub>O<sub>2</sub> [M + H]<sup>+</sup> 485.1978, found 485.1979.



**(5R\*,6R\*)-4,10-Dimethyl-11-phenyl-2,8-di-*p*-tolyl-2,3,8,9-tetraazadispiro[4.0.4.1]undeca-3,9-diene-1,7-dione (3r).** White solid, 89% yield, mp 141–142 °C; <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>)  $\delta$  7.79 (d, *J* = 8.5 Hz, 2H), 7.75 (d, *J* = 8.5 Hz, 2H), 7.37–7.33 (m, 3H), 7.22 (d, *J* = 8.3 Hz, 2H), 7.20–7.16 (m, 4H), 4.41 (s, 1H), 2.51 (s, 3H), 2.35 (s, 3H), 2.33 (s, 3H), 2.06 (s, 3H); <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>)  $\delta$  167.6, 165.4, 155.9, 155.2, 135.5, 135.4, 135.3, 135.2, 130.0 (2C), 129.6 (2C), 129.5 (2C), 128.7, 128.6 (2C), 128.2, 119.1 (4C), 51.3, 50.2, 43.1, 21.09, 21.06, 20.3, 18.4; HRMS (ESI-TOF) calcd for C<sub>29</sub>H<sub>27</sub>N<sub>4</sub>O<sub>2</sub> [M + H]<sup>+</sup> 463.2134, found 463.2110.

## 4. Copies of NMR Spectra for 3

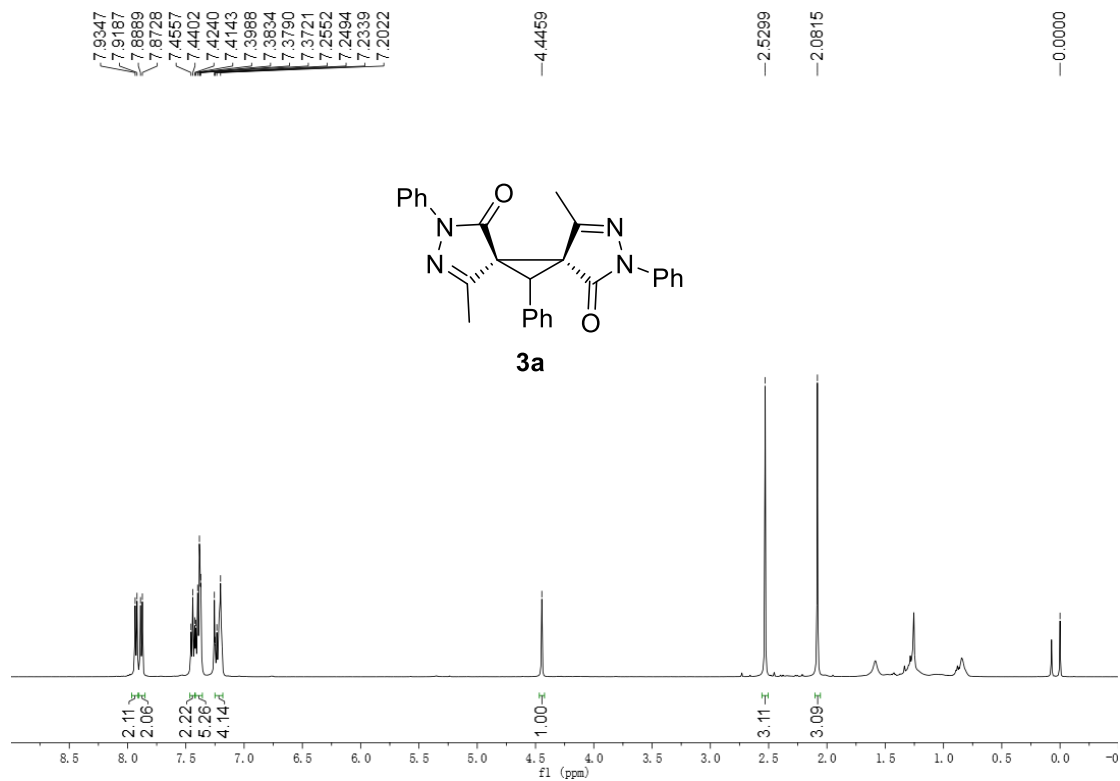


Figure S1. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) of compound 3a

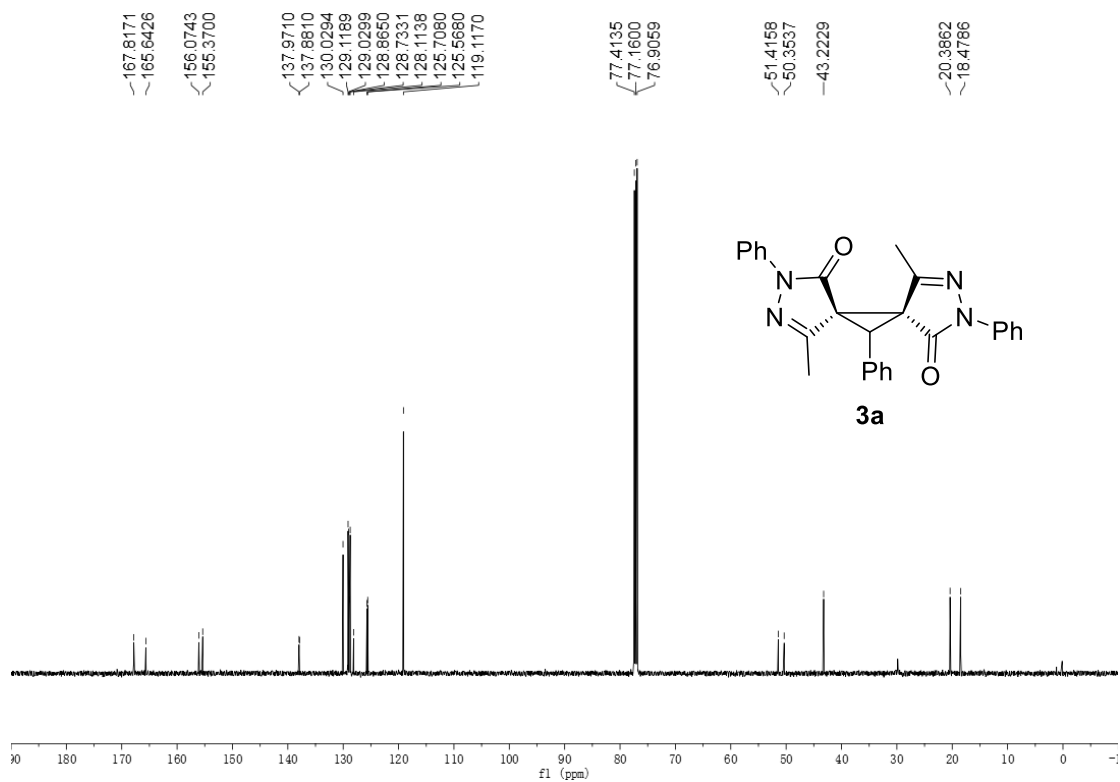
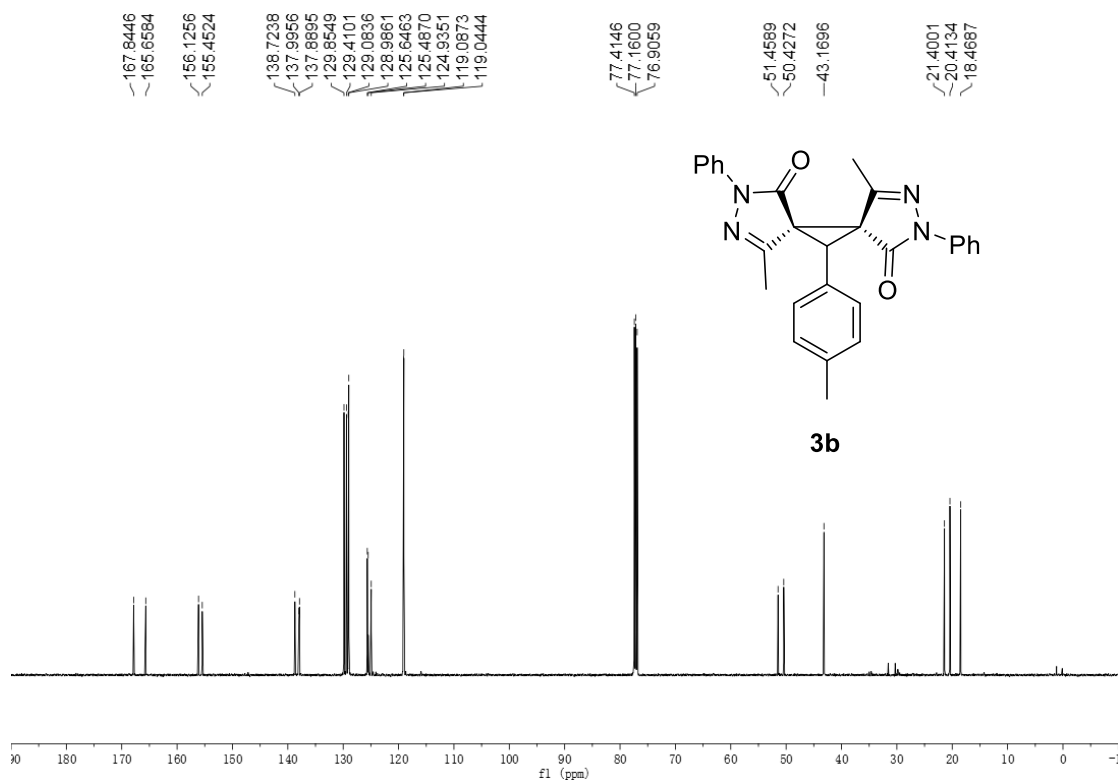
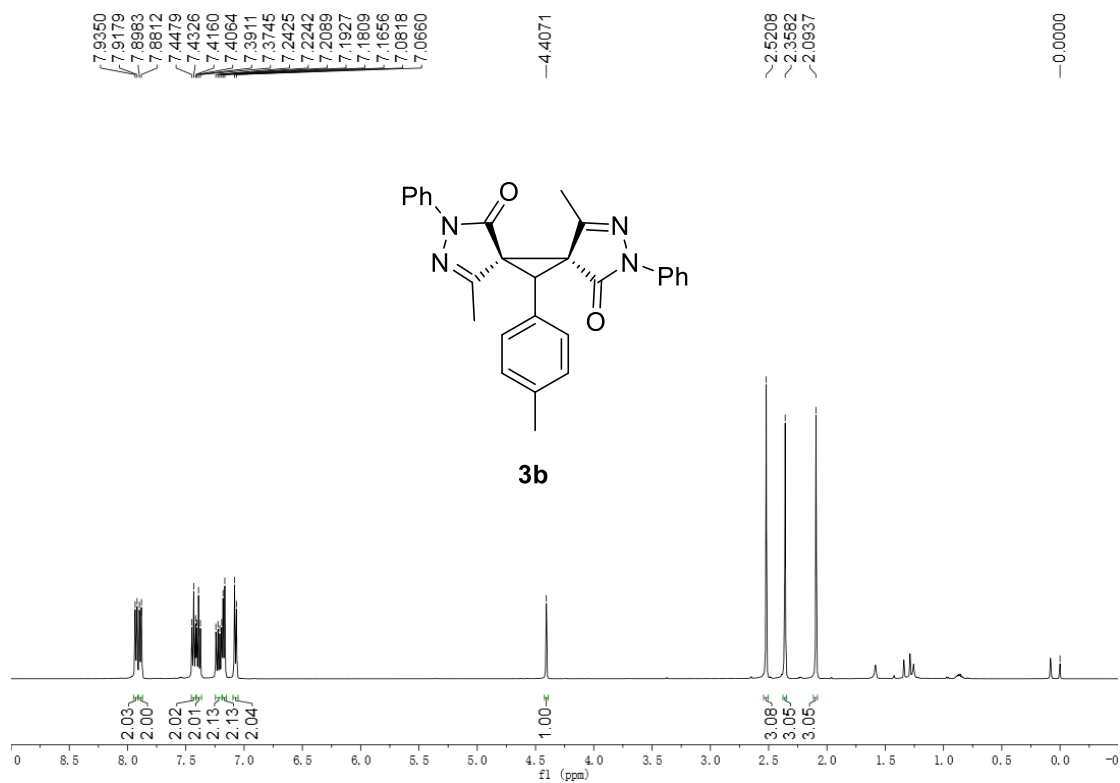


Figure S2. <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) of compound 3a



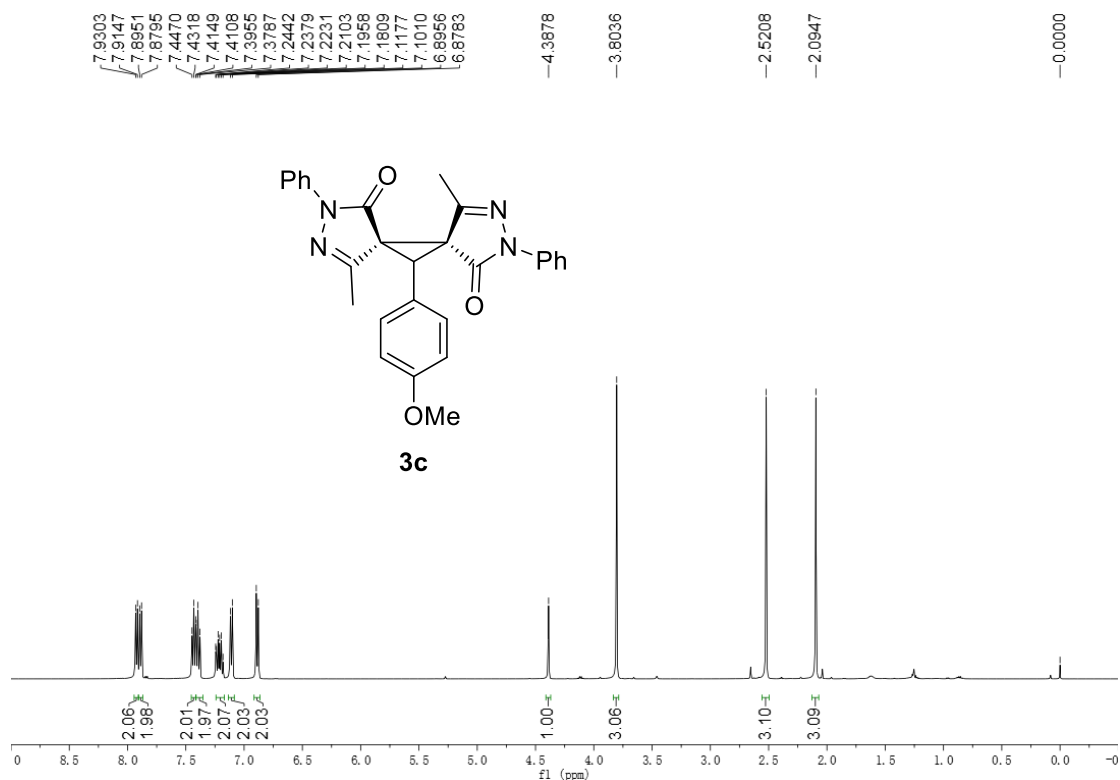


Figure S5. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) of compound **3c**

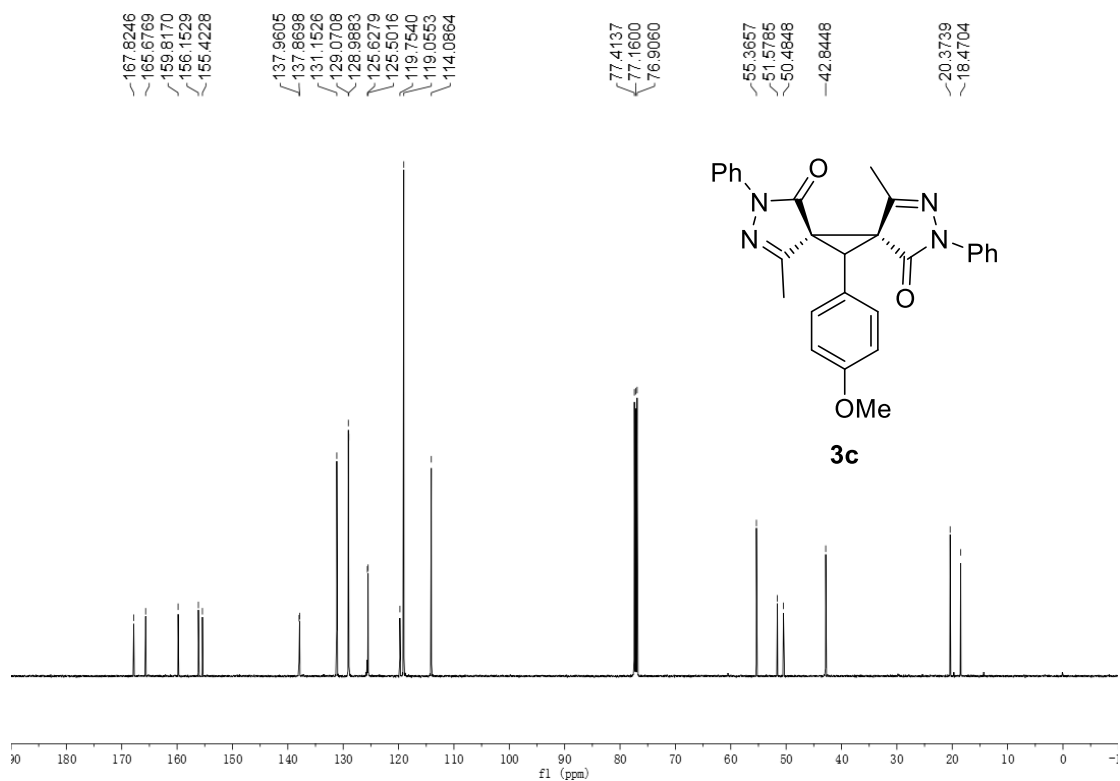


Figure S6. <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) of compound **3c**

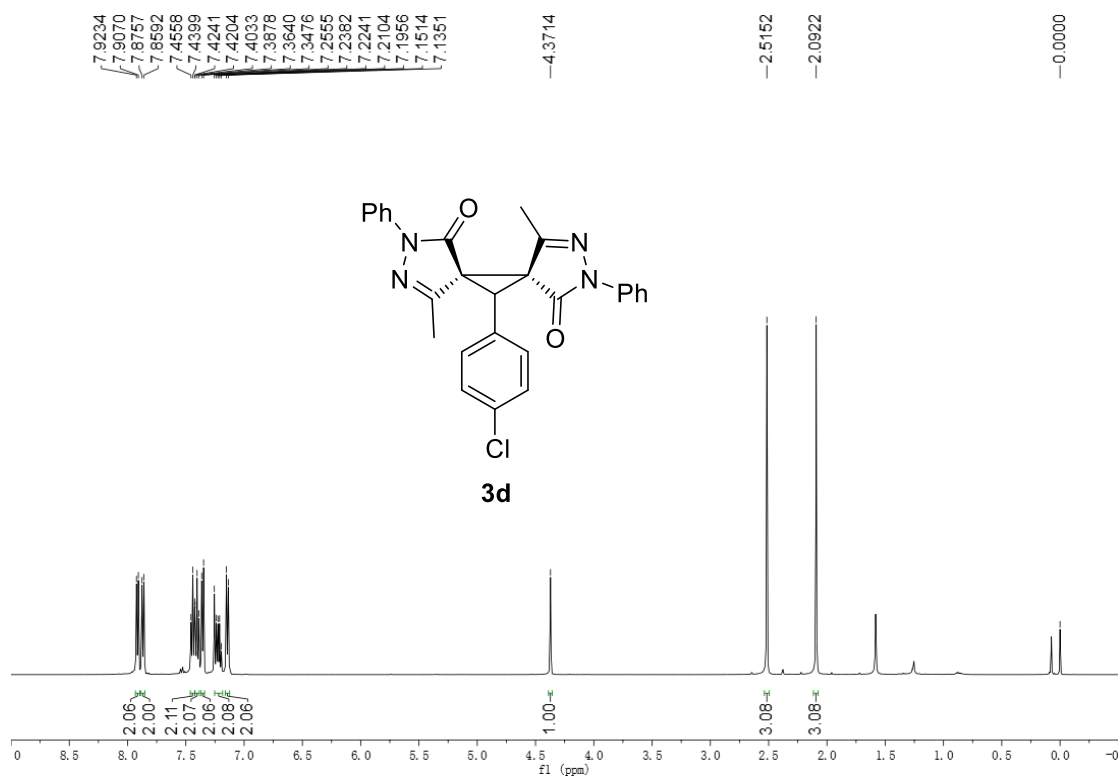


Figure S7. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) of compound **3d**

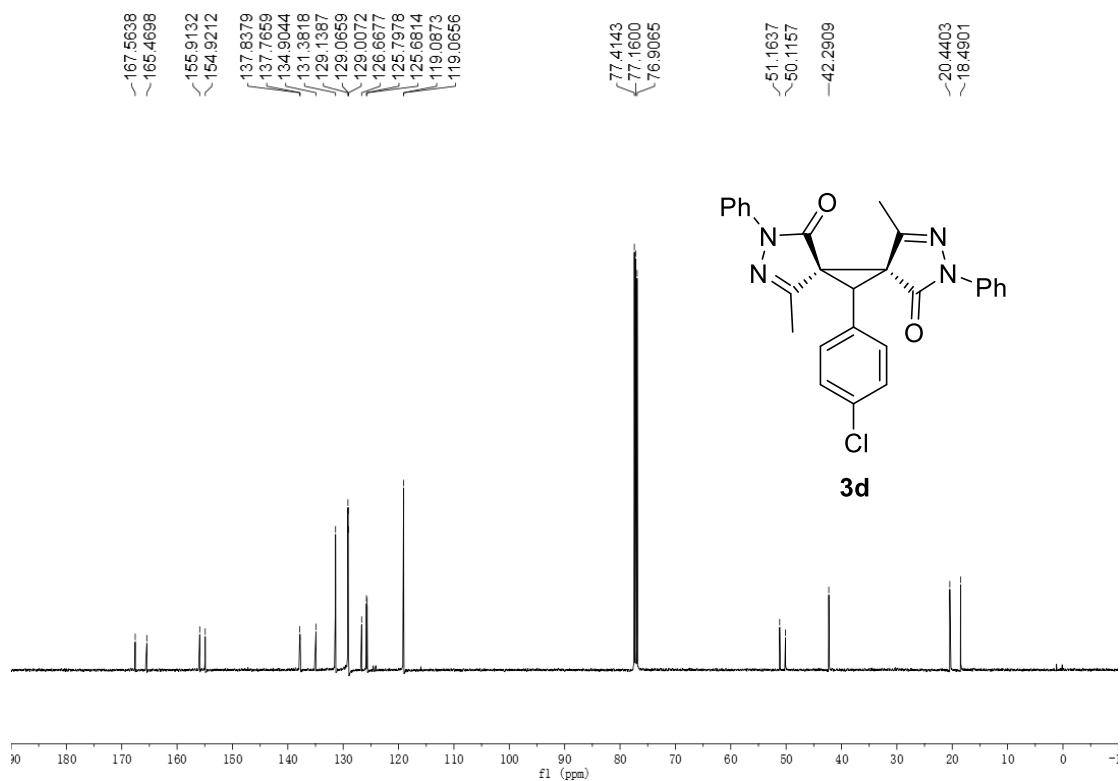
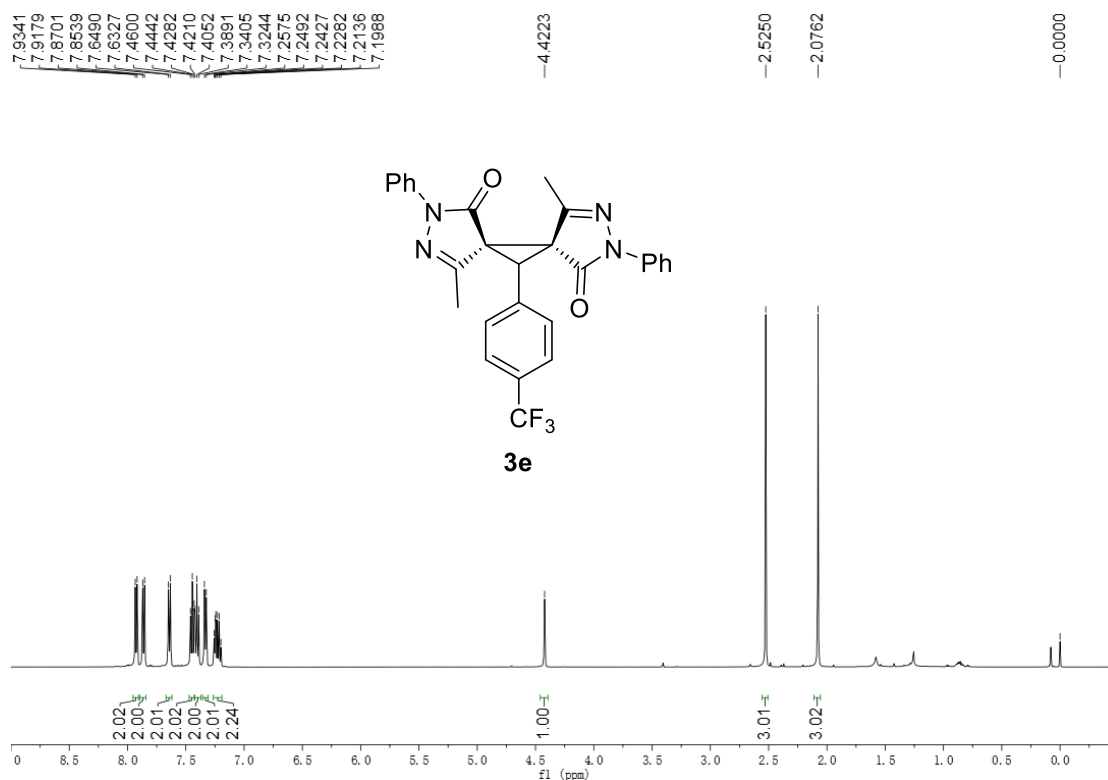
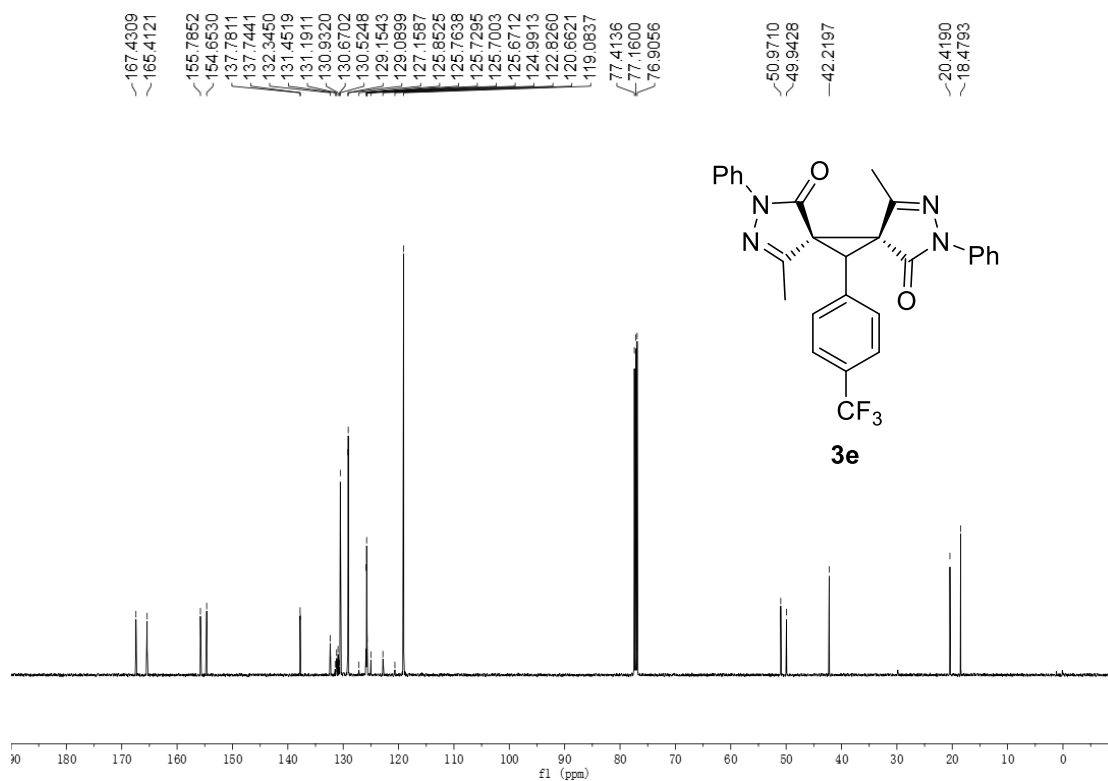


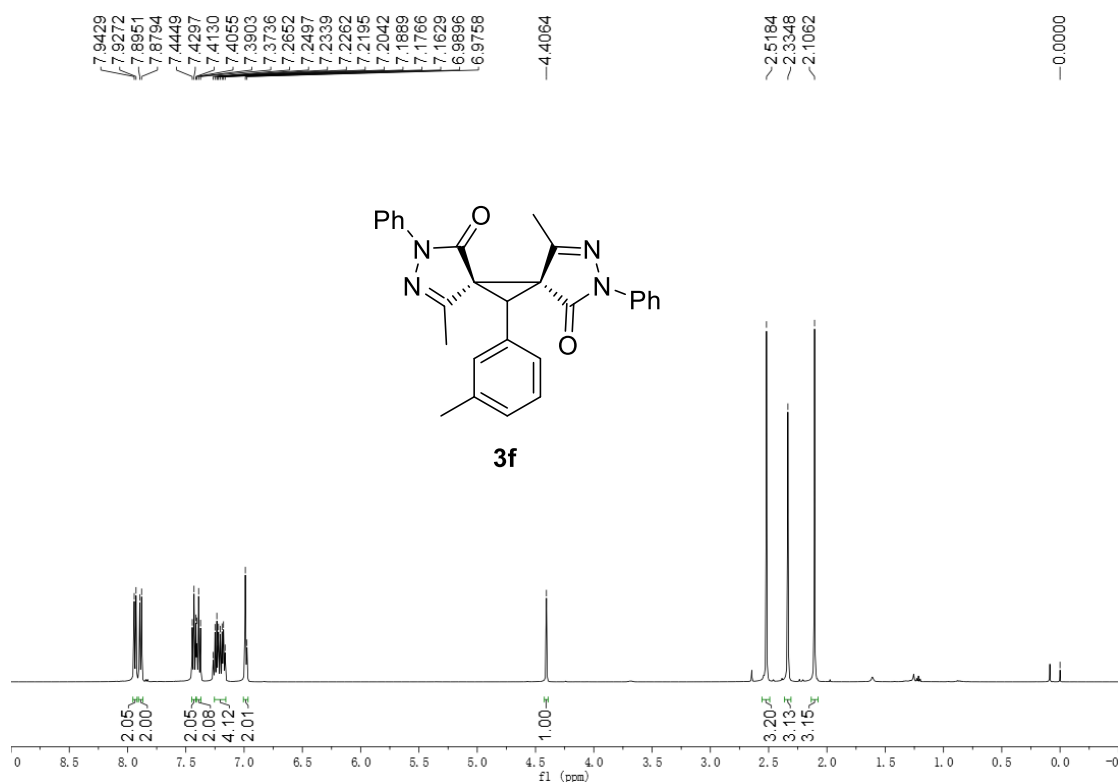
Figure S8. <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) of compound **3d**



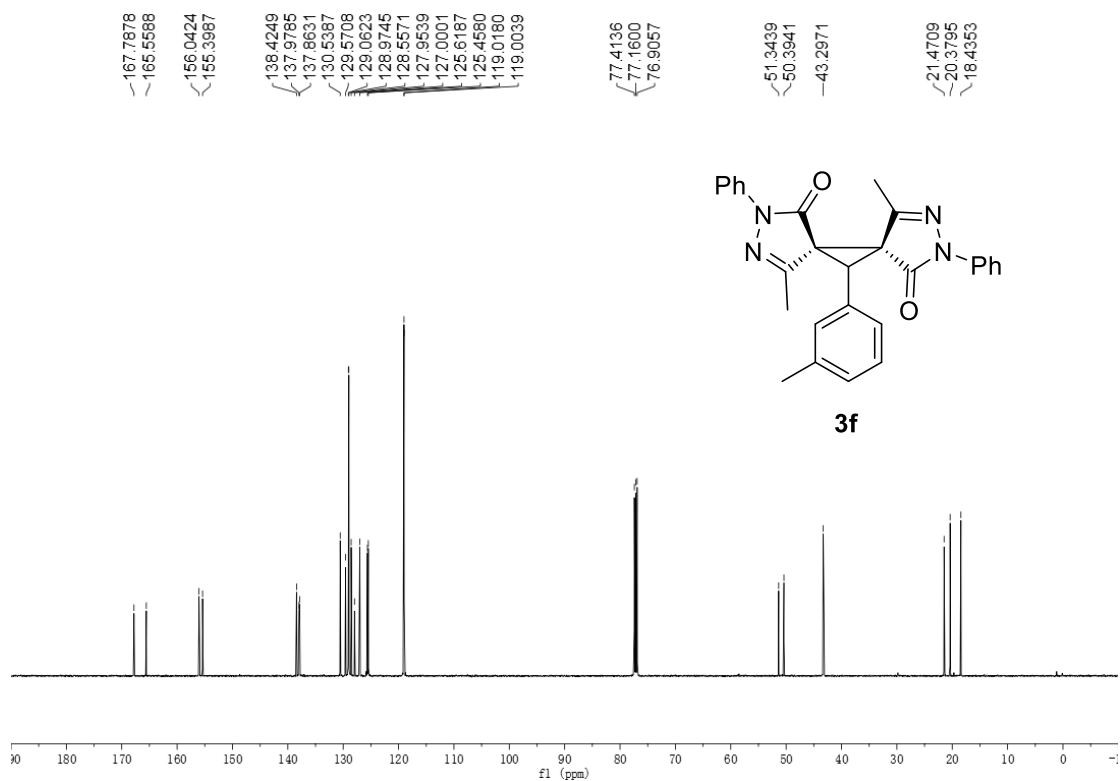
**Figure S9. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) of compound 3e**



**Figure S10. <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) of compound 3e**



**Figure S11.** <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) of compound **3f**



**Figure S12.** <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) of compound **3f**

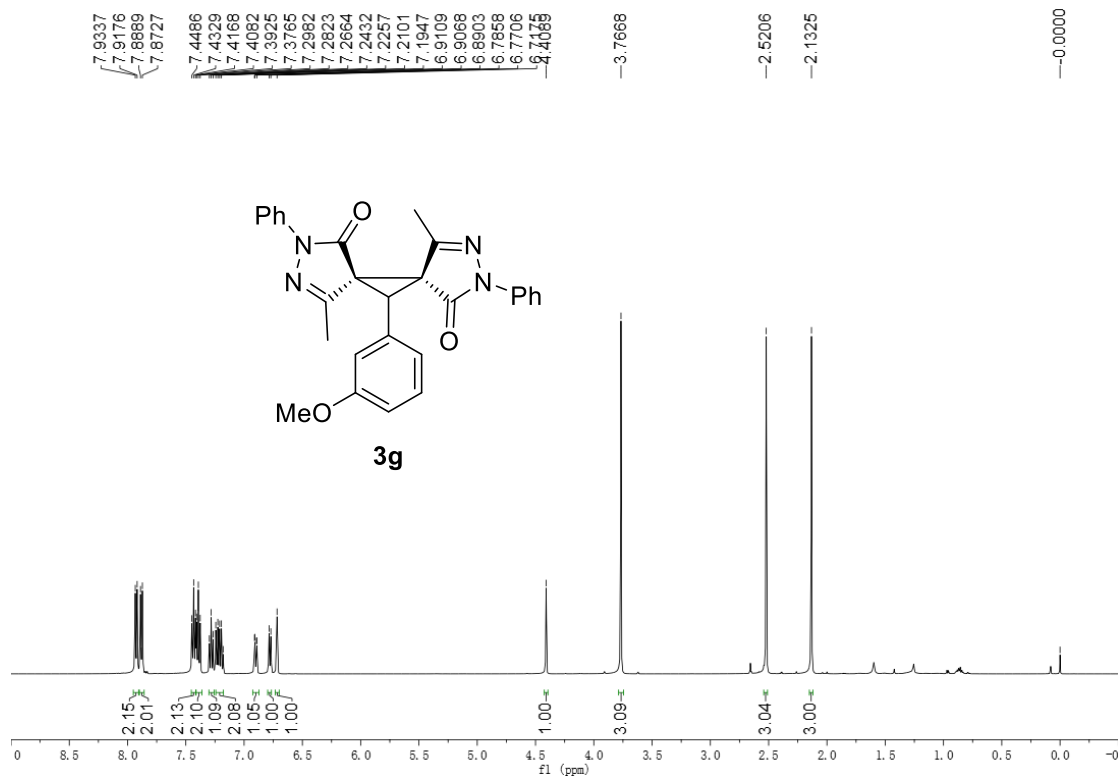


Figure S13. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) of compound **3g**

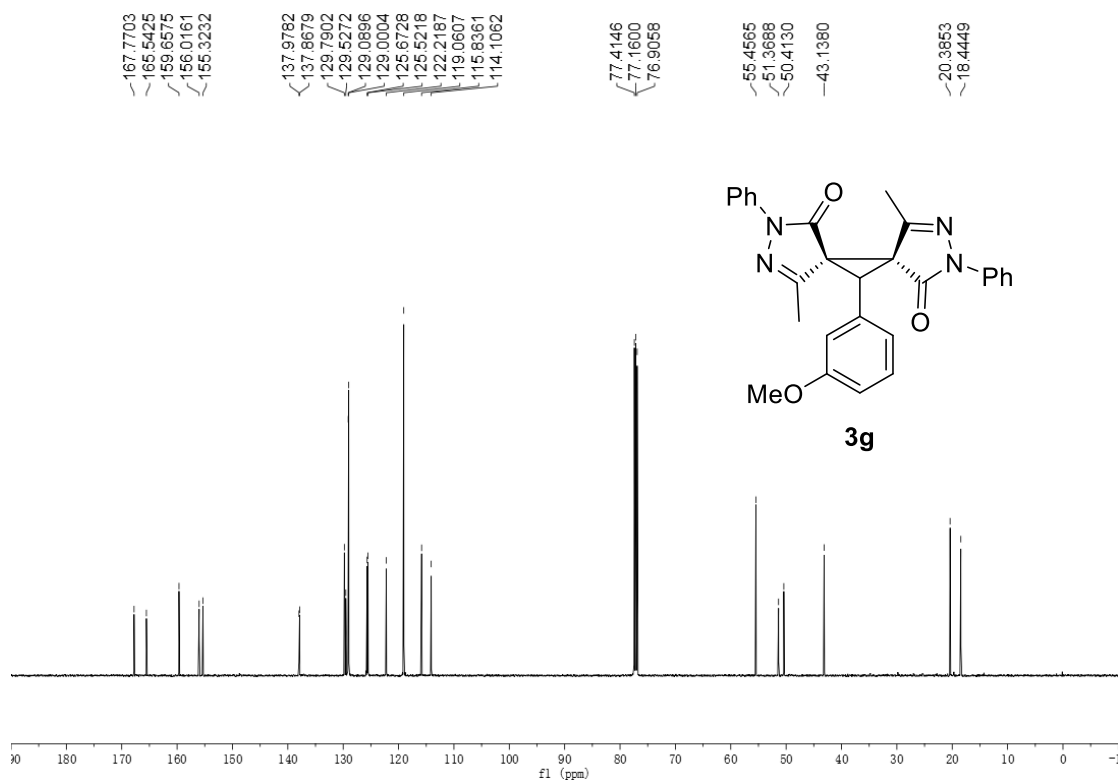
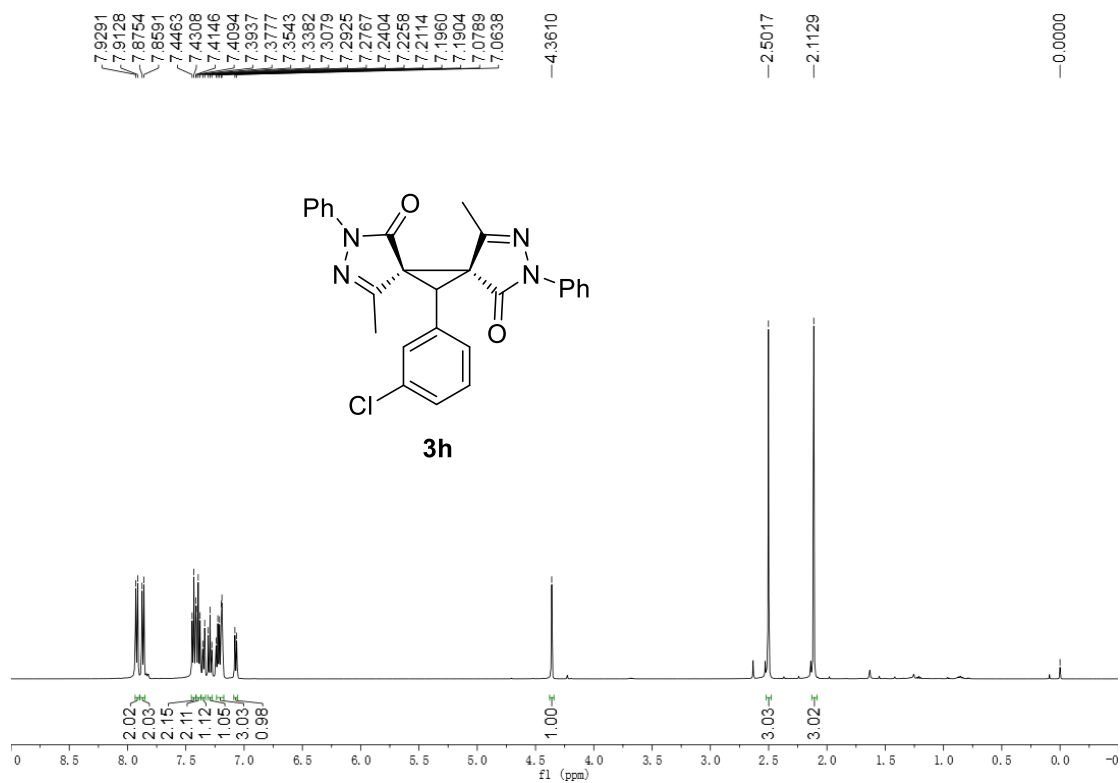
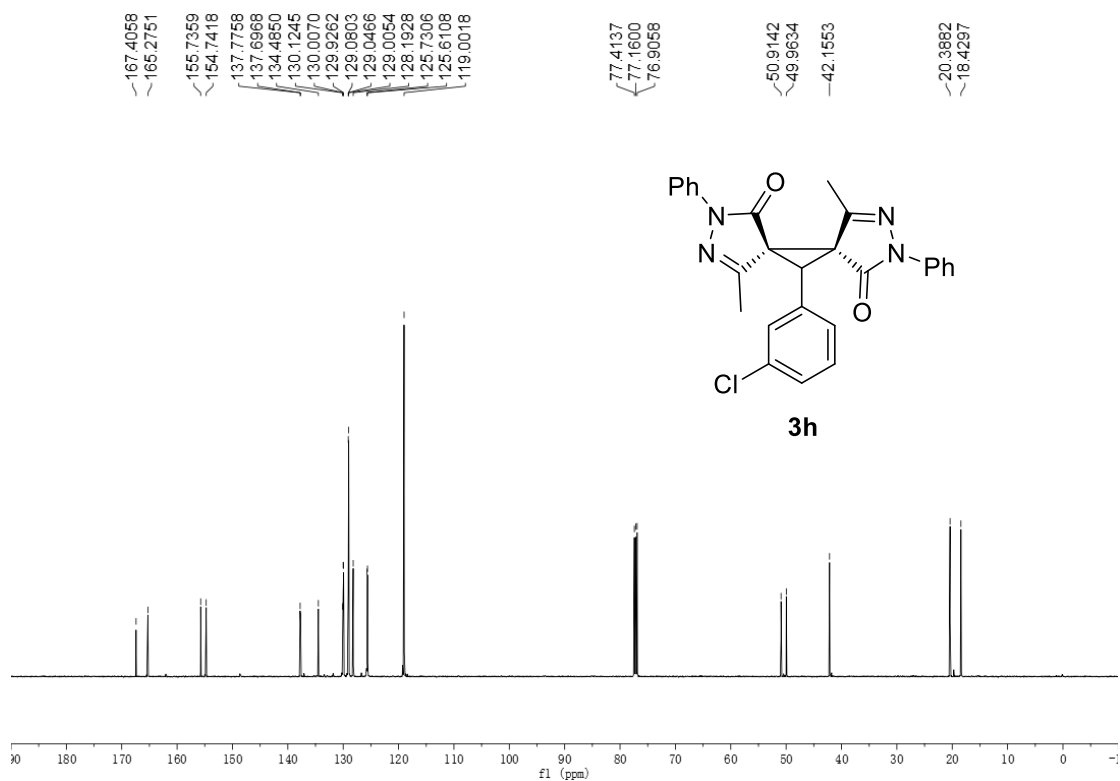


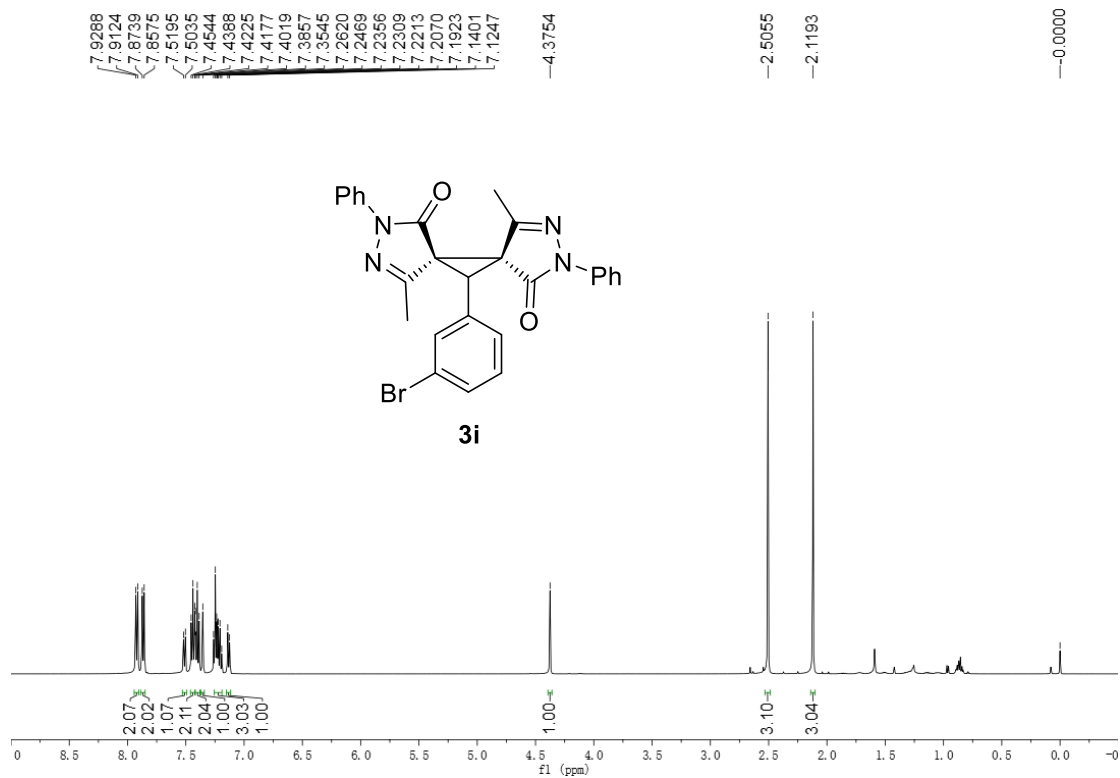
Figure S14. <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) of compound **3g**



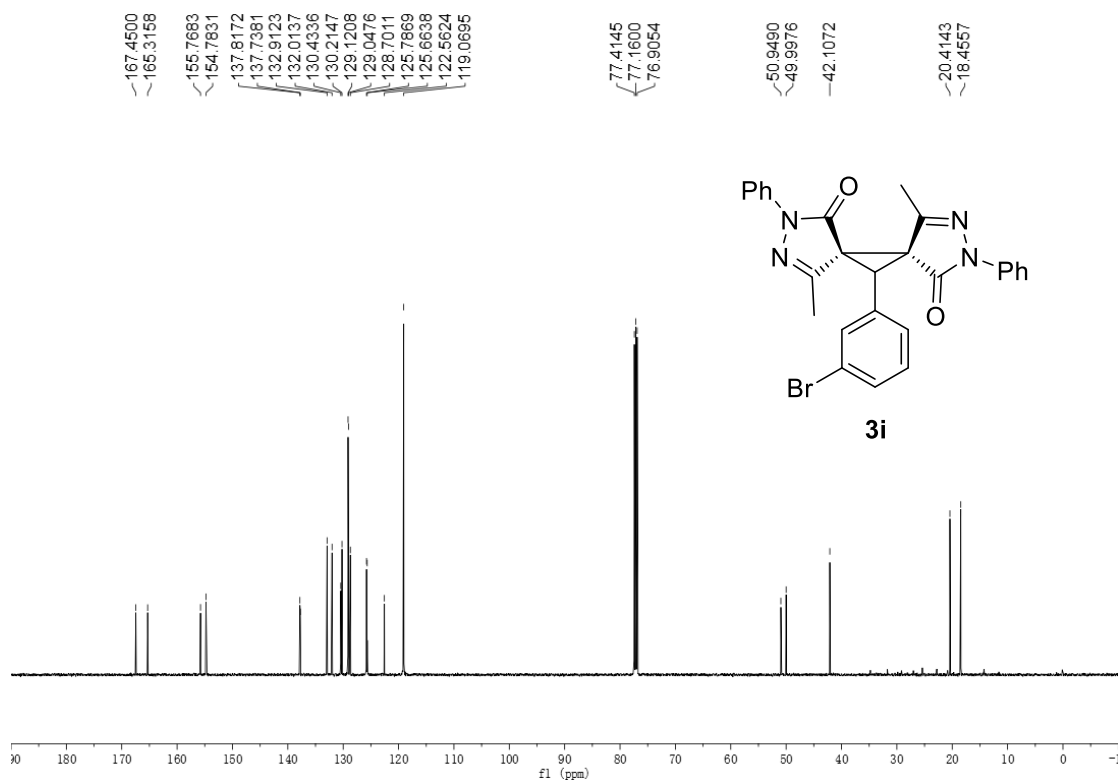
**Figure S15.** <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) of compound **3h**



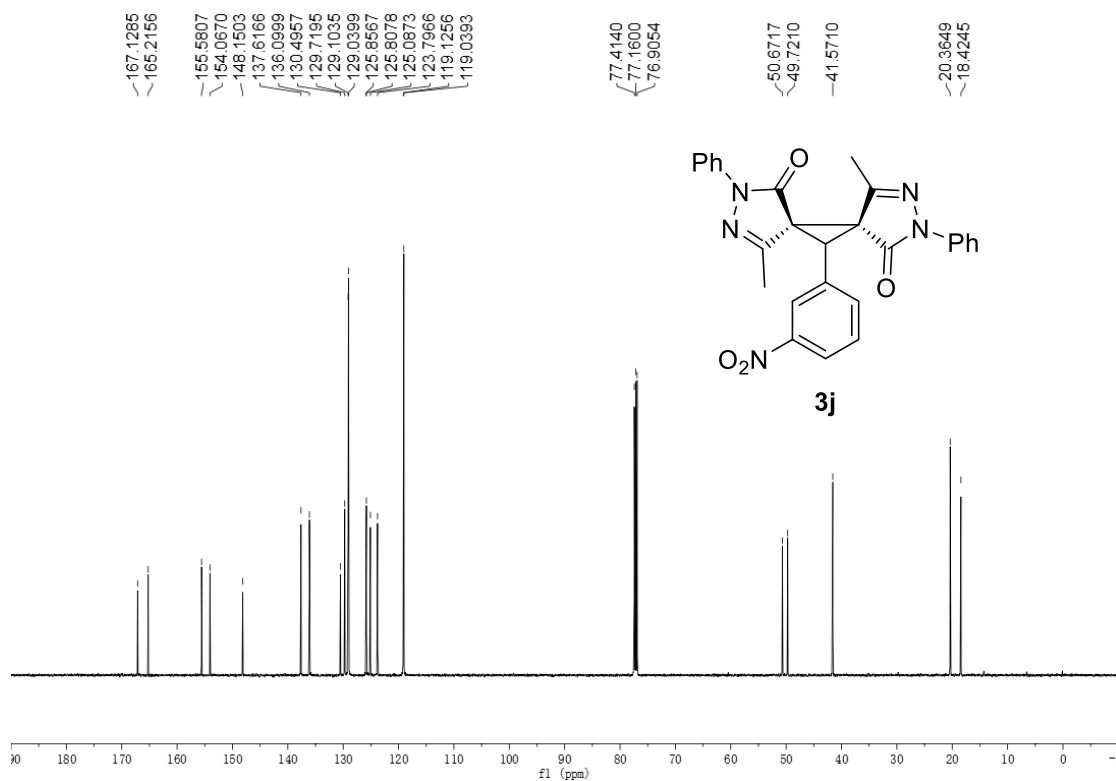
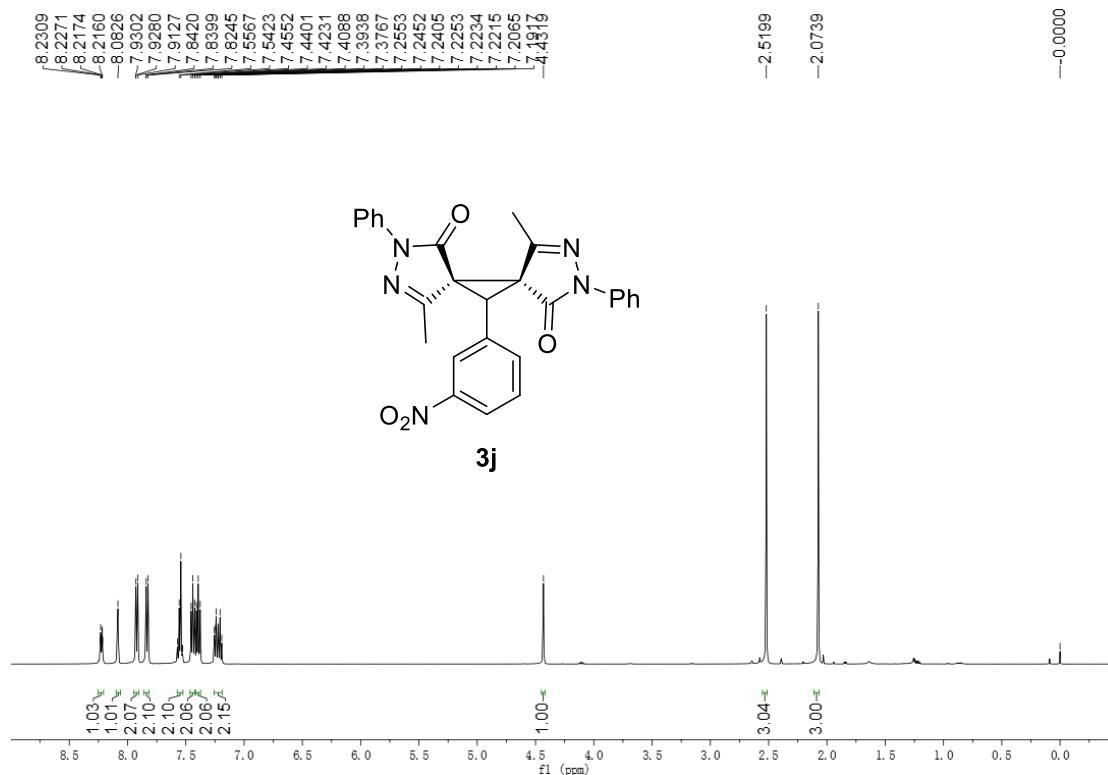
**Figure S16.** <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) of compound **3h**



**Figure S17.** <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) of compound **3i**



**Figure S18.** <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) of compound **3i**



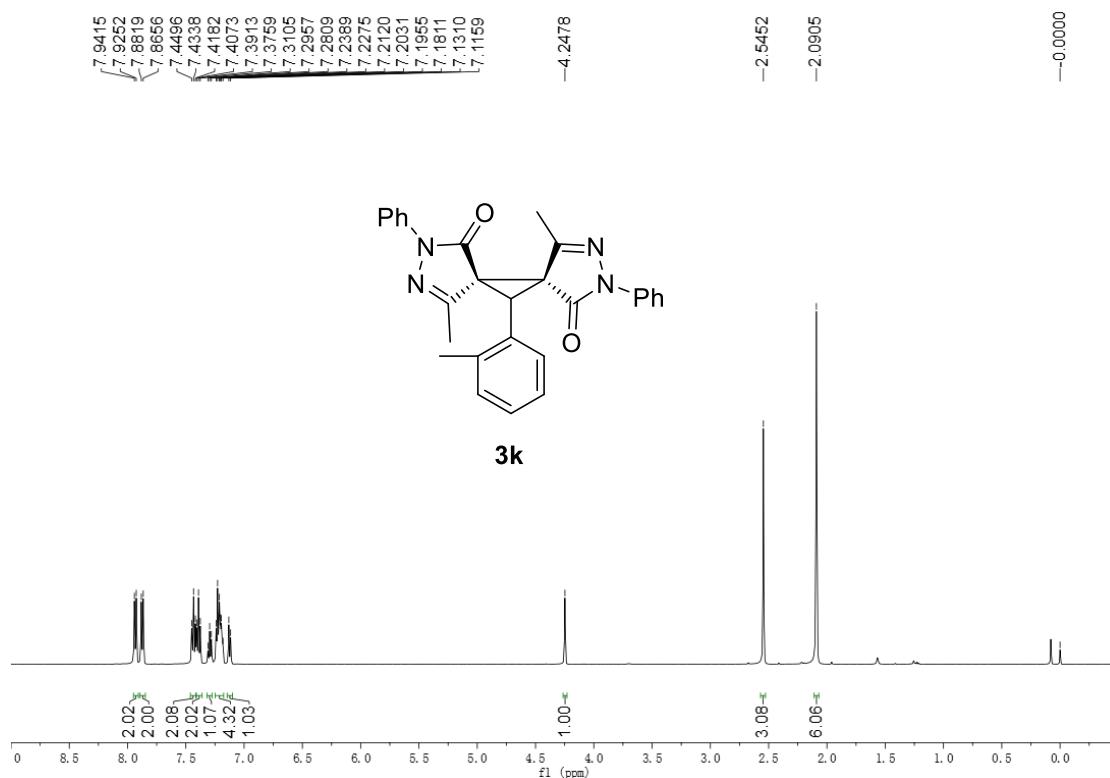


Figure S21. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) of compound **3k**

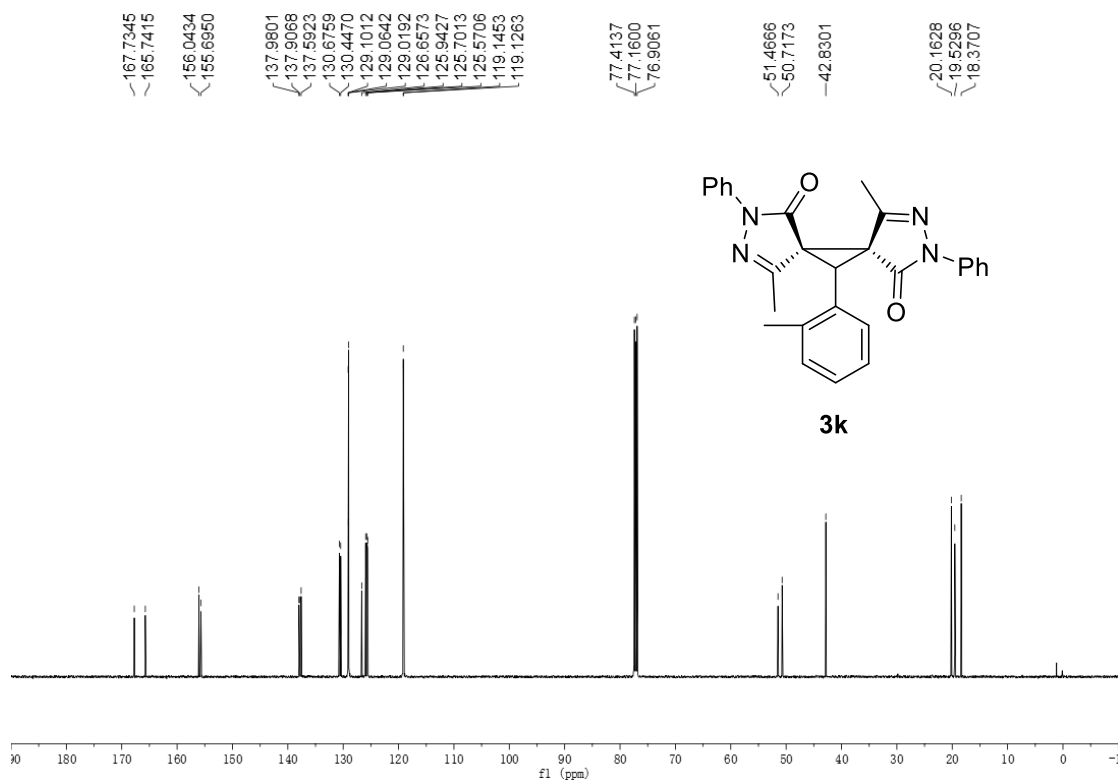
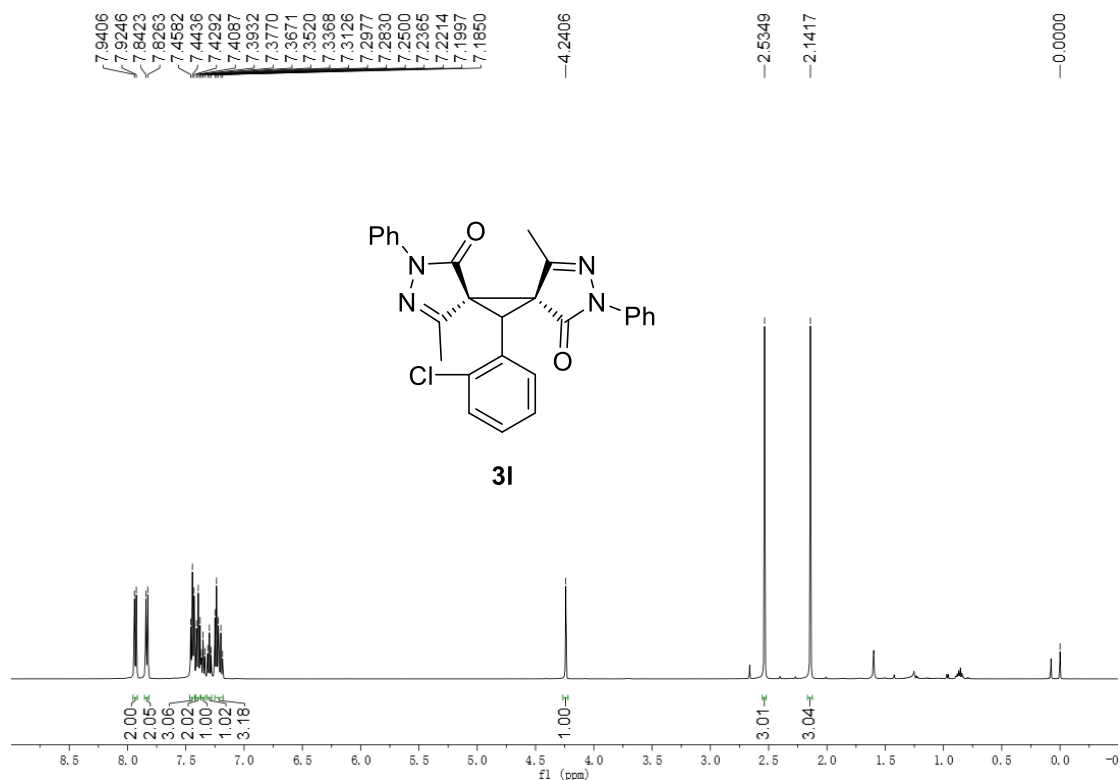
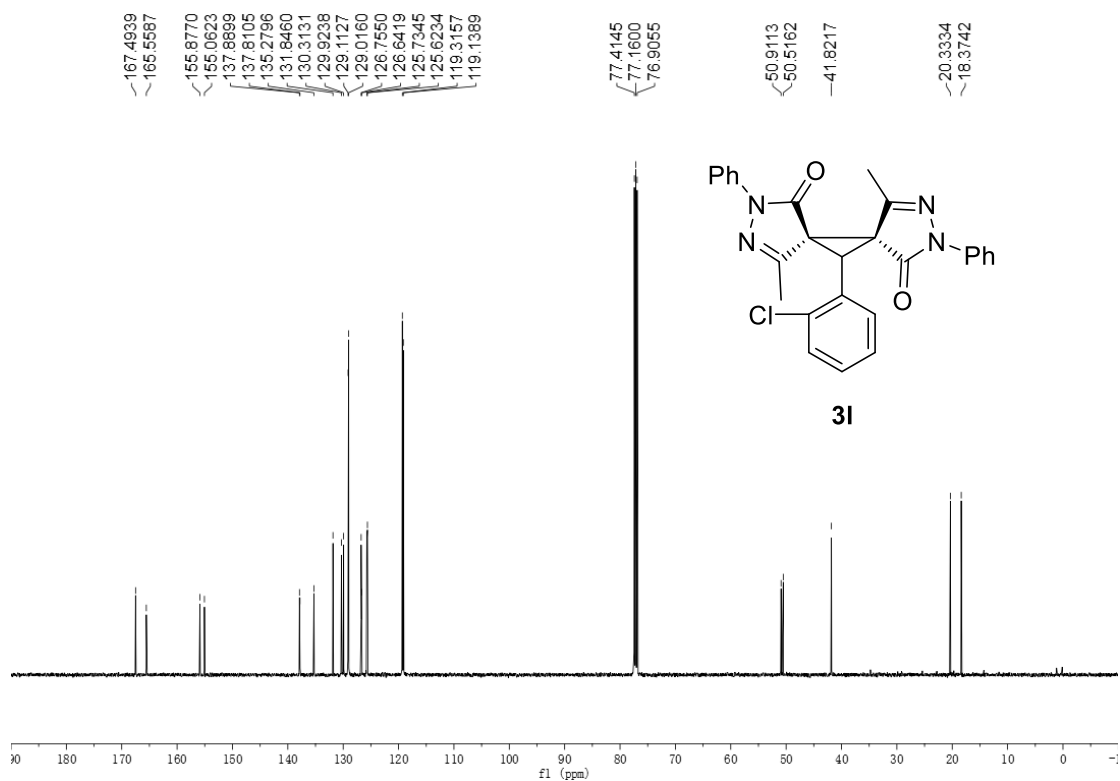


Figure S22. <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) of compound **3k**



**Figure S23.** <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) of compound **31**



**Figure S24.** <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) of compound **31**

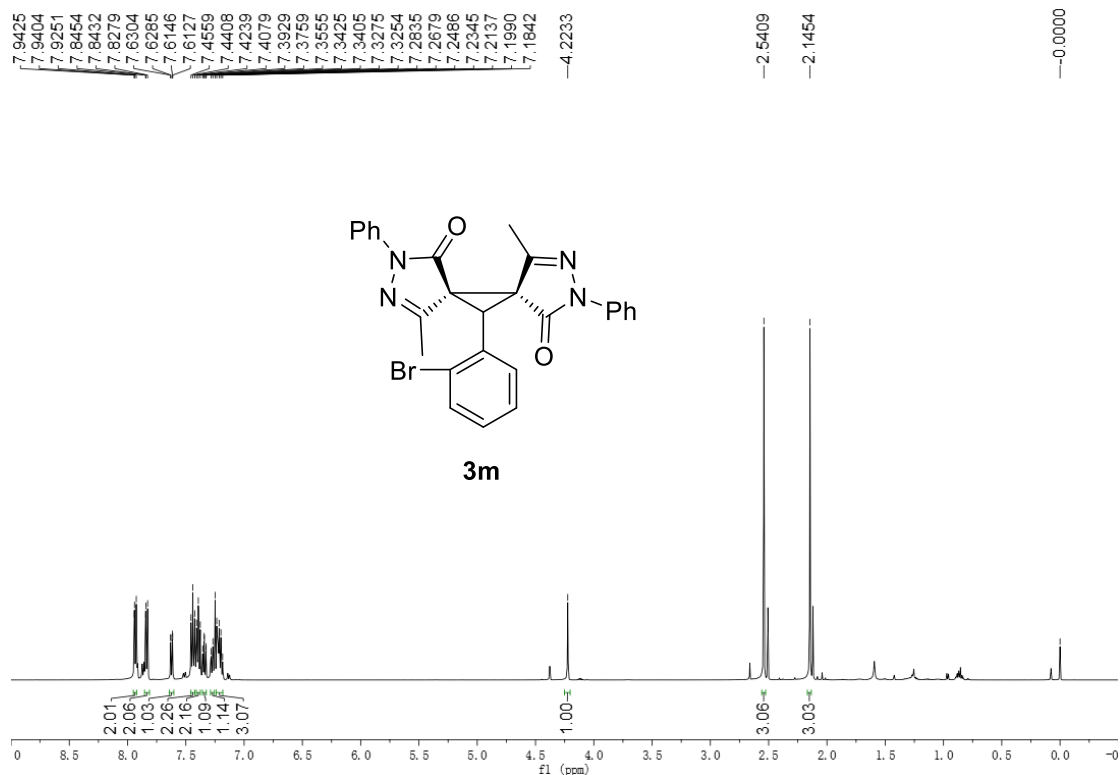


Figure S25.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ ) of compound **3m**

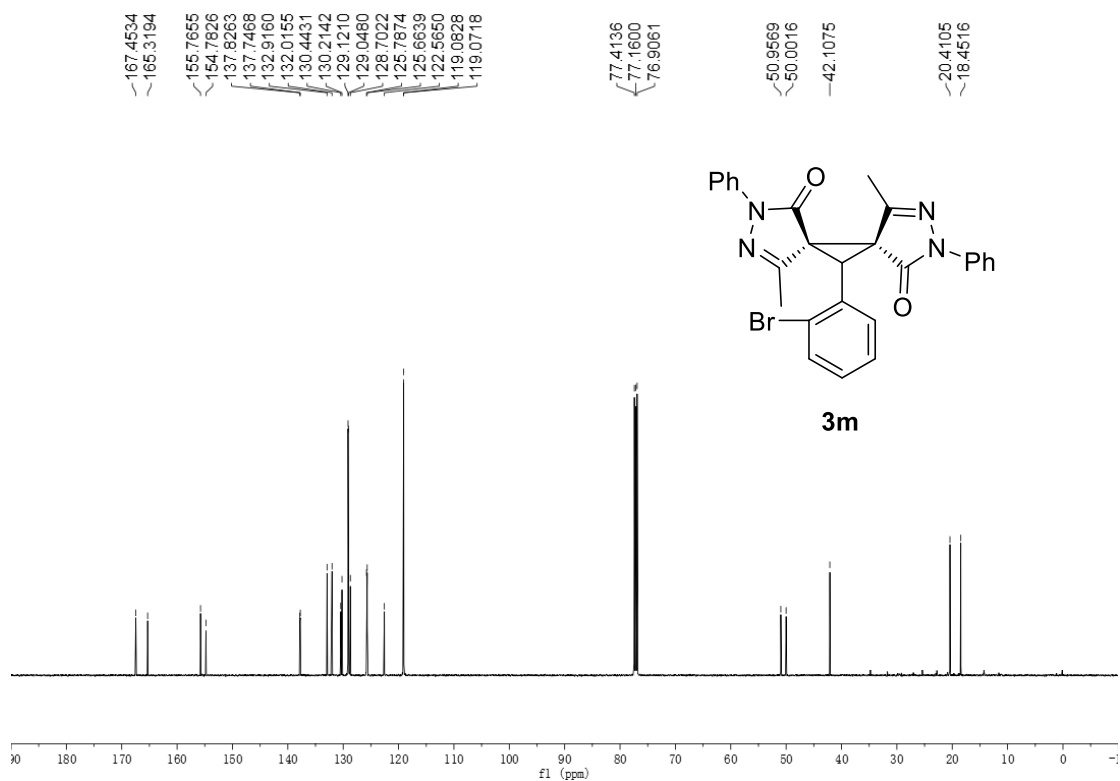
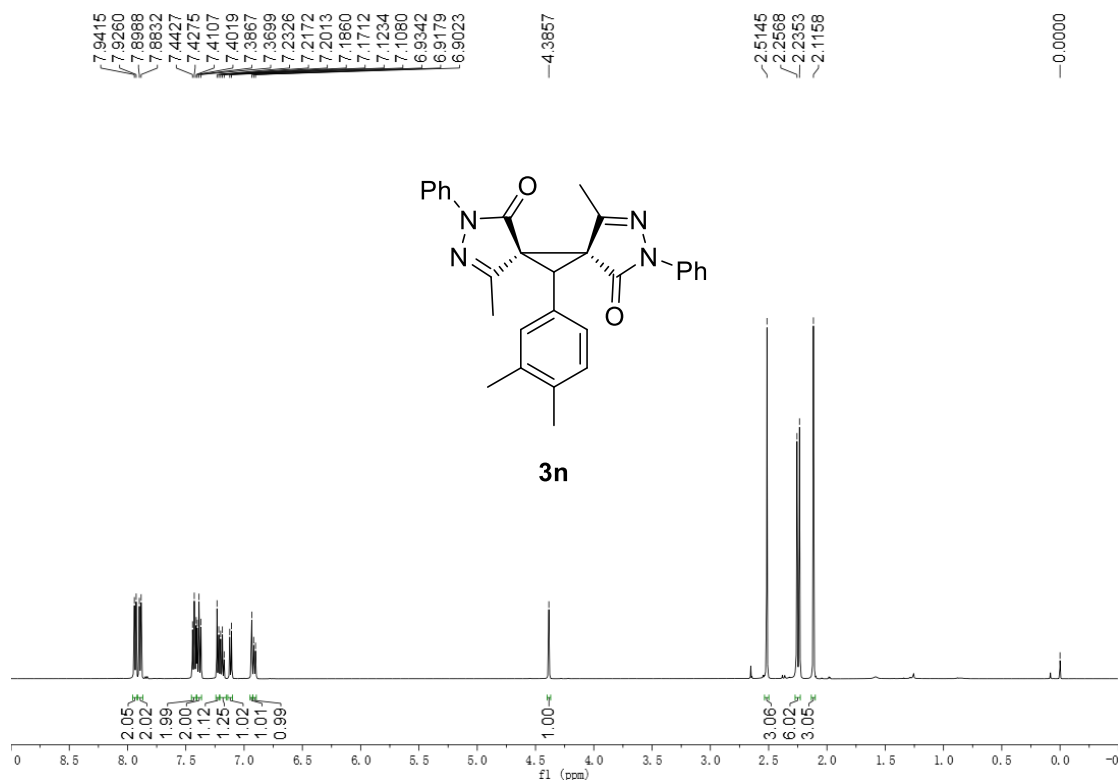
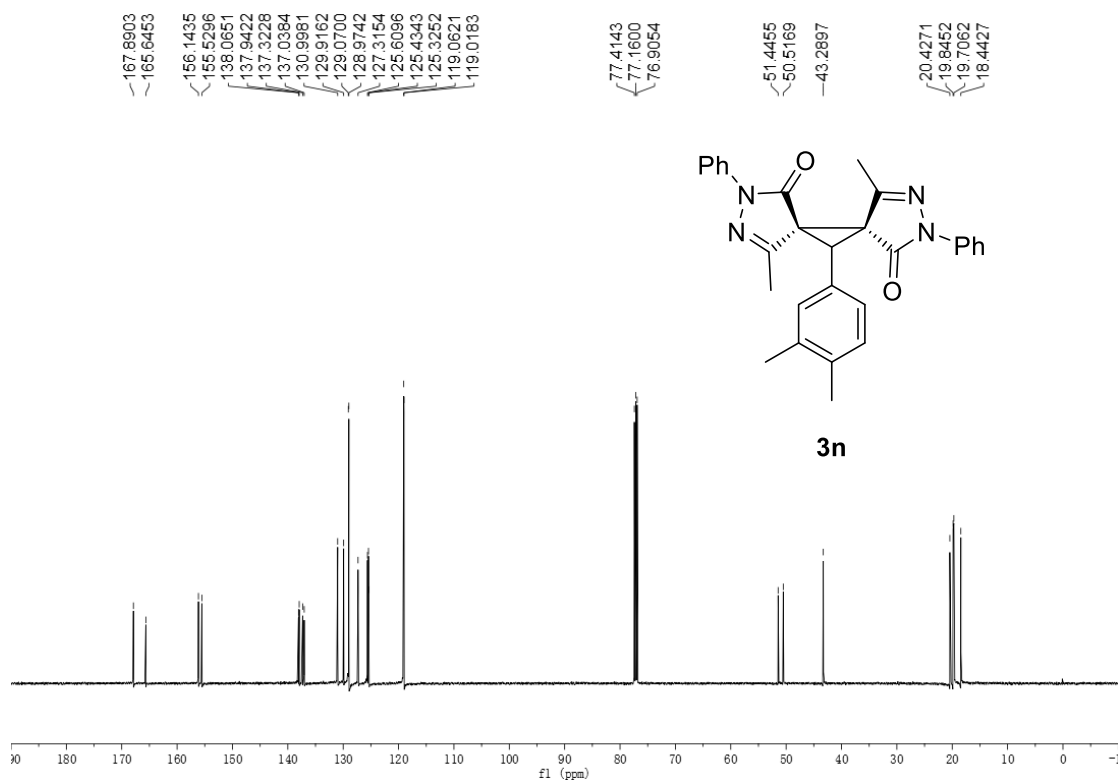


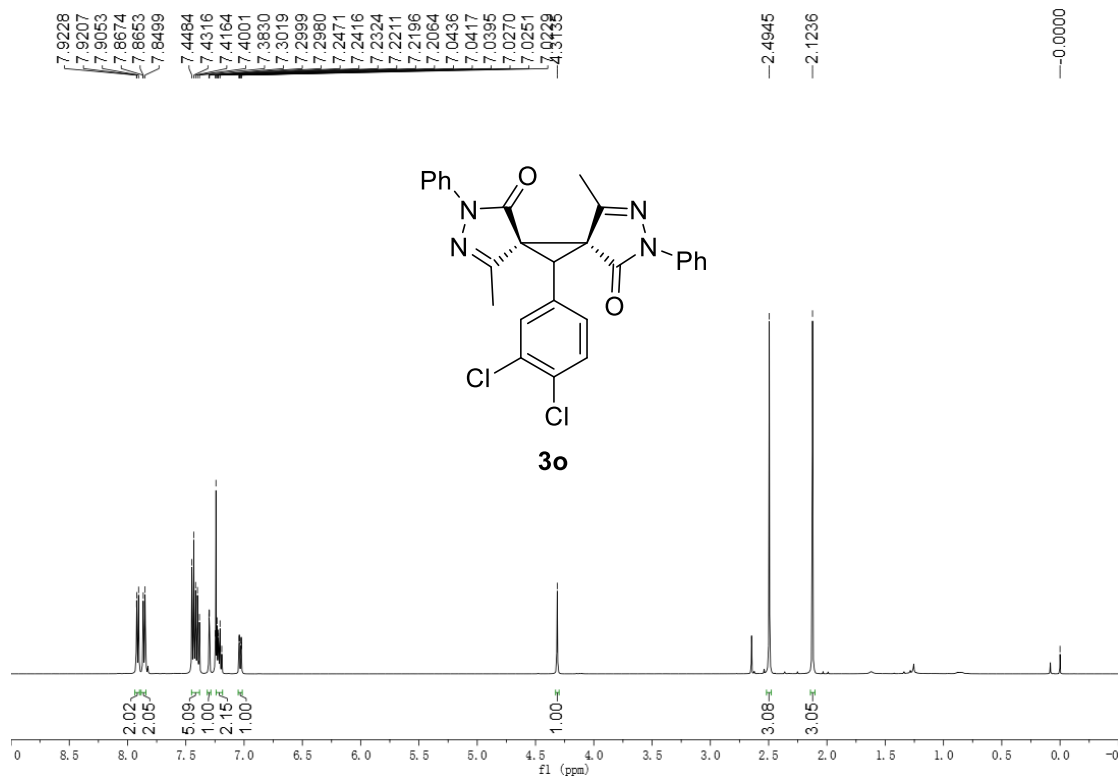
Figure S26.  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ ) of compound **3m**



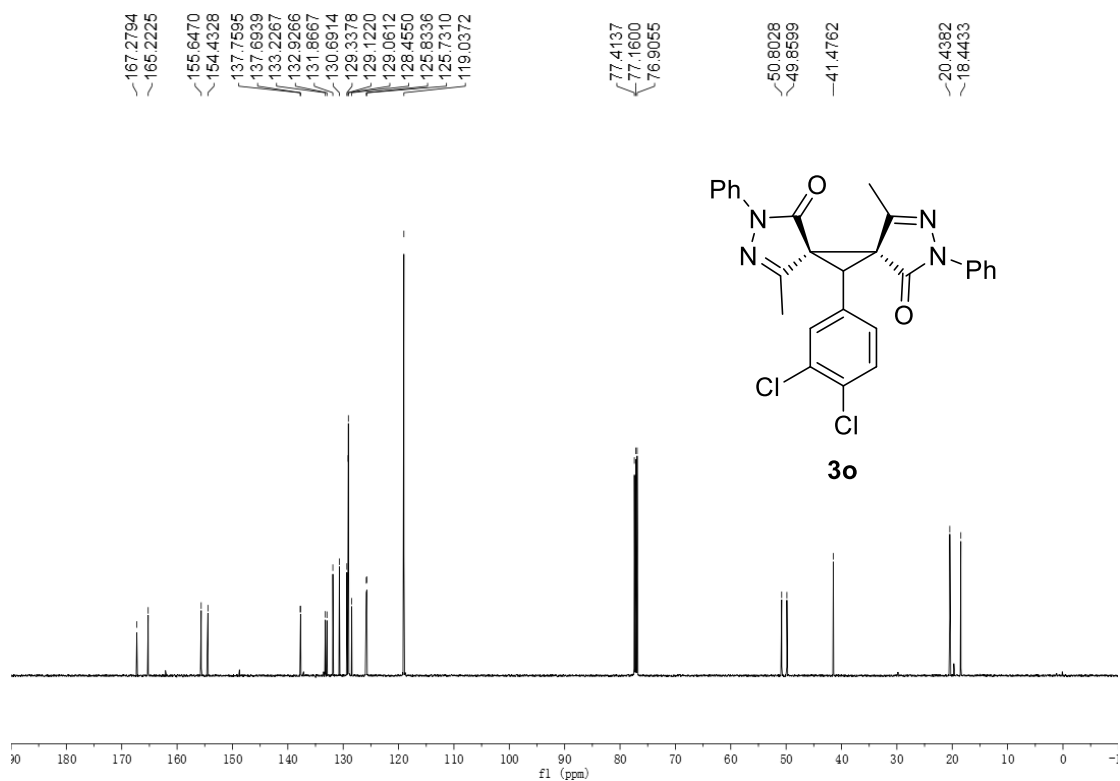
**Figure S27.** <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) of compound **3n**



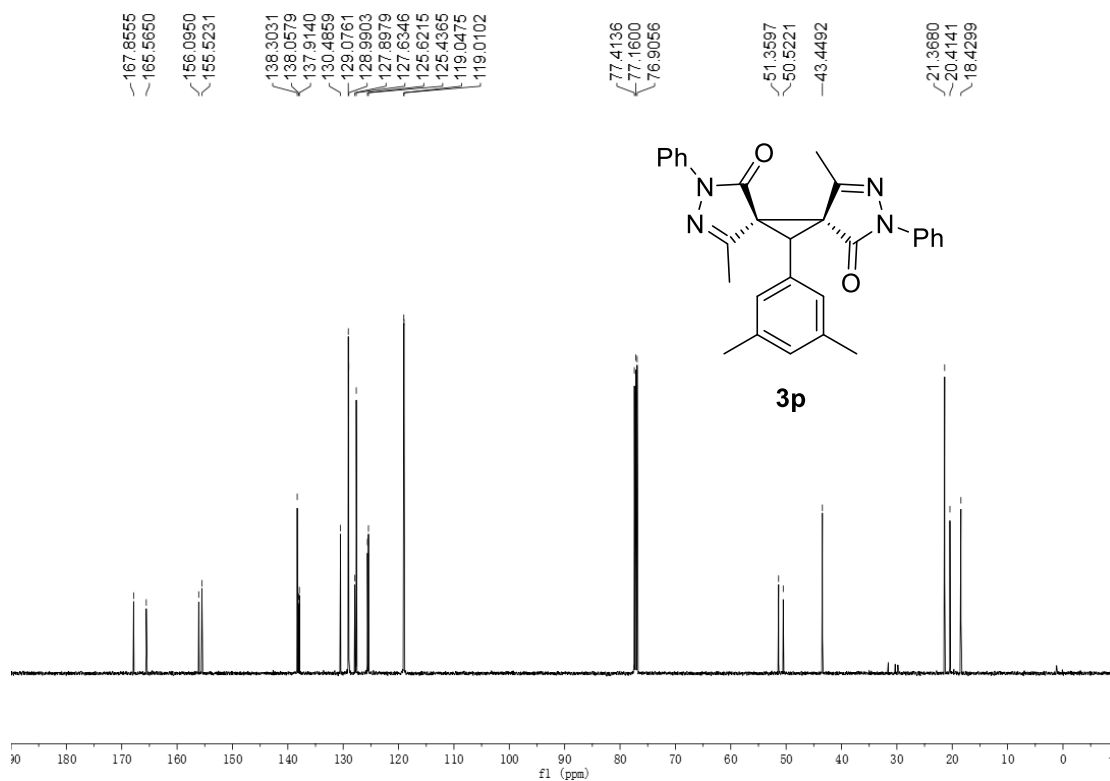
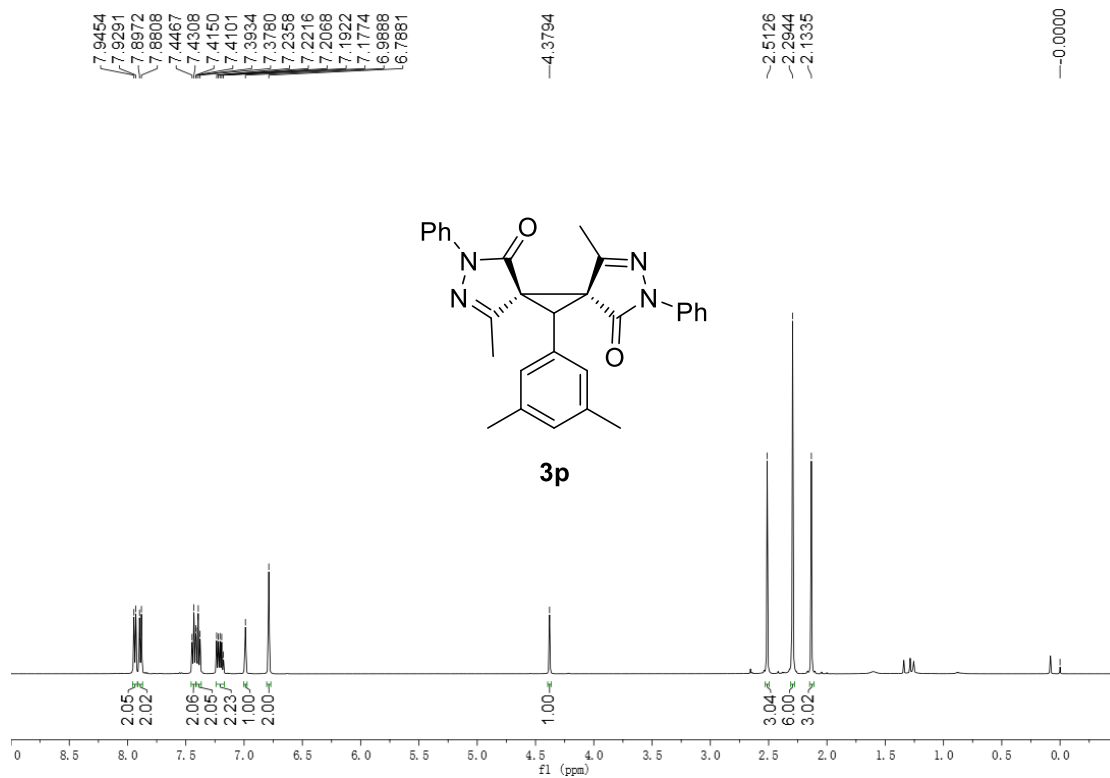
**Figure S28.** <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) of compound **3n**

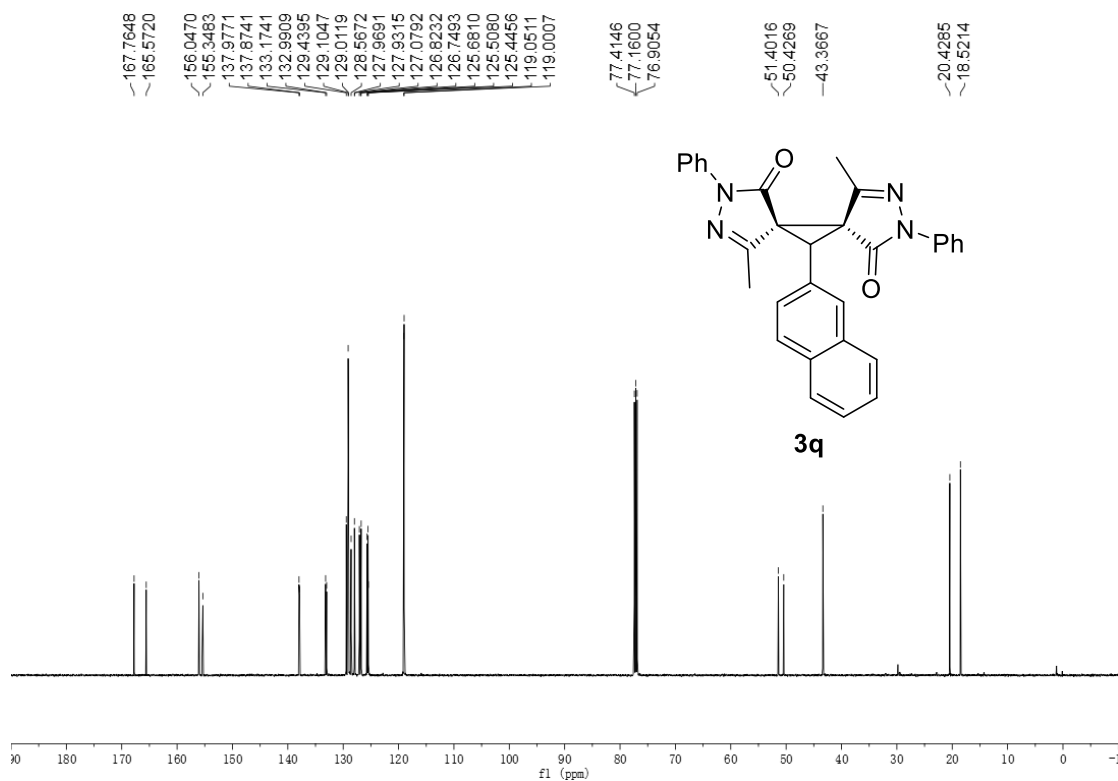
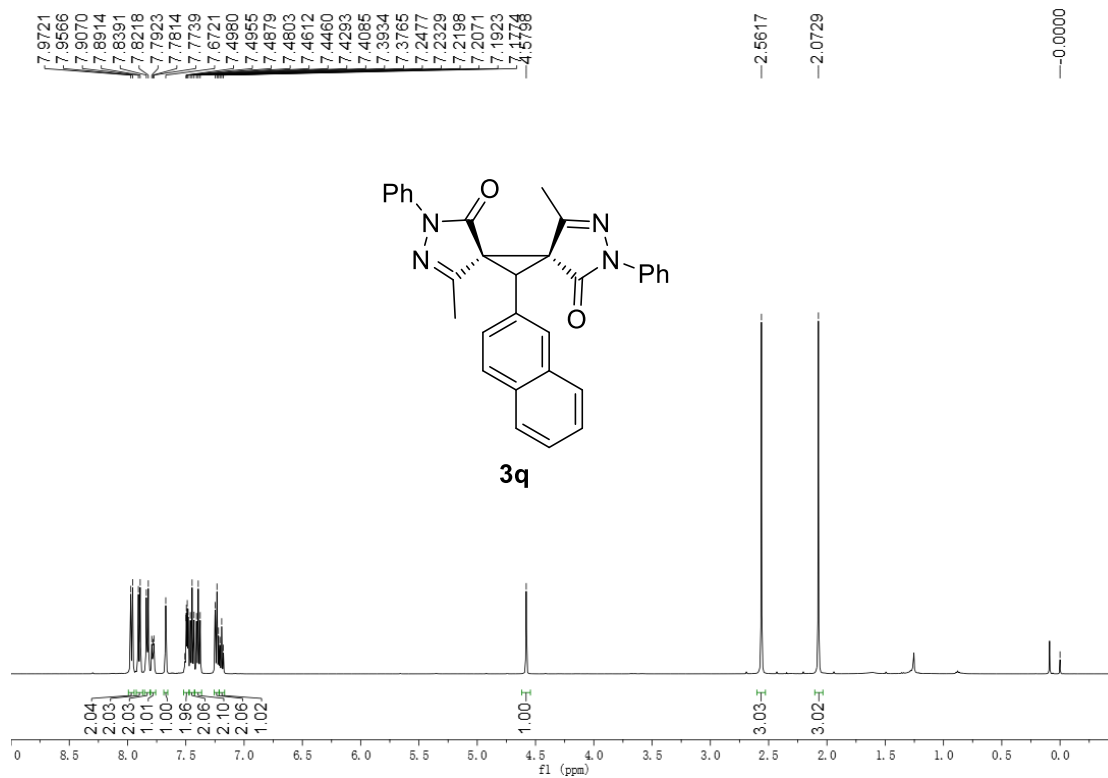


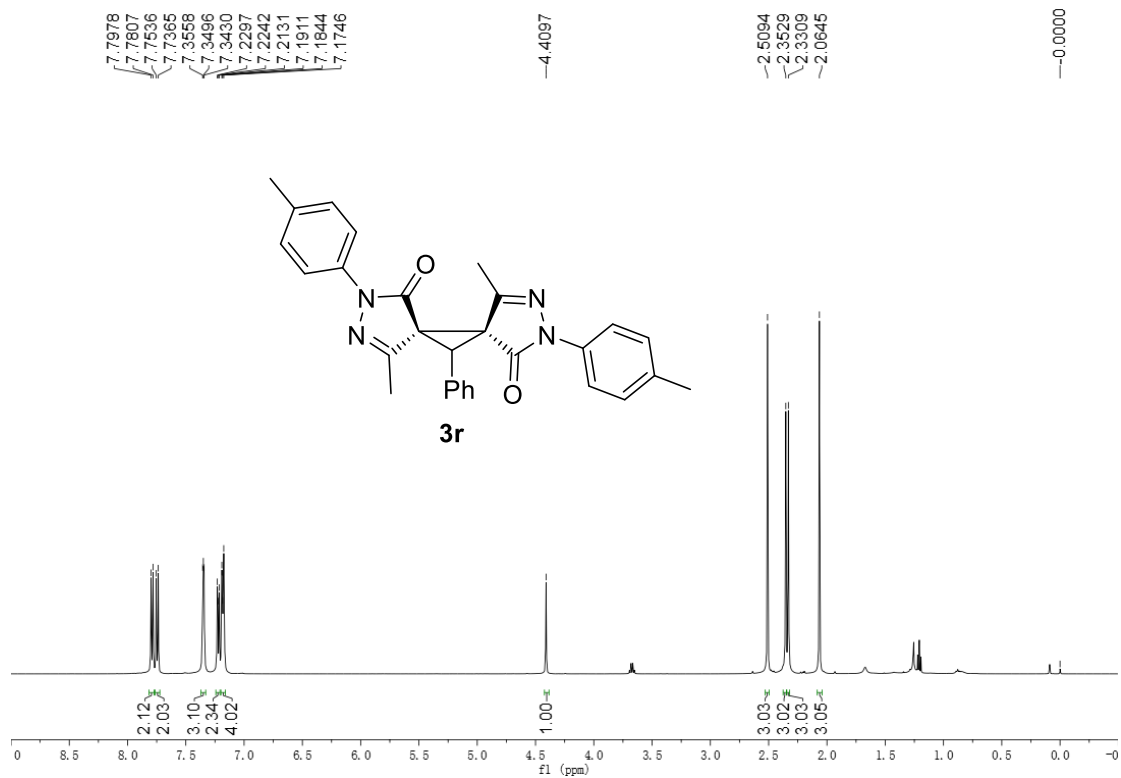
**Figure S29.** <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) of compound **3o**



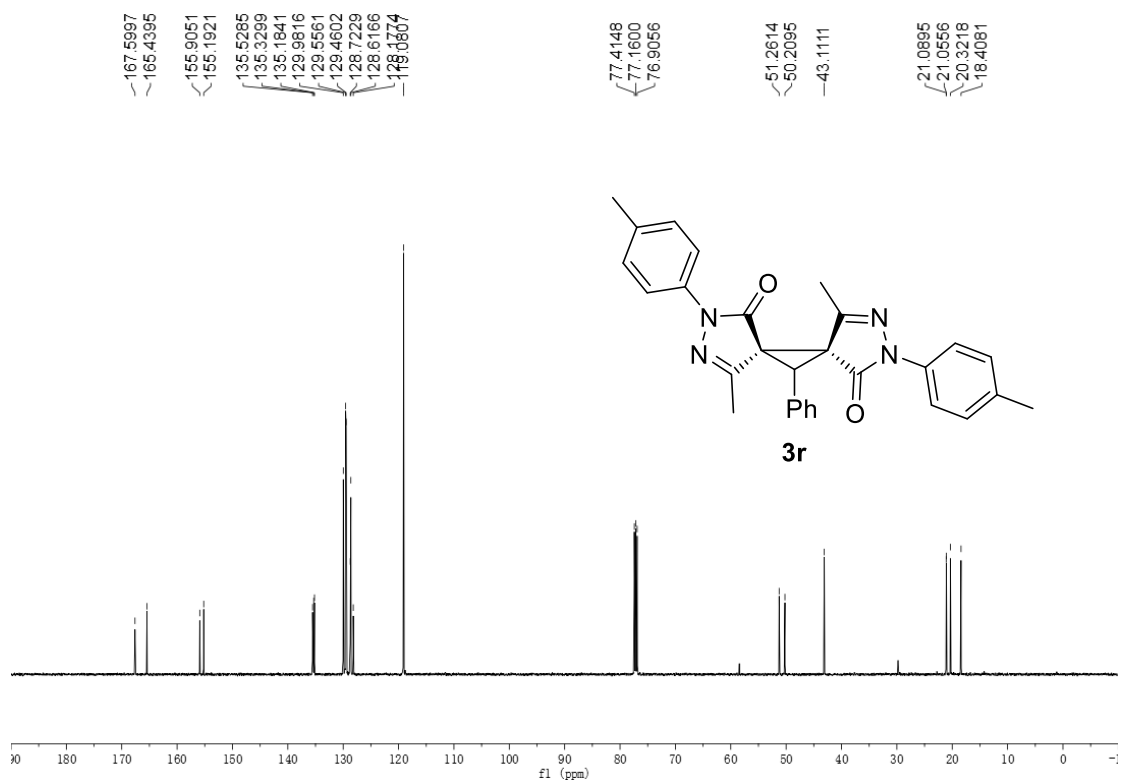
**Figure S30.** <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) of compound **3o**







**Figure S35.** <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) of compound **3r**



**Figure S36.** <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) of compound **3r**

## 5. References

- [1] S. Devi, A. Nayak, and A. S. Mitra, *J. Indian Chem. Soc.*, 1984, **61**, 640.
- [2] M. N. Elinson, A. N. Vereshchagin, E. O. Tretyakova, I. S. Bushmarinov, and G. I. Nikishin, *Synthesis*, 2011, **43**, 3015.
- [3] O. Barreiro-Costa, G. Morales-Noboa, P. Rojas-Silva, E. Lara-Barba, J. Santamaría-Aguirre, N. Bailón-Moscoso, J. C. Romero-Benavides, A. Ana Herrera, C. Cueva, L. Ron-Garrido, A. Poveda, and J. Heredia-Moya, *Molecules*, 2021, **26**, 4960.
- [4] M. N. Elinson, Y. E. Ryzhkova, F. V. Ryzhkov, V. M. Kalashnikova, and O. I. Maslov, *Monatsh. Chem.*, 2023, **154**, 625.