

Supplementary Information

Ionic Organic Solid 1,3-bis(Sulfomethyl)Imidazoliumate As an Effective Metal-Free Catalyst for Sustainable Organic Syntheses

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Detailed Experimental Protocols

Procedure for the preparation of **bsmim**

Glyoxal (40% aq., 5 mmol, 0.57 mL), formaldehyde (37% aq., 5 mmol, 0.37 mL) and aminomethanesulfonic acid (10 mmol, 1.11 g) were added to a round-bottom flask along with water (2 mL) and sulfuric acid (catalytic, 100 μ L) and stirred at 95 $^{\circ}$ C for 20 minutes, after which it was quickly put in an ice-brine bath at -15 $^{\circ}$ C. Then, acetone (20 mL) was added and the mixture was vigorously stirred (1200 rpm), which caused the precipitation of a fluffy brown solid over the next 20 minutes. The solid was then filtered, affording 628 mg of pure **bsmim** (49% yield).

General procedure for the Friedländer synthesis of quinolines promoted by **bsmim**

2-Aminobenzophenone (0.5 mmol), ketone (2.5 mmol) and **bsmim** (10 mol%, 13 mg) were added to a reaction tube. The reaction was then stirred at 80 $^{\circ}$ C for 16 hours, after which ethyl acetate was added (1 mL). After filtering the organic phase to remove the catalyst and removing the solvent under vacuum, the crude product was purified by column chromatography using mixtures of hexane and ethyl acetate.

General procedure for the allylation of heterocycles with **bsmim**

In a glass tube, precisely weighed allyl alcohol (0.5 mmol, 105 mg), heterocycle (0.5 mmol) and **bsmim** (10 mol%, 13 mg) were added. The mixture was then stirred at 80 $^{\circ}$ C until completion (monitored by GC-MS), after which the crude reaction mixture was diluted with ethyl acetate (1 mL) and filtered through a thin plug of silica to remove the catalyst. After evaporation of the solvent under reduced pressure, the corresponding allyl heterocycles were obtained.

Spectral data for all compounds

1,3-Bis(sulfomethyl)imidazole (1): Light brown solid, 49% yield; m.p. = 291-294 °C; ^1H NMR (400 MHz, D_2O) δ_{H} = 9.26 (s, 1H, NCHN), 7.76 (d, J = 1.6 Hz, 2H, NCHCHN), 5.43 (s, 4H, CH_2); ^{13}C NMR (100 MHz, D_2O) δ_{C} = 138.3, 123.5, 62.6. MS (EI, 70 eV) m/z (%): 66 (5), 64 (100), 48 (40); MS/MS (ESI^+) [256]: 261 (11), 242 (26), 238 (20), 193 (13), 176 (100), 163 (27).

3-Acetyl-2-methyl-4-phenylquinoline (3): Yellow solid, purification by column chromatography (hexane/ethyl acetate 7:3), 99% yield; m.p. 120-122 °C (lit. 117-119 °C)¹; ^1H NMR (300 MHz, CDCl_3): δ_{H} = 8.13 (d, J = 8.4 Hz, 1H, CH_{Ar}), 7.74 (ddd, J = 8.4, 6.9, 1.4 Hz, 1H, CH_{Ar}), 7.65-7.62 (m, 1H, CH_{Ar}), 7.53-7.46 (m, 4H, CH_{Ar}), 7.38-7.35 (m, 2H, CH_{Ar}), 2.73 (s, 3H, NCCH_3), 2.00 (s, 3H, COCH_3); ^{13}C NMR (100 MHz, CDCl_3): δ_{C} = 205.5, 153.7, 147.1, 144.7, 135.2, 134.9, 130.6, 130.1, 129.2, 128.9, 128.6, 126.9, 126.4, 125.2, 32.1, 23.7; MS (EI, 70 eV) m/z (%): 261 (M^+ , 49), 247 (19), 246 (100), 219 (7), 218 (38), 217 (31), 176 (22), 151 (8).

3-(Ethoxycarbonyl)-2-methyl-4-phenylquinoline (4): Yellow solid, purification by column chromatography (hexane/ethyl acetate 9:1), 98% yield; m.p. 99-100 °C (lit. 98-100 °C)¹; ^1H NMR (400 MHz, CDCl_3): δ_{H} = 8.06 (d, J = 8.1 Hz, 1H, CH_{Ar}), 7.68 (ddd, J = 8.4, 6.8, 1.4 Hz, 1H, CH_{Ar}), 7.56 (dd, J = 8.4, 0.9 Hz, 1H, CH_{Ar}), 7.47-7.43 (m, 3H, CH_{Ar}), 7.41-7.33 (m, 3H, CH_{Ar}), (q, J = 7.1 Hz, 2H, CH_2), 2.78 (s, 3H, NCCH_3), 0.92 (t, J = 7.1 Hz, 3H, COCCH_3); ^{13}C NMR (100 MHz, CDCl_3): δ_{C} = 168.5, 154.6, 147.7, 146.4, 135.8, 130.3, 129.4, 128.9, 128.5, 128.3, 127.5, 126.5, 126.5, 125.2, 61.4, 23.8, 13.7; MS (EI, 70 eV) m/z (%): 292 ($\text{M}^+ + 1$, 20), 291 (M^+ , 96), 263 (8), 262 (8), 247 (20), 246 (100), 245 (34), 219 (10), 218 (44), 217 (41), 216 (14), 177 (8), 176 (23), 151 (8).

3-acetyl-6-chloro-2-methyl-4-phenylquinoline (5): Yellow solid, purification by column chromatography (hexane/ethyl acetate 85:15), 93% yield; m.p. 160-161 °C (lit. 149-152 °C)¹; ^1H NMR (400 MHz, CDCl_3): δ_{H} = 8.06 (d, J = 8.9 Hz, 1H, CH_{Ar}), 7.66 (dd, J = 8.9, 2.3 Hz, 1H, CH_{Ar}), 7.58 (d, J = 2.3 Hz, 1H, CH_{Ar}), 7.55-7.52 (m, 3H, CH_{Ar}), 7.35-7.32 (m, 2H, J = 8.9, 2.3 Hz, 1H, CH_{Ar}), 2.69 (s, 3H, NCCH_3), 1.99 (s, 3H, COCH_3); ^{13}C NMR (100 MHz, CDCl_3): δ_{C} = 204.9, 154.1, 145.3, 143.9, 135.7, 134.4, 132.9, 131.5, 130.0, 129.5, 129.1, 126.1, 125.1, 31.9, 23.6; MS (EI, 70 eV) m/z (%): 297 ($\text{M}^+ + 2$, 16), 296 ($\text{M}^+ + 1$, 10), 295 (M^+ , 46), 282 (33), 281 (19), 280 (100), 254 (7), 252 (22), 218 (8), 217 (32), 216 (13), 189 (8), 176 (23).

9-Phenyl-1,2,3,4-tetrahydroacridine (6): Yellow solid, purification by column chromatography (hexane/ethyl acetate 8:2), 94% yield; m.p. 151-153 °C (lit. 152-155 °C)²; ^1H NMR (300 MHz, CDCl_3): δ_{H} = 8.13 (d, J = 8.5 Hz, 1H, CH_{Ar}), 7.66-7.60 (m, 1H, CH_{Ar}), 7.56-7.45 (m, 3H, CH_{Ar}), 7.35-7.33 (m, 2H, CH_{Ar}), 7.25-7.22 (m, 2H, CH_{Ar}), 3.27 (t, J = 6.6 Hz, 2H, NCCH_2), 2.62 (t, J = 6.4 Hz, 2H, PhCCCH_2), 2.02-1.93 (m, 2H, NCCCH_2), 1.84-1.76 (m, 2H, PhCCCH_2); ^{13}C NMR (75 MHz, CDCl_3): δ_{C} = 158.9, 147.7, 145.4, 136.9, 129.1, 129.0, 128.8, 128.7, 128.1, 127.7, 126.9, 126.0, 125.9, 33.8, 28.1, 23.0, 22.8; MS (EI, 70 eV) m/z (%): 260 ($\text{M}^+ + 1$, 19), 259 (M^+ , 100), 258 ($\text{M}^+ - 1$, 66), 244 (8), 230 (14), 182 (8).

9-Phenyl-2,3-dihydro-1H-cyclopenta[b]quinoline (7): Faint yellow solid, purification by column chromatography (hexane/ethyl acetate 98:2), 93% yield, m.p. 138–141 °C (lit. 138–139 °C)²; ¹H NMR (400 MHz, CDCl₃): δ_H = 8.02–8.00 (m, 1H, CH_{Ar}), 7.57–7.53 (m, 2H, CH_{Ar}), 7.47–7.37 (m, 3H, CH_{Ar}), 7.32–7.28 (m, 3H, CH_{Ar}), 3.17 (t, *J* = 7.7 Hz, 2H, NCCH₂), 2.83 (t, *J* = 7.4 Hz, 2H, PhCCCH₂), 2.13–2.07 (m, 2H, NCCCCH₂); ¹³C NMR (100 MHz, CDCl₃): δ_C = 167.5, 147.9, 142.9, 136.9, 133.8, 129.4, 128.9, 128.6, 128.4, 128.1, 126.4, 125.8, 125.7, 35.3, 30.5, 23.7; MS (EI, 70 eV) *m/z* (%): 246 (M⁺+1, 18), 245 (M⁺, 100), 244 (M⁺-1, 80), 243 (12), 242 (12), 241 (7), 217 (9), 168 (15), 167 (10), 108 (7).

12-Phenyl-6,7,8,9,10,11-hexahydrocycloocta[b]quinoline (8): Faint yellow solid, purification by column chromatography (hexane/ethyl acetate 95:5), 96% yield; m.p. 209–211 °C (lit. 214–215 °C)¹; ¹H NMR (300 MHz, CDCl₃): δ_H = 8.01–7.98 (m, 1H, CH_{Ar}), 7.54–7.48 (m, 1H, CH_{Ar}), 7.46–7.36 (m, 3H, CH_{Ar}), 7.27–7.11 (m, 4H, CH_{Ar}), 3.17–3.13 (m, 2H, NCCH₂), 2.69–2.65 (m, 2H, PhCCCH₂), 1.88–1.84 (m, 2H, CH₂), 1.42–1.27 (m, 6H, 3xCH₂); ¹³C NMR (75 MHz, CDCl₃): δ_C = 163.5, 146.7, 146.3, 137.7, 131.9, 129.4, 128.5, 128.4, 127.7, 127.3, 126.2, 125.5, 36.3, 31.3, 31.3, 28.2, 26.8, 25.9; MS (EI, 70 eV) *m/z* (%): 288 (M⁺+1, 20), 287 (M⁺, 93), 286 (M⁺-1, 100), 272 (9), 260 (8), 259 (17), 258 (40), 256 (9), 245 (8), 244 (25), 243 (9), 242 (9), 232 (19), 231 (14), 230 (16), 217 (14), 216 (7), 202 (8), 189 (10).

9-Phenyl-3,4-dihydroacridin-1(2H)-one (9): Yellow solid, purification by column chromatography (hexane/ethyl acetate 8:2), 96% yield; m.p. 163–165 °C (lit. 161–162 °C)²; ¹H NMR (400 MHz, CDCl₃): δ_H = 8.18 (d, *J* = 8.4 Hz, 1H, CH_{Ar}), 7.80 (ddd, *J* = 8.4, 6.6, 1.6 Hz, 1H, CH_{Ar}), 7.53–7.41 (m, 5H, CH_{Ar}), 7.19–7.17 (m, 2H, CH_{Ar}), 3.45 (t, *J* = 6.3 Hz, 2H, NCCH₂), 2.72 (t, *J* = 6.1 Hz, 2H, COCH₂), 2.28–2.25 (m, 2H, COCCH₂); ¹³C NMR (100 MHz, CDCl₃): δ_C = 197.6, 162.1, 152.5, 147.7, 137.4, 132.4, 128.4, 128.3, 128.1, 127.9, 127.7, 126.9, 124.0, 40.7, 34.1, 21.4; MS (EI, 70 eV) *m/z* (%): 274 (M⁺+1, 19), 273 (M⁺, 100), 272 (M⁺-1, 94), 246 (7), 245 (47), 244 (97), 217 (32), 216 (31), 214 (8), 190 (9), 189 (16), 176 (7).

2,9-Diphenyl-1,2,3,4-tetrahydroacridine (10): Yellow solid, purification by column chromatography (hexane/ethyl acetate 9:1), 97% yield; ¹H NMR (400 MHz, CDCl₃): δ_H = 7.98–7.96 (m, 1H, CH_{Ar}), 7.57–7.52 (m, 1H, CH_{Ar}), 7.41–7.35 (m, 3H, CH_{Ar}), 7.25–7.10 (m, 9H, CH_{Ar}), 3.37–3.22 (m, 2H, CH_{Alk}), 2.95 (tdd, *J* = 11.4, 4.7, 3.0 Hz, 1H, CH_{Alk}), 2.83 (ddd, *J* = 17.1, 4.9, 2.0 Hz, 1H, CH_{Alk}), 2.68 (dd, *J* = 17.1, 4.9 Hz, 1H, CH_{Alk}), 2.25–2.19 (m, 1H, CH_{Alk}), 2.13–2.02 (m, 1H, CH_{Alk}); ¹³C NMR (100 MHz, CDCl₃): δ_C = 158.4, 146.9, 146.6, 145.9, 136.9, 129.2, 129.0, 128.9, 128.8, 128.7, 128.7, 128.5, 127.9, 127.8, 127.0, 126.8, 126.5, 126.0, 125.7, 40.9, 36.2, 34.4, 30.3; MS (EI, 70 eV) *m/z* (%): 336 (M⁺+1, 14), 335 (M⁺, 65), 334 (M⁺-1, 100), 231 (8), 230 (19), 91 (8).

(E)-3-(1,3-Diphenylallyl)-1H-indole (11): Yellow oil, obtained pure, 99% yield; ¹H NMR (400 MHz, CDCl₃): δ_H = 7.96 (br s, 1H, NH), 7.51 (d, *J* = 8.0 Hz, 1H, CH_{Ar}), 7.45–7.22 (m, 12H, CH_{Ar}), 7.10 (ddd, *J* = 8.0, 7.1, 1.0 Hz, 1H, CH_{Ar}), 6.93 (d, *J* = 1.3 Hz, 1H, CH_{Ar}), 6.80 (dd, *J* = 15.9, 7.4 Hz, 1H, PhC=CH), 6.52 (br d, *J* = 15.9 Hz, 1H, C=CHPh), 5.19 (br d, *J* = 7.4 Hz, 1H, C=CCH); ¹³C NMR (100 MHz, CDCl₃): δ_C = 143.5, 137.6, 136.8, 132.7, 130.7, 128.6, 128.6, 127.3, 126.9, 126.5, 126.5, 122.7, 122.2, 120.0, 119.6, 118.8, 111.2, 46.3; MS (EI, 70 eV) *m/z* (%): 310 (M⁺+1, 25), 309 (M⁺, 100), 308 (M⁺-1, 39), 294 (10), 233 (7), 232 (36), 231 (7), 230 (20), 218 (15), 217 (17), 206 (28), 205 (8), 204 (22), 202 (8), 192 (14), 191 (16), 178 (9), 130 (19), 115 (17).



(E)-3-(1,3-Diphenylallyl)-2-phenyl-1H-indole (12): Faint orange oil, purified by preparative TLC (hexane/ethyl acetate 9:1), 60% yield; ^1H NMR (300 MHz, CDCl_3): δ_{H} = 8.02 (br s, 1H, NH), 7.52–7.48 (m, 2H, CH_{Ar}), 7.44–7.12 (m, 16H, CH_{Ar}), 6.98 (ddd, J = 8.0, 7.1, 1.0 Hz, 1H, CH_{Ar}), 6.88 (dd, J = 15.8, 7.3 Hz, 1H, $\text{PhC}=\text{CH}$), 6.39 (dd, J = 15.8, 1.0 Hz, 1H, $\text{C}=\text{CHPh}$), 5.27 (br d, J = 7.3 Hz, 1H, $\text{C}=\text{CCH}$); ^{13}C NMR (75 MHz, CDCl_3): δ_{C} = 143.6, 137.6, 136.3, 135.7, 133.0, 132.4, 131.2, 128.9, 128.7, 128.6, 128.4, 128.2, 128.0, 127.2, 126.4, 126.2, 122.2, 121.3, 119.8, 113.9, 111.1, 45.2; MS (EI, 70 eV) m/z (%): 386 ($\text{M}^+ + 1$, 30), 385 (M^+ , 100), 384 ($\text{M}^+ - 1$, 19), 309 (12), 308 (46), 307 (7), 306 (17), 304 (11), 295 (21), 294 (96), 293 (29), 292 (9), 291 (11), 282 (17), 281 (8), 280 (18), 278 (8), 230 (14), 218 (9), 217 (13), 207 (9), 206 (47), 205 (8), 204 (23), 203 (8), 202 (9), 194 (9), 193 (45), 192 (22), 191 (22), 189 (8), 178 (9), 176 (7), 165 (14), 153 (9), 152 (10), 146 (9), 115 (9), 91 (7).

(E)-3-(1,3-Diphenylallyl)-9-ethyl-1H-indole (13): Reddish oil, obtained pure, 99% yield; ^1H NMR (300 MHz, CDCl_3) δ_{H} = 7.89 (br s, 1H, NH), 7.36–7.15 (m, 11H, CH_{Ar}), 7.02–6.97 (m, 2H, CHN , CH_{Ar}), 6.84 (dd, J = 2.4, 0.9 Hz, 1H, CH_{Ar}), 6.72 (dd, J = 15.8, 7.4 Hz, 1H, $\text{PhC}=\text{CH}$), 6.43 (br d, J = 15.8 Hz, 1H, $\text{C}=\text{CHPh}$), 5.10 (br d, J = 7.4 Hz, 1H, $\text{C}=\text{CCH}$), 2.82 (q, J = 7.6 Hz, 2H, CH_2), 1.34 (t, J = 7.6 Hz, 3H, CH_3); ^{13}C NMR (75 MHz, CDCl_3): δ_{C} = 143.6, 137.6, 135.6, 132.7, 130.6, 128.6, 128.6, 128.5, 127.3, 126.7, 126.6, 126.4, 122.3, 120.7, 119.8, 119.2, 117.8, 46.4, 24.1, 13.9; MS (EI, 70 eV) m/z (%): 338 ($\text{M}^+ + 1$, 27), 337 (M^+ , 100), 336 ($\text{M}^+ - 1$, 34), 334 (9), 333 (28), 332 (9), 308 (20), 261 (7), 260 (33), 234 (23), 231 (9), 230 (24), 218 (9), 217 (14), 204 (10), 192 (17), 191 (20), 189 (7), 158 (15), 130 (12), 115 (11); HRMS (QTOF) calculated for $\text{C}_{25}\text{H}_{23}\text{N}$ = 337.1830, observed = 337.1823.

(E)-1-(1,3-Diphenylallyl)-1H-pyrazole (14): Colorless oil, obtained pure, 99% yield; ^1H NMR (300 MHz, CDCl_3): δ_{H} = 7.60 (d, J = 1.4 Hz, 1H, CH_{Ar}), 7.45 (d, J = 2.2 Hz, 1H, CH_{Ar}), 7.39–7.20 (m, 10H, CH_{Ar}), 6.71 (dd, J = 16.0, 6.9 Hz, 1H, $\text{PhC}=\text{CH}$), 6.43 (br d, J = 16.0 Hz, 1H, $\text{C}=\text{CHPh}$), 6.30–6.28 (m, 1H, CH_{Ar}), 6.18 (br d, J = 6.9 Hz, 1H, $\text{C}=\text{CCH}$); ^{13}C NMR (75 MHz, CDCl_3): δ_{C} = 139.6, 139.4, 136.1, 133.8, 128.9, 128.7, 128.2, 127.4, 127.3, 126.8, 105.7, 67.6; MS (EI, 70 eV) m/z (%): 261 ($\text{M}^+ + 1$, 15), 260 (M^+ , 78), 259 ($\text{M}^+ - 1$, 24), 232 (7), 193 (28), 192 (43), 191 (55), 190 (11), 189 (23), 184 (8), 183 (55), 179 (7), 178 (33), 169 (31), 165 (21), 157 (18), 156 (36), 144 (21), 143 (8), 117 (9), 115 (100), 91 (27), 89 (7), 77 (8).

(E)-1-(1,3-Diphenylallyl)-3,5-dimethyl-1H-pyrazole (15): White solid, obtained pure, 99% yield; m.p. 108–110 $^{\circ}\text{C}$; ^1H NMR (400 MHz, CDCl_3): δ_{H} = 7.43–7.41 (m, 2H, CH_{Ar}), 7.33–7.23 (m, 6H, CH_{Ar}), 7.16–7.14 (m, 2H, CH_{Ar}), 6.88 (dd, J = 15.9, 7.5 Hz, 1H, $\text{PhC}=\text{CH}$), 6.51 (br d, J = 15.9 Hz, 1H, $\text{C}=\text{CHPh}$), 5.98 (br d, J = 7.5 Hz, 1H, $\text{C}=\text{CCH}$), 5.87 (s, 1H, MeCCH), 2.27 (s, 3H, CH_3), 2.17 (s, 3H, CH_3); ^{13}C NMR (100 MHz, CDCl_3): δ_{C} = 147.8, 140.2, 139.2, 136.5, 133.1, 128.8, 128.6, 128.0, 127.9, 127.7, 126.9, 126.9, 105.9, 64.5, 13.8, 11.5; MS (EI, 70 eV) m/z (%): 289 ($\text{M}^+ + 1$, 10), 288 (M^+ , 50), 287 ($\text{M}^+ - 1$, 18), 273 (8), 212 (16), 211 (100), 194 (7), 193 (38), 192 (14), 185 (9), 184 (9), 178 (30), 170 (12), 165 (3), 116 (10), 115 (91), 108 (8), 91 (25).

NMR spectra

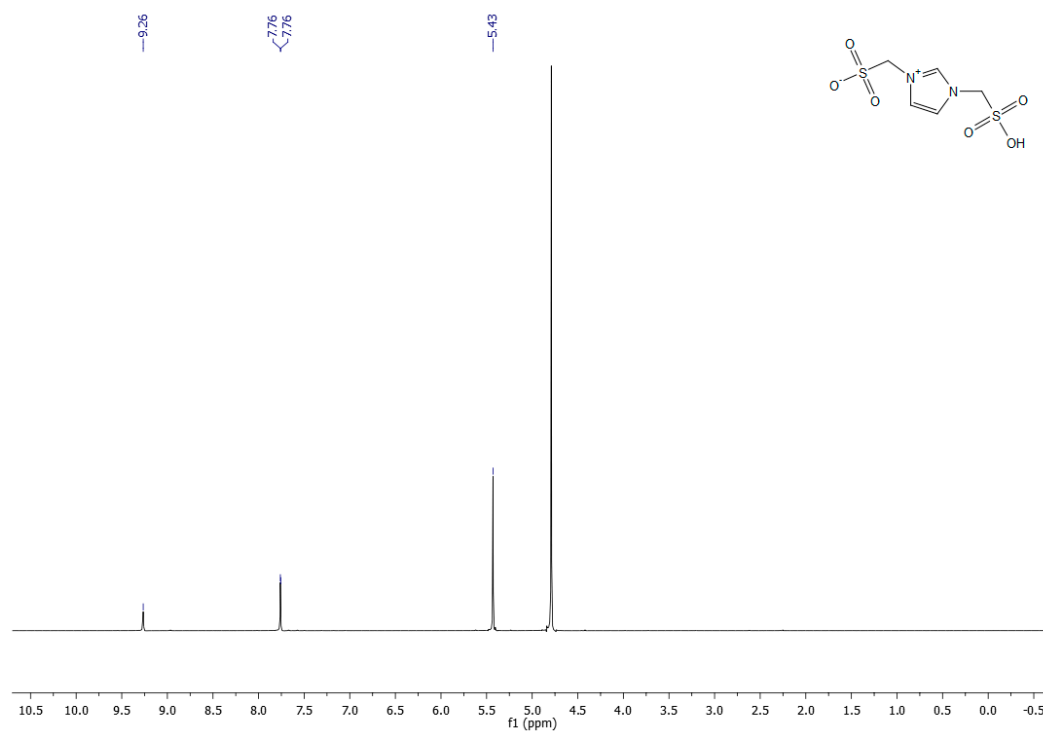


Figure SI.1. ¹H NMR spectrum of 1,3-bis(sulfomethyl)imidazole (1)

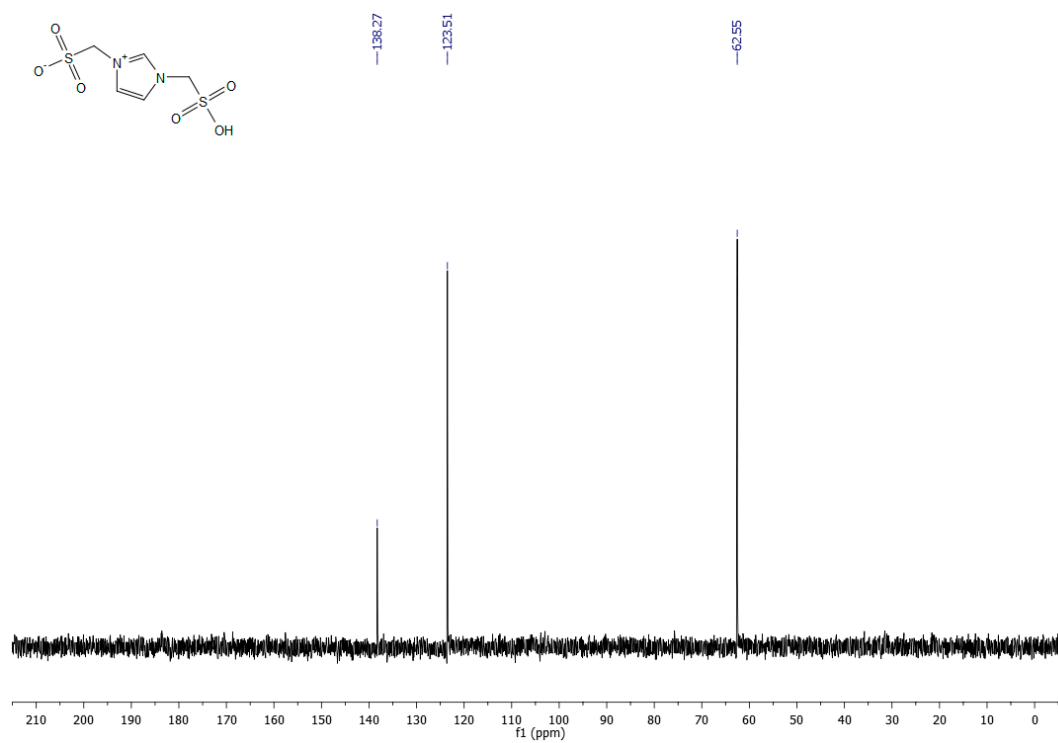


Figure SI.2. ¹³C NMR spectrum of 1,3-bis(sulfomethyl)imidazole (1)

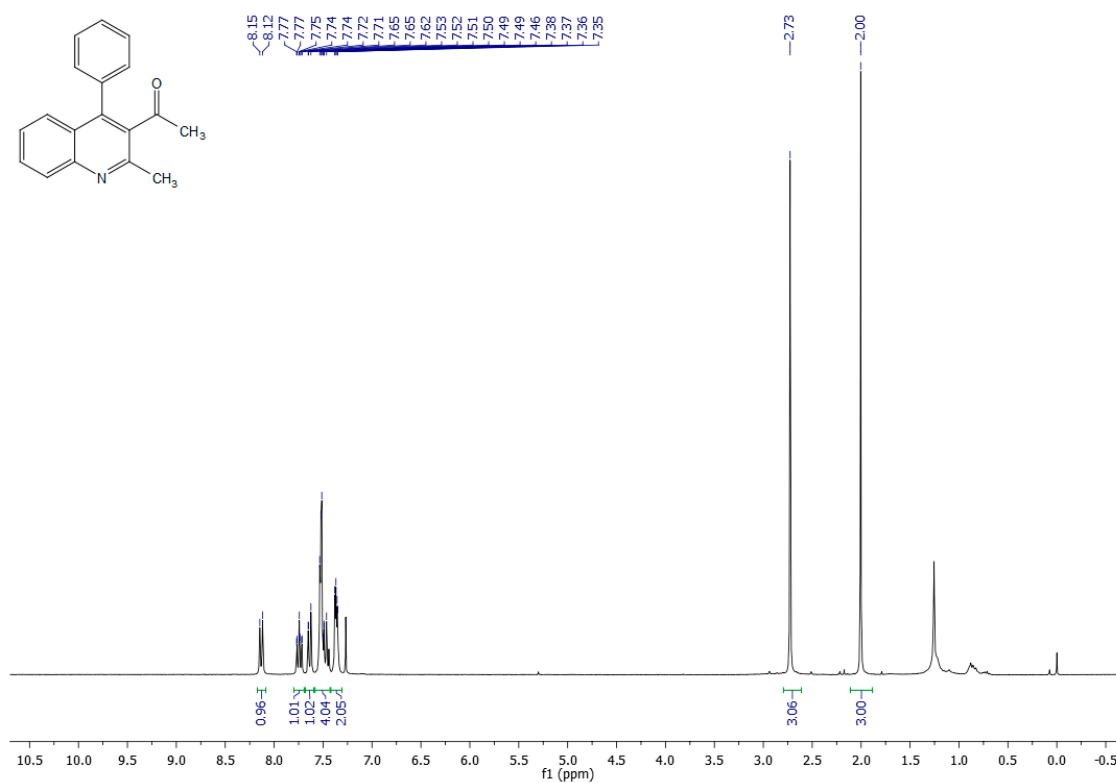


Figure SI.3. ¹H NMR spectrum of 3-acetyl-2-methyl-4-phenylquinoline (3)

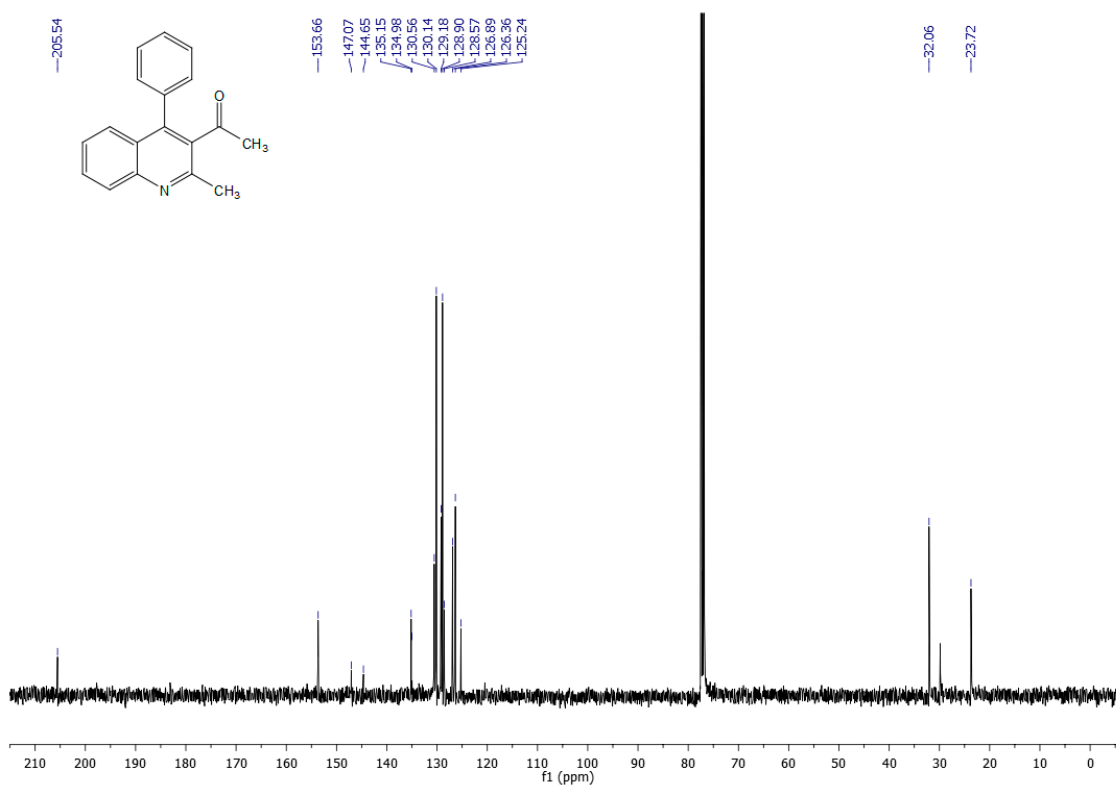


Figure SI.4. ¹³C NMR spectrum of 3-acetyl-2-methyl-4-phenylquinoline (3)

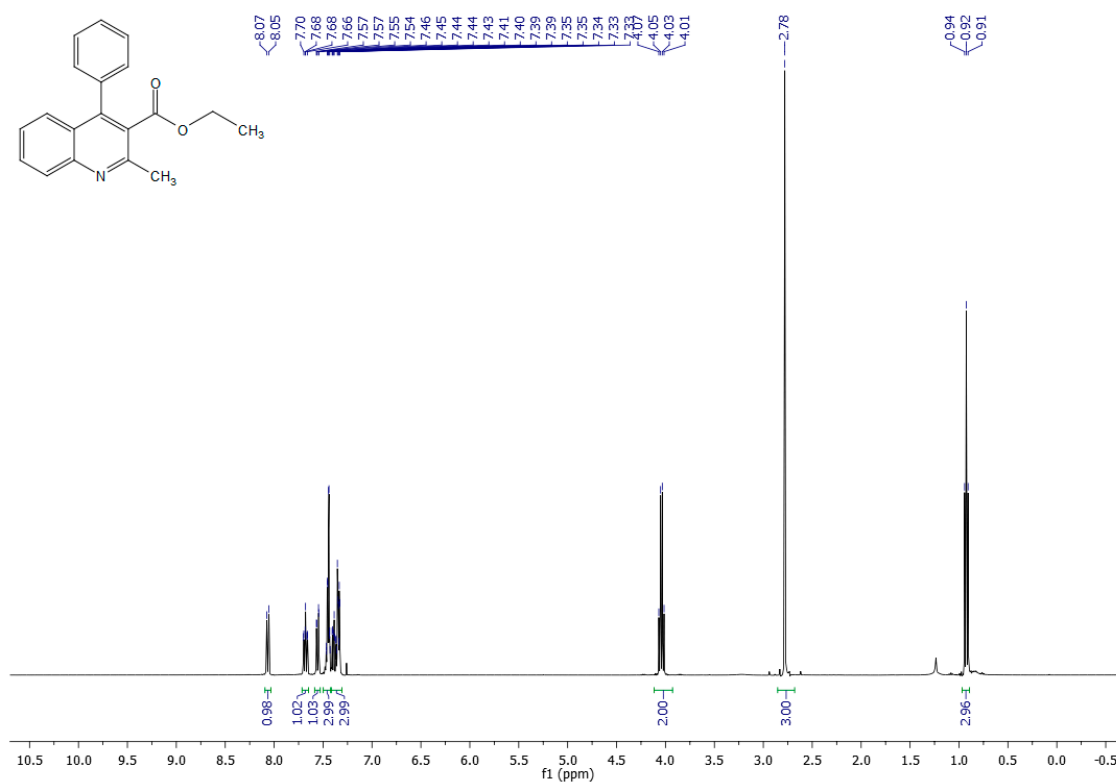


Figure SI.5. ¹H NMR spectrum of 3-(ethoxycarbonyl)-2-methyl-4-phenylquinoline (4)

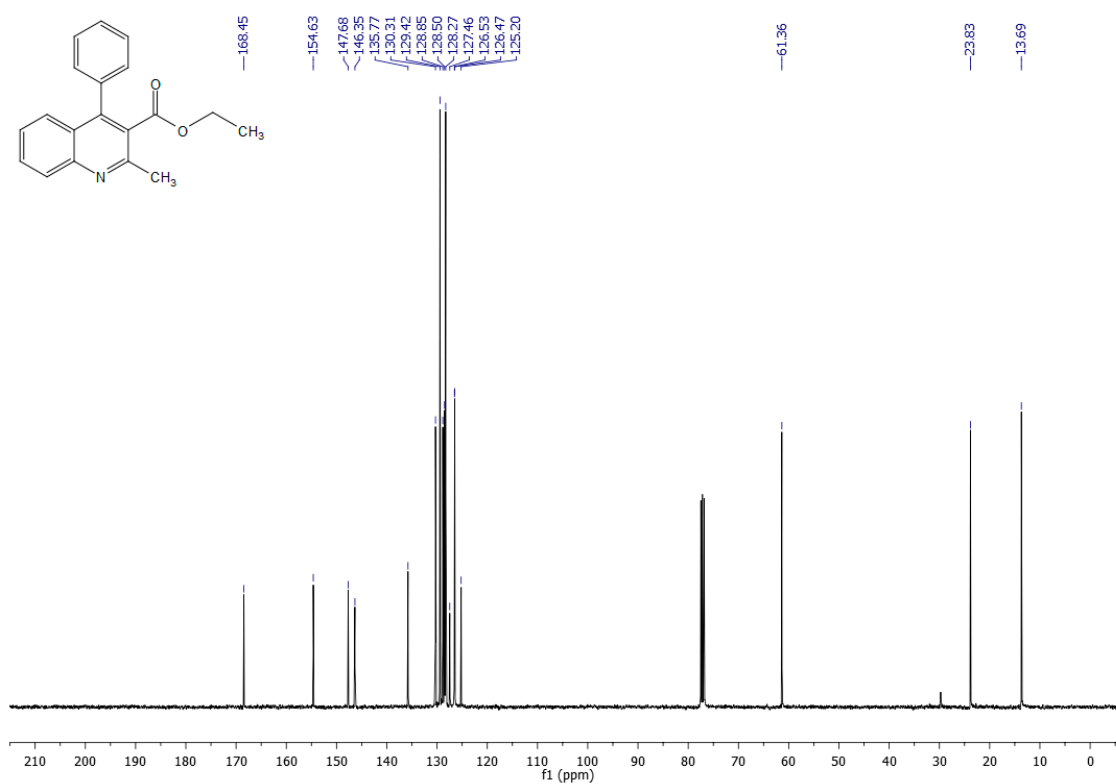


Figure SI.6. ¹³C NMR spectrum of 3-(ethoxycarbonyl)-2-methyl-4-phenylquinoline (4)

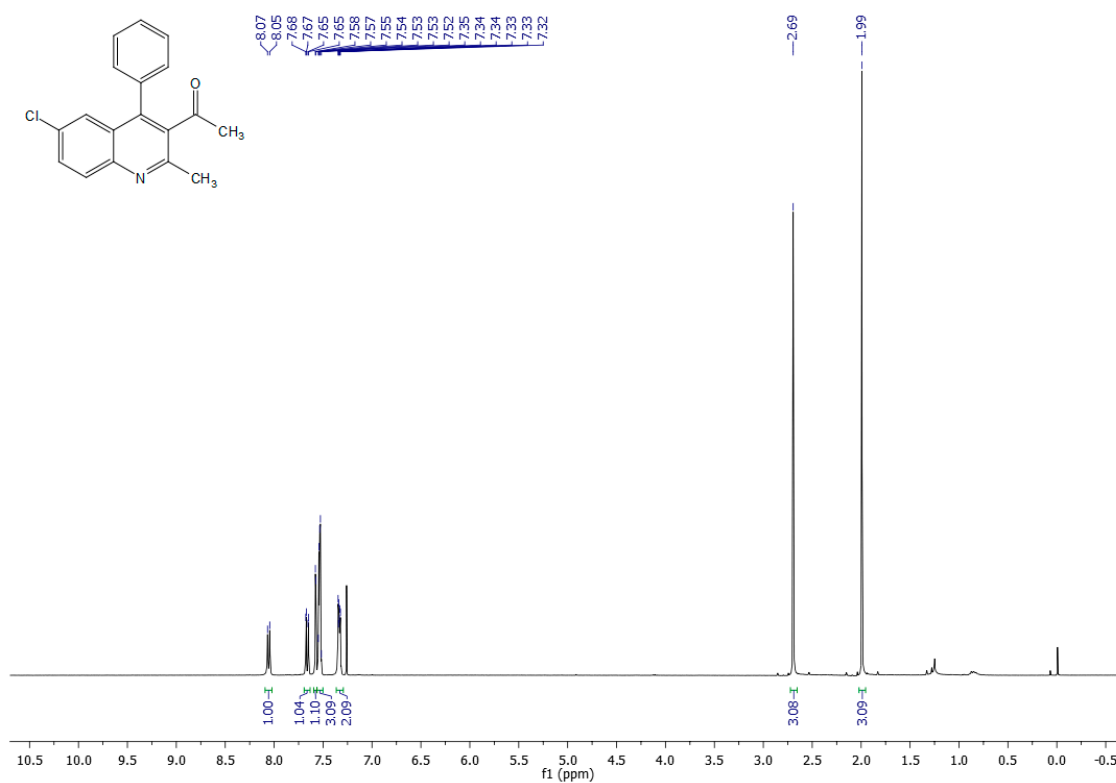


Figure SI.7. ¹H NMR spectrum of 3-acetyl-6-chloro-2-methyl-4-phenylquinoline (5)

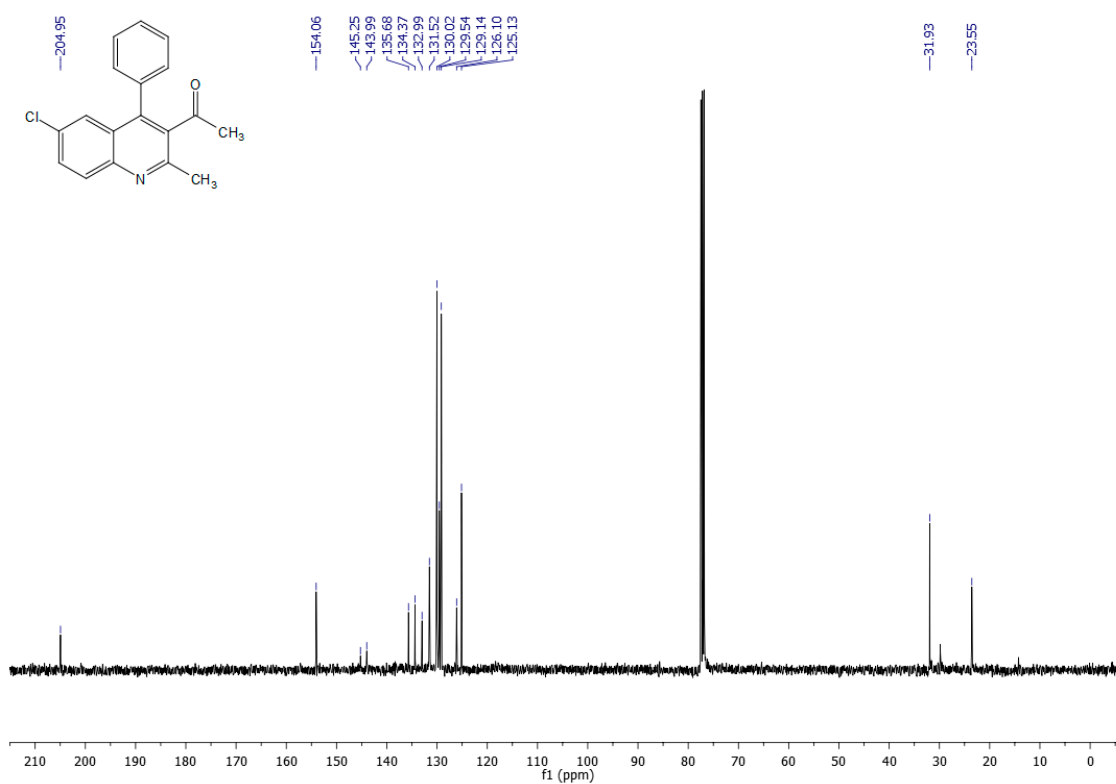


Figure SI.8. ¹³C NMR spectrum of 3-acetyl-6-chloro-2-methyl-4-phenylquinoline (5)

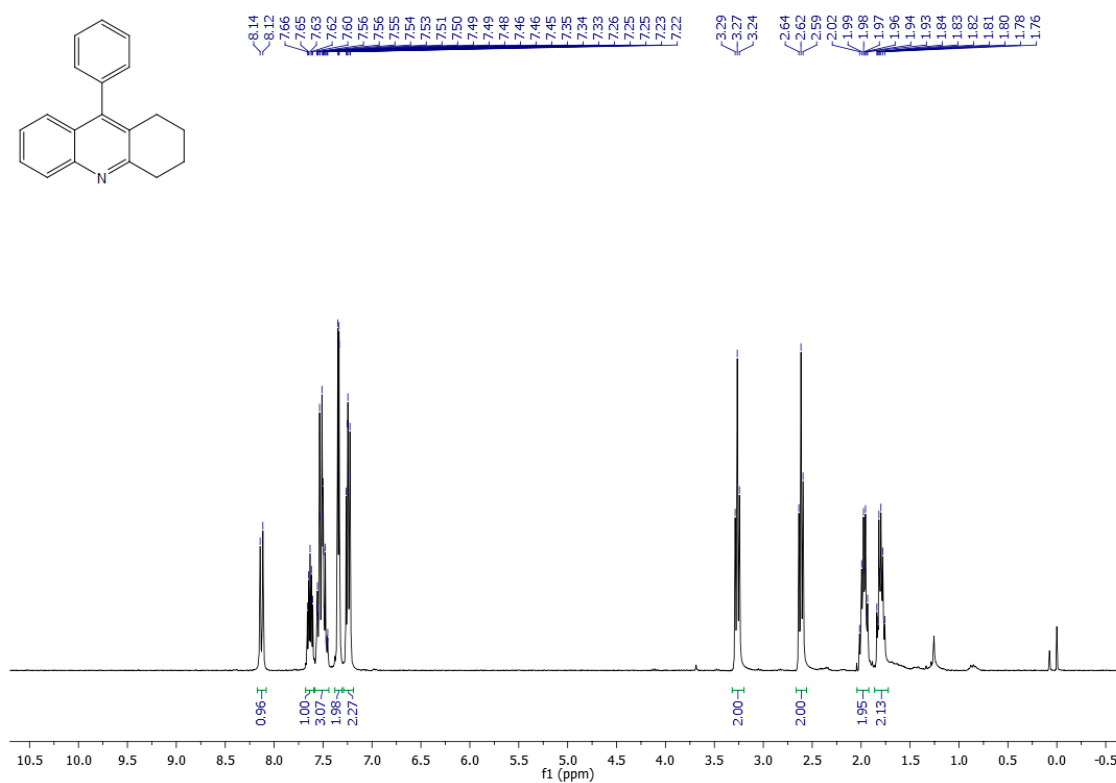


Figure SI.9. ¹H NMR spectrum of 9-phenyl-1,2,3,4-tetrahydroacridine (6)

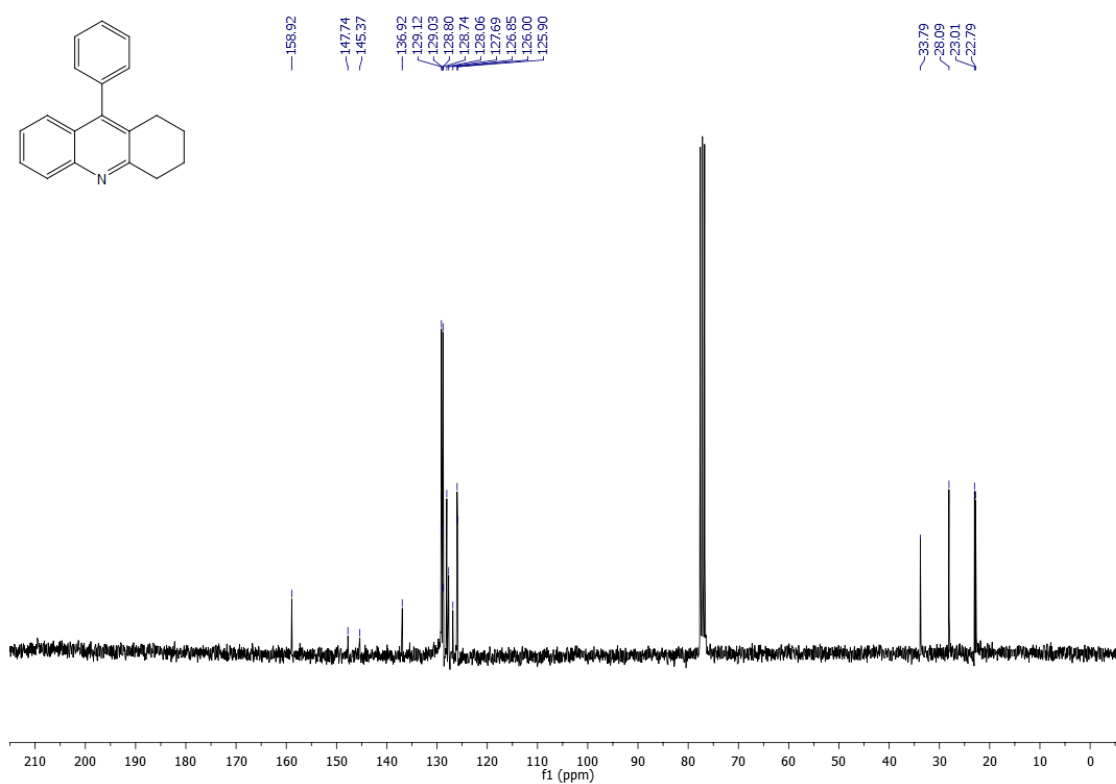


Figure SI.10. ¹³C NMR spectrum of 9-phenyl-1,2,3,4-tetrahydroacridine (6)

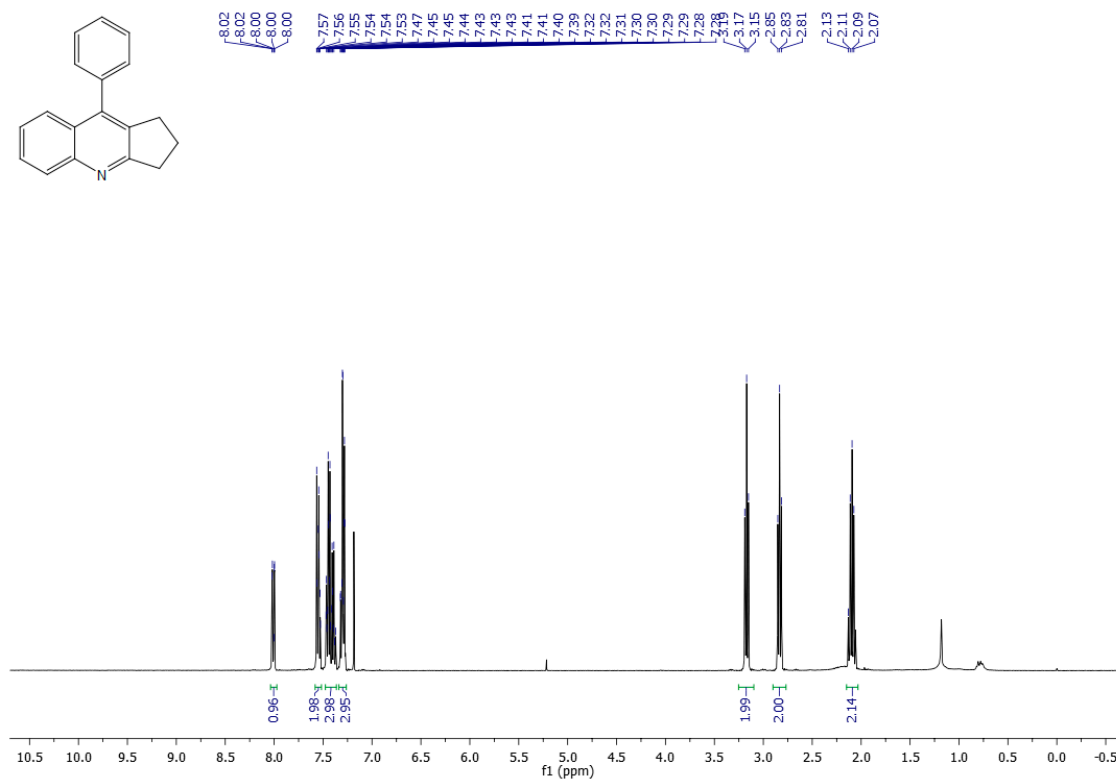


Figure SI.11. ^1H NMR spectrum of 9-phenyl-2,3-dihydro-1H-cyclopenta[b]quinoline (7)

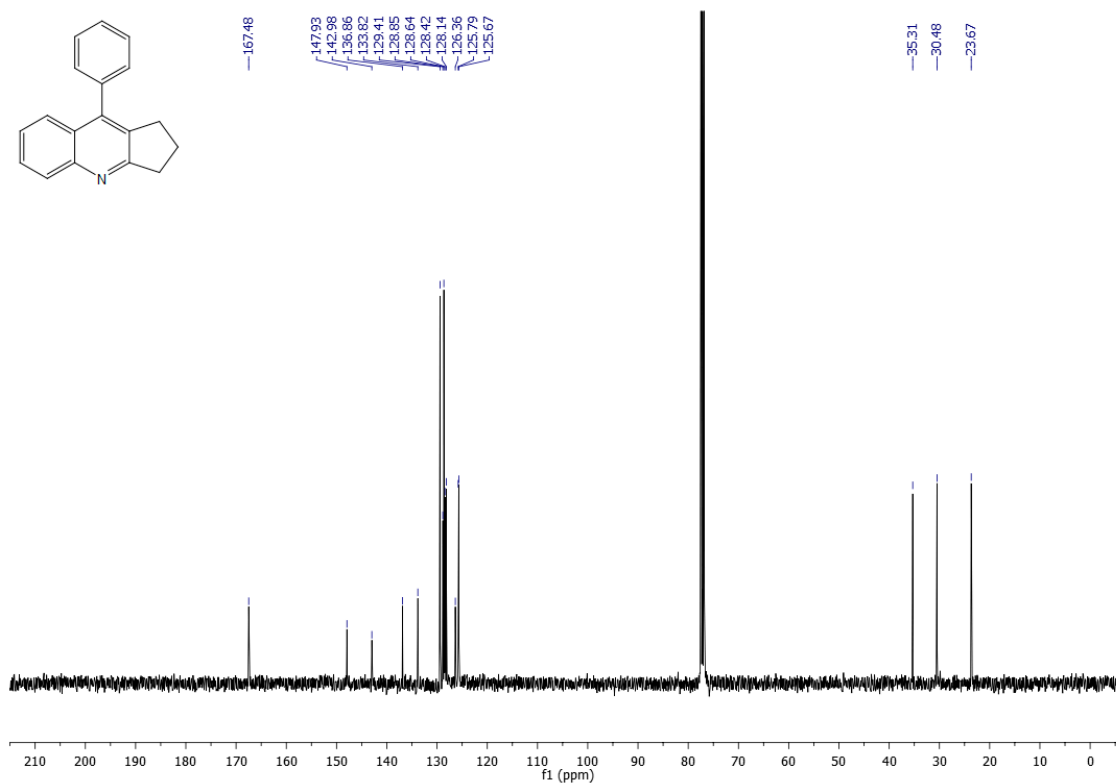


Figure SI.12. ^{13}C NMR spectrum of 9-phenyl-2,3-dihydro-1H-cyclopenta[b]quinoline (7)

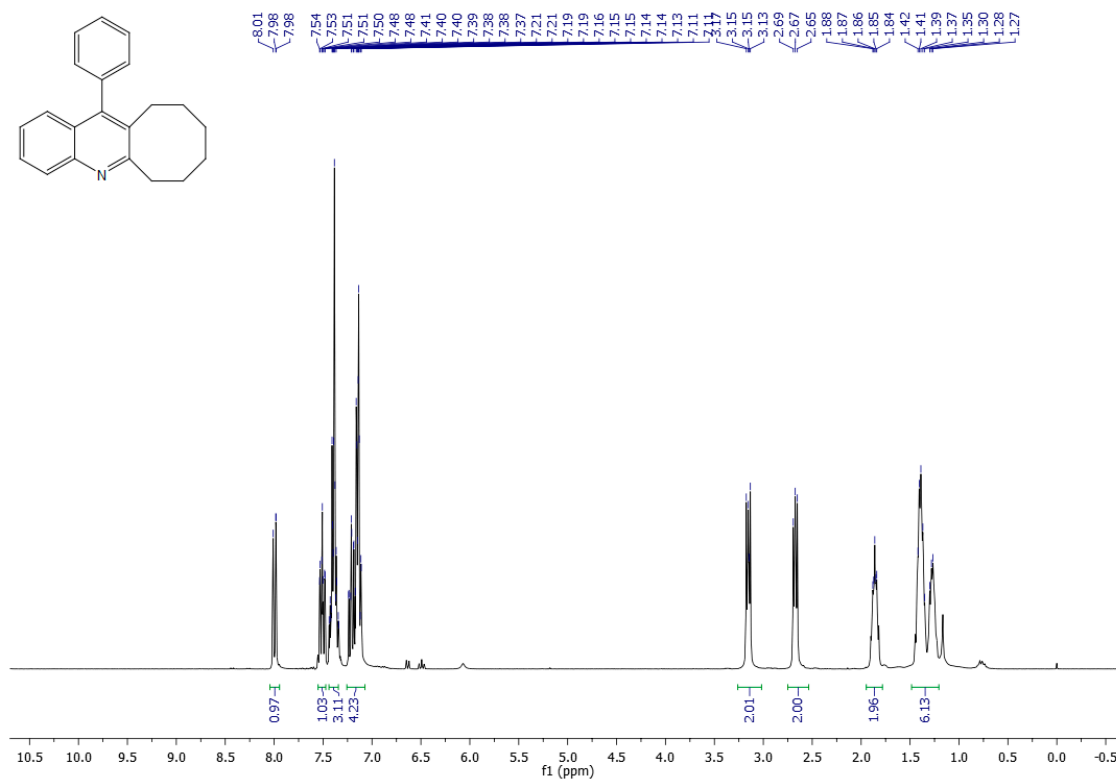


Figure SI.13. ¹H NMR spectrum of 12-phenyl-6,7,8,9,10,11-hexahydrocycloocta[b]quinoline (8)

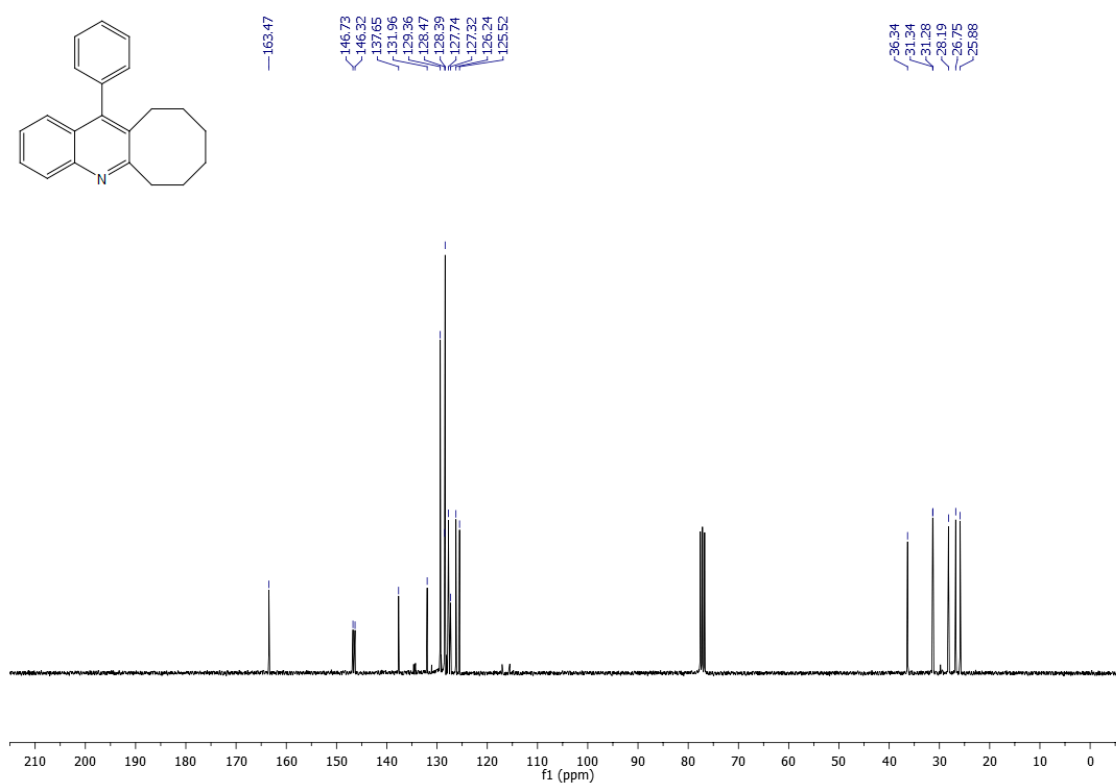


Figure SI.14. ¹³C NMR spectrum of 12-phenyl-6,7,8,9,10,11-hexahydrocycloocta[b]quinoline (8)

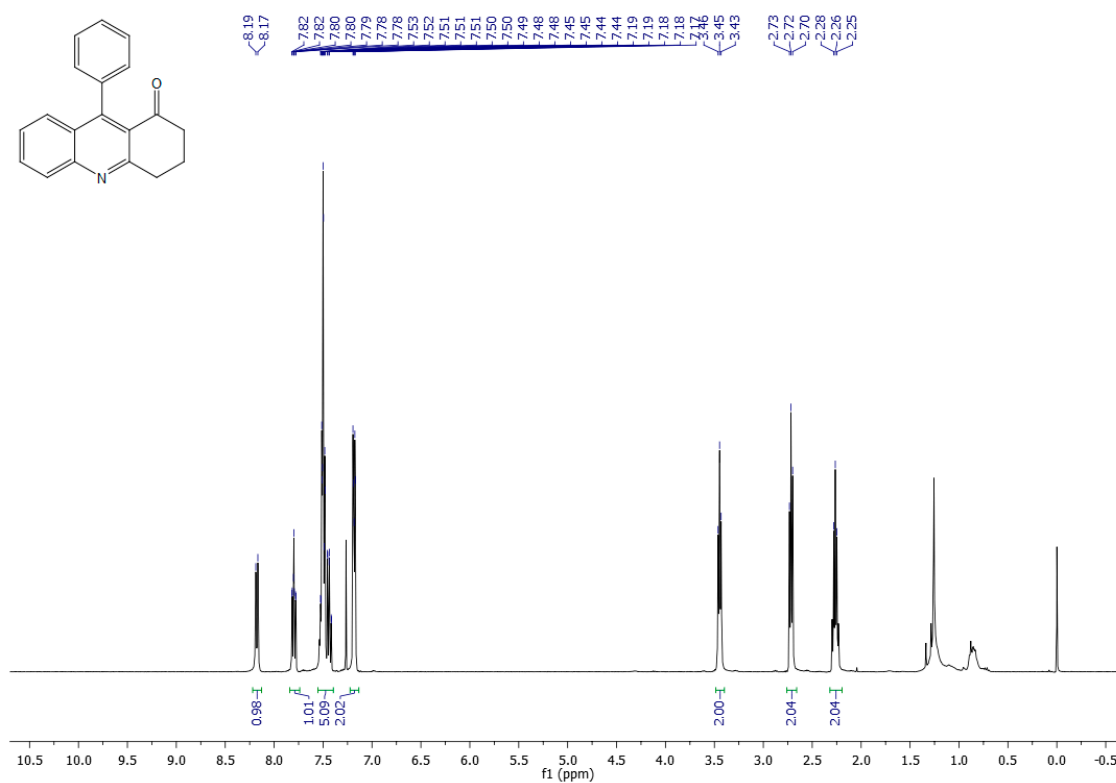


Figure SI.15. ¹H NMR spectrum of 9-phenyl-3,4-dihydroacridin-1(2H)-one (9)

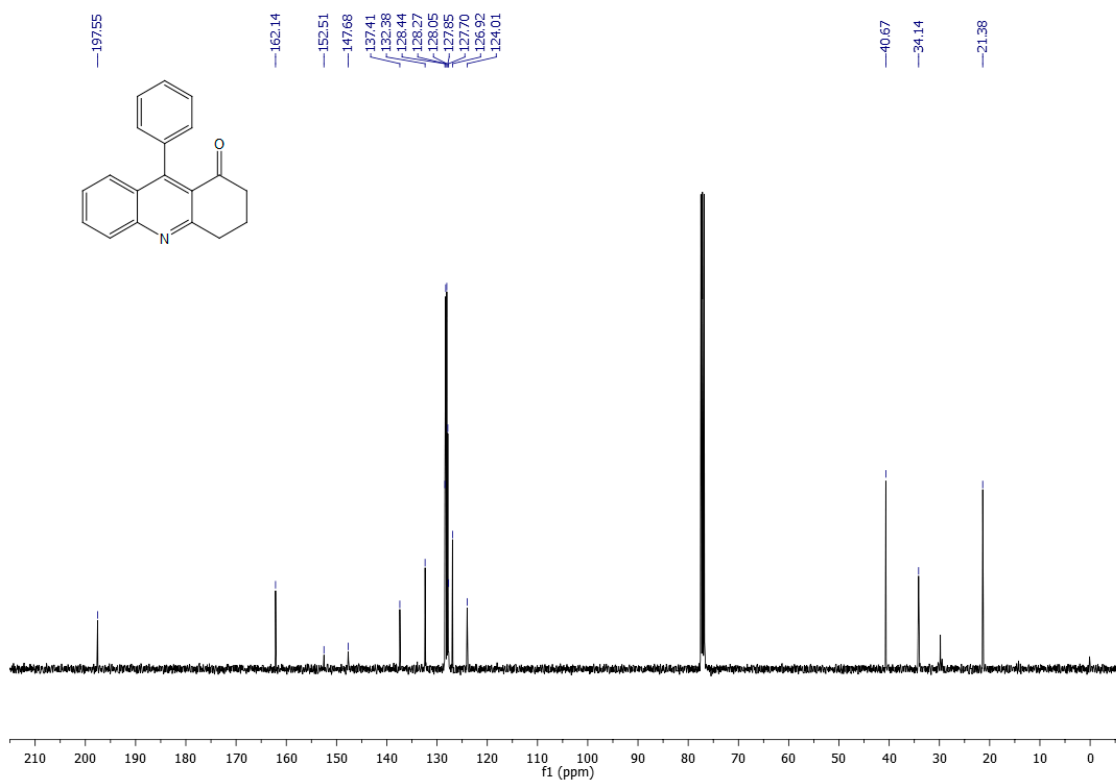


Figure SI.16. ¹³C NMR spectrum of 9-phenyl-3,4-dihydroacridin-1(2H)-one (9)

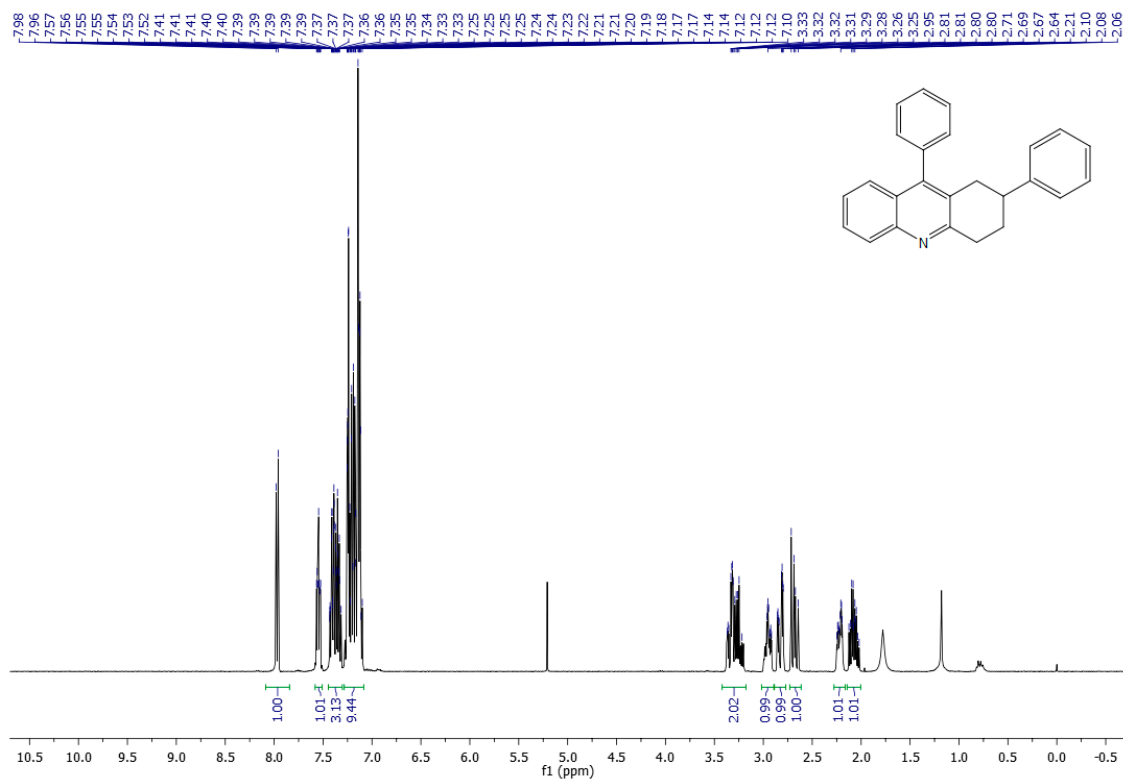


Figure SI.17. ¹H NMR spectrum of 2,9-diphenyl-1,2,3,4-tetrahydroacridine (10)

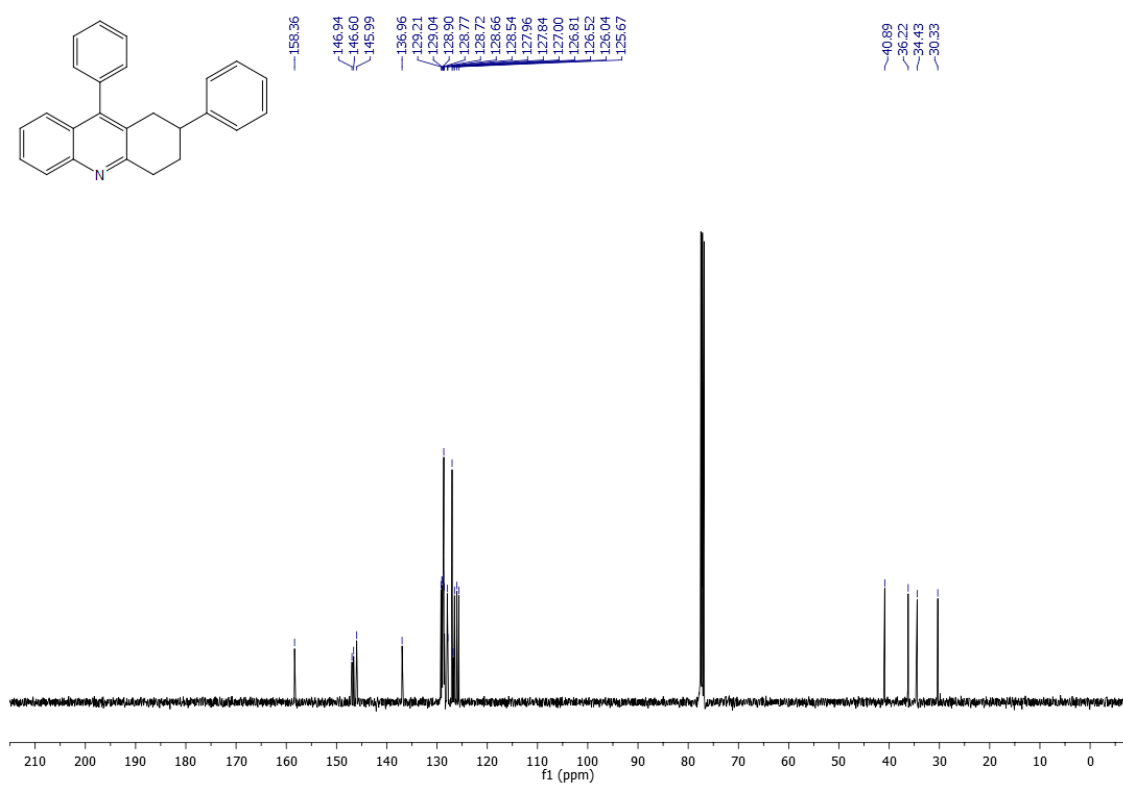


Figure SI.18. ¹³C NMR spectrum of 2,9-diphenyl-1,2,3,4-tetrahydroacridine (10)

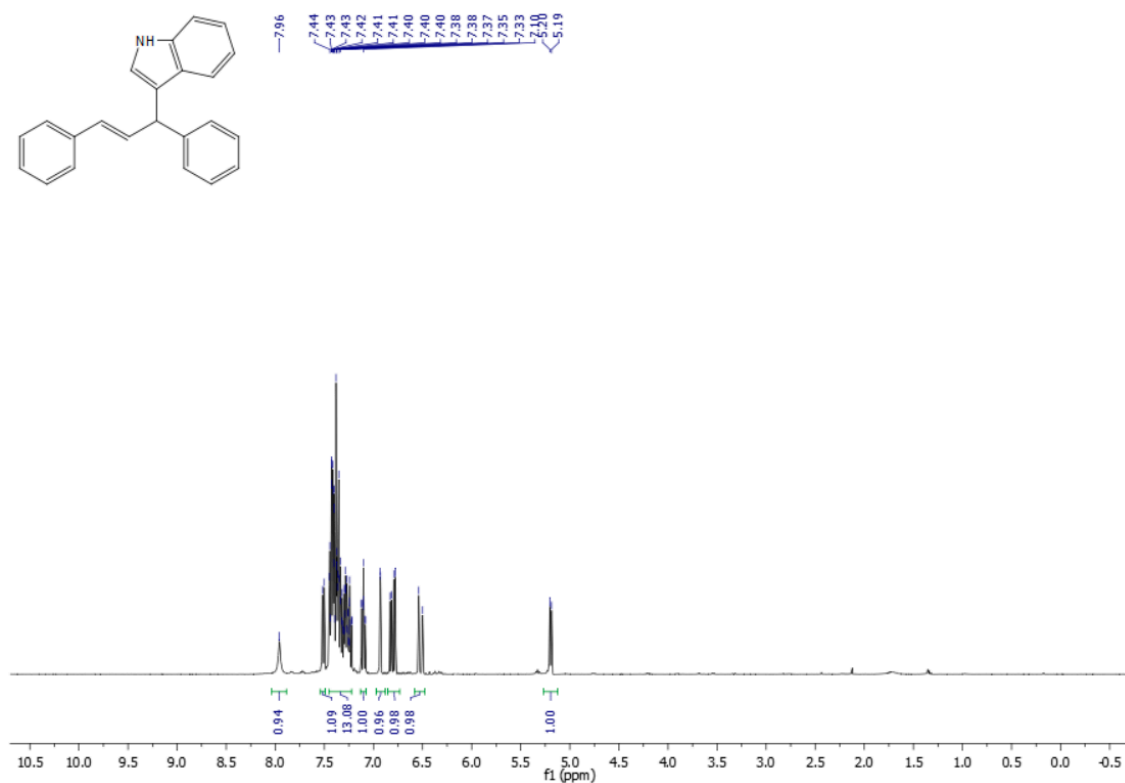


Figure SI.19. ¹H NMR spectrum of (E)-3-(1,3-diphenylallyl)-1H-indole (11)

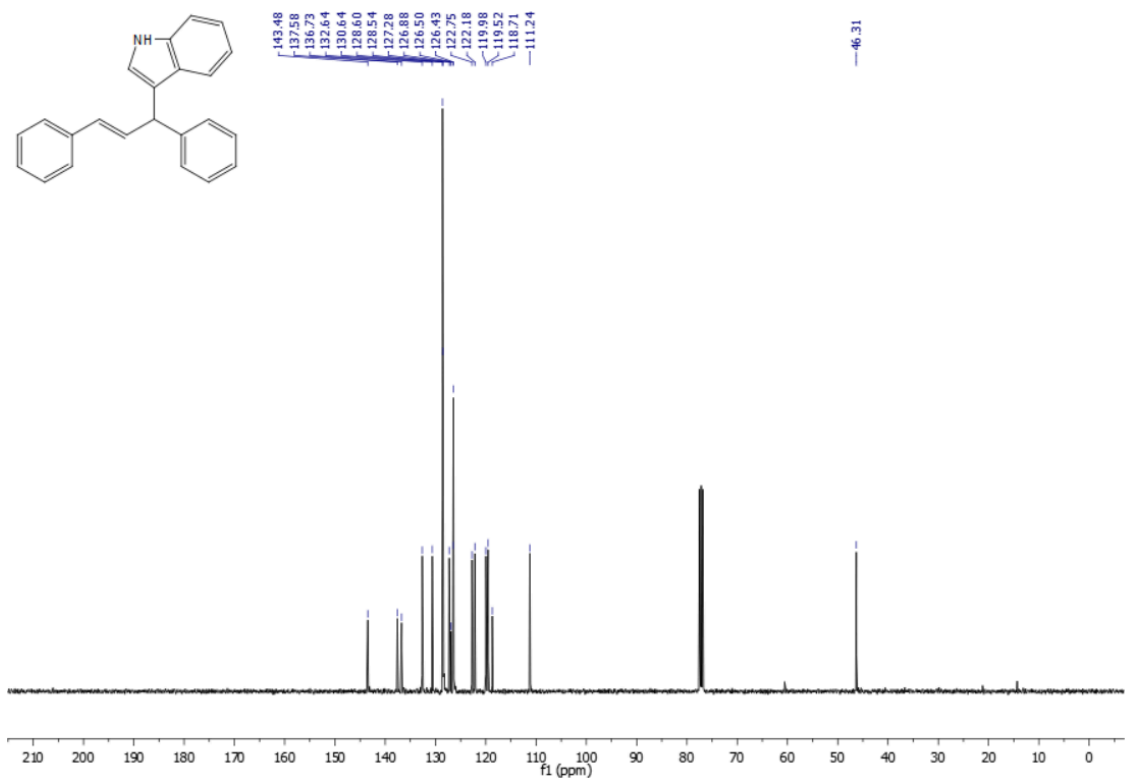


Figure SI.20. ¹³C NMR spectrum of (E)-3-(1,3-diphenylallyl)-1H-indole (11)

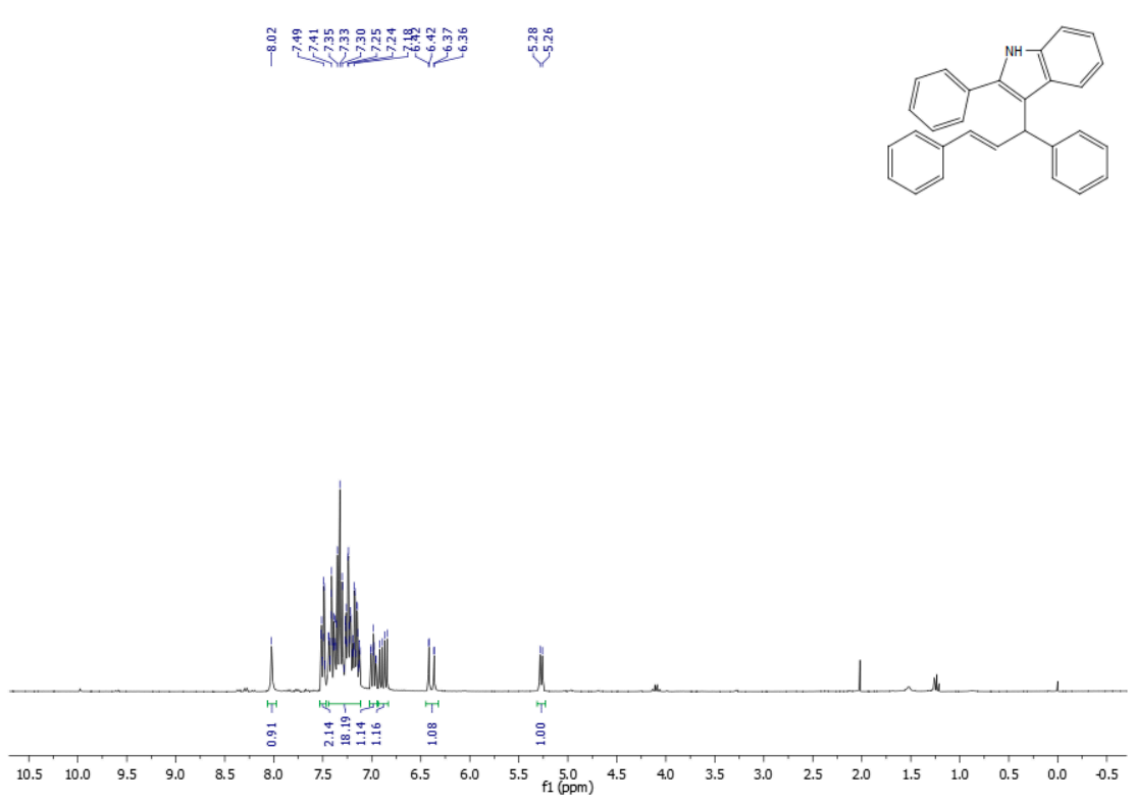


Figure SI.21. ¹H NMR spectrum of (E)-3-(1,3-diphenylallyl)-2-phenyl-1H-indole (12)

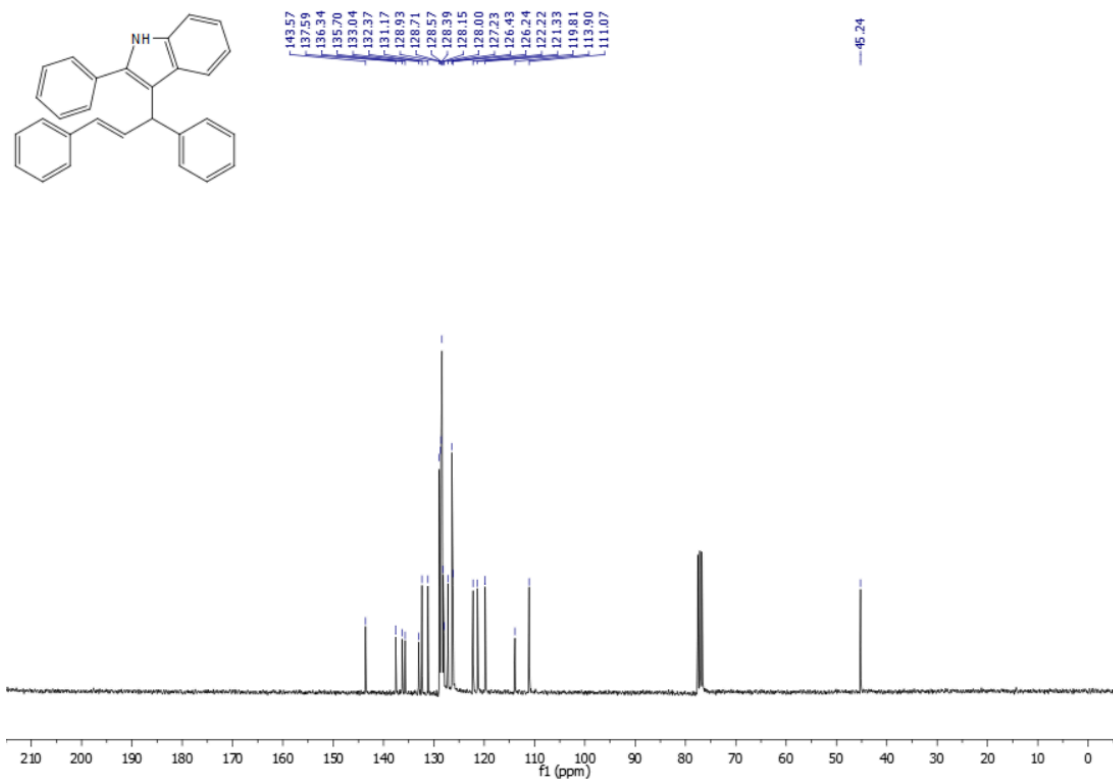


Figure SI.22. ¹³C NMR spectrum of (E)-3-(1,3-diphenylallyl)-2-phenyl-1H-indole (12)

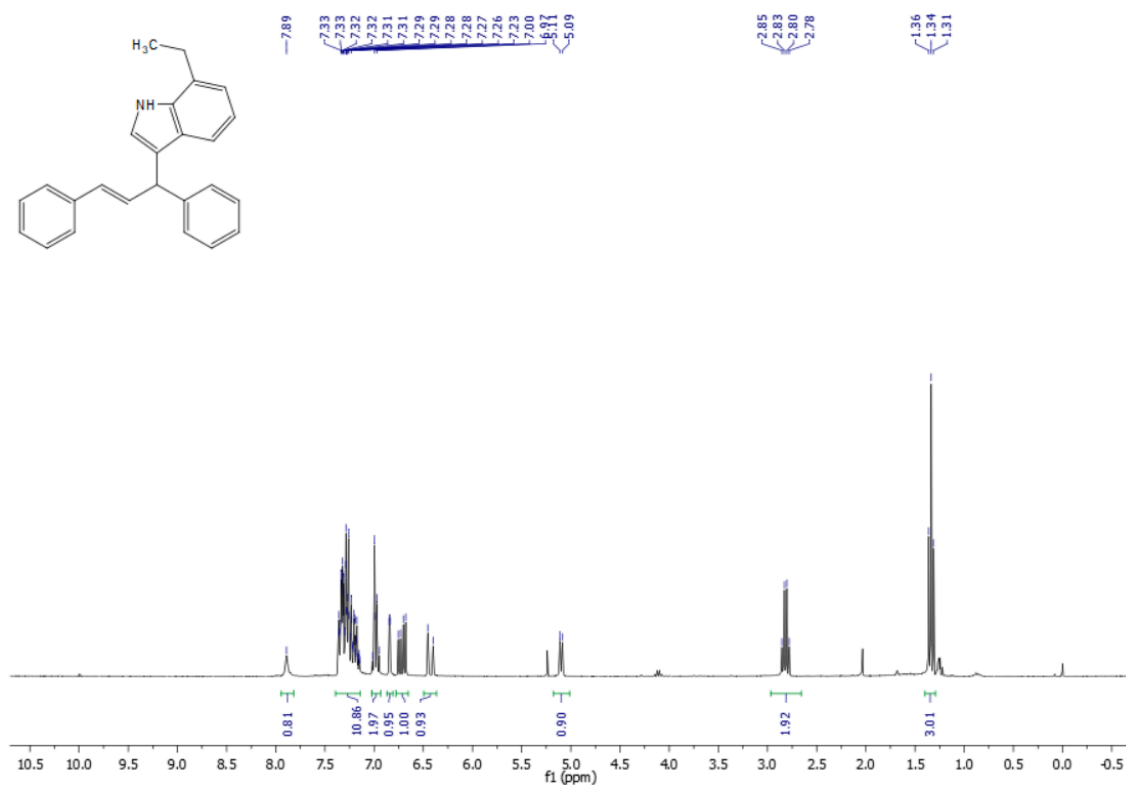


Figure SI.23. ¹H NMR spectrum of (*E*)-3-(1,3-diphenylallyl)-9-ethyl-1*H*-indole (**13**)

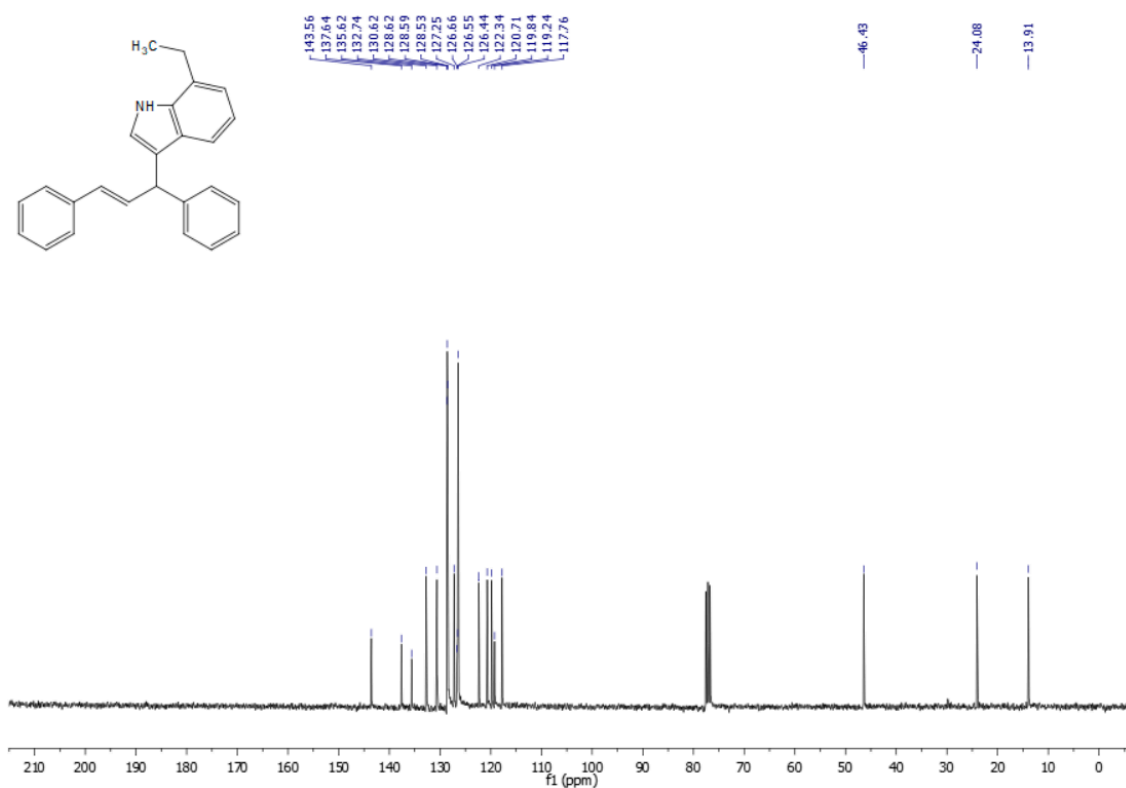


Figure SI.24 ¹³C NMR spectrum of (*E*)-3-(1,3-diphenylallyl)-9-ethyl-1*H*-indole (**13**)

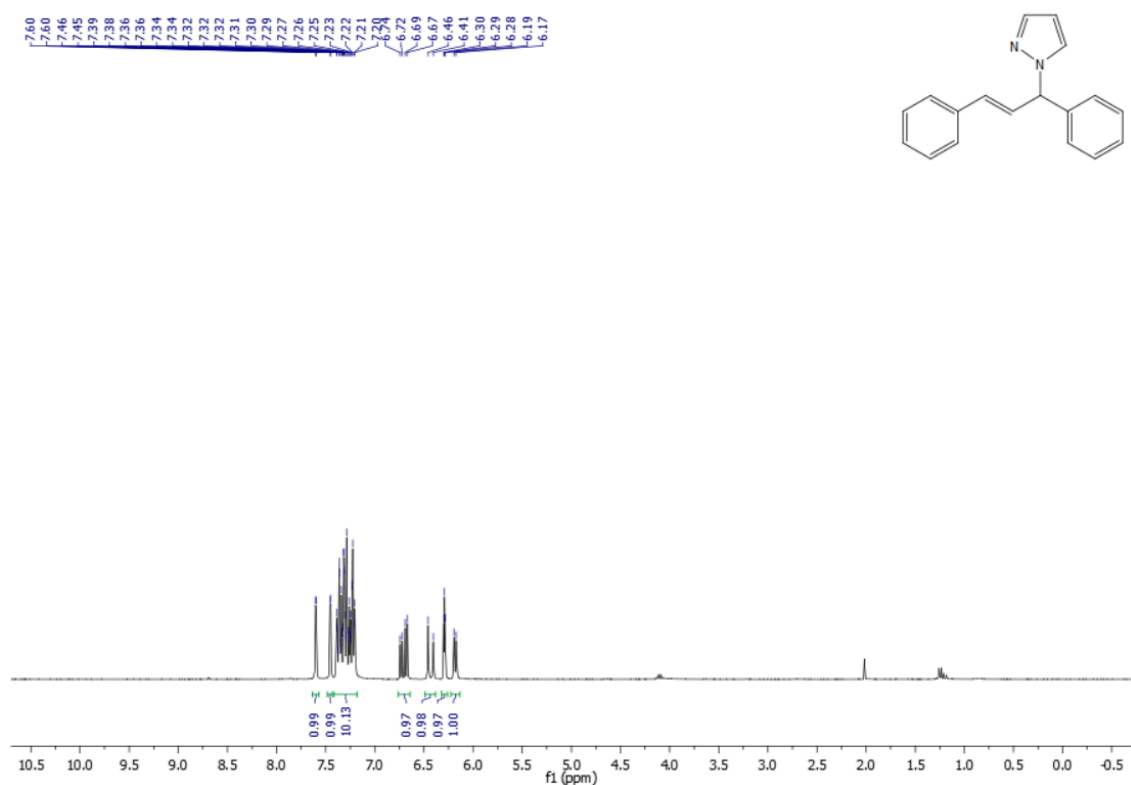


Figure SI.25. ¹H NMR spectrum of (E)-1-(1,3-diphenylallyl)-1H-pyrazole (14)

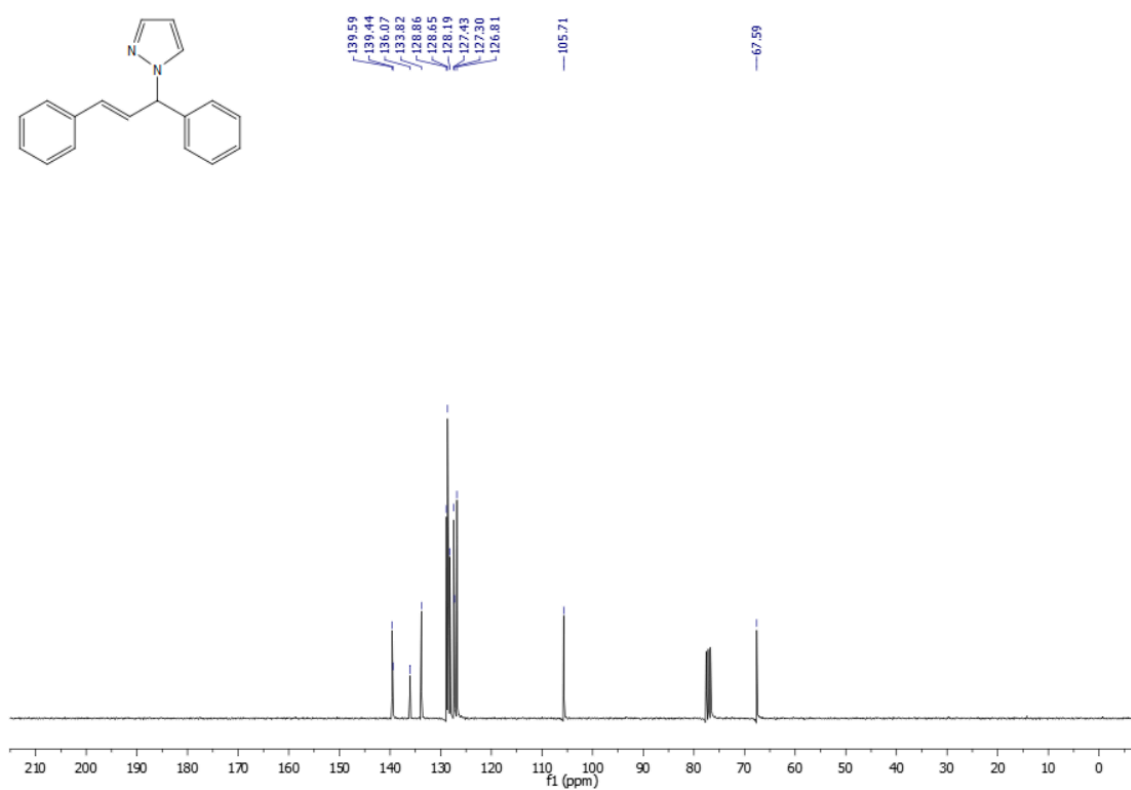


Figure SI.26. ¹³C NMR spectrum of (E)-1-(1,3-diphenylallyl)-1H-pyrazole (14)

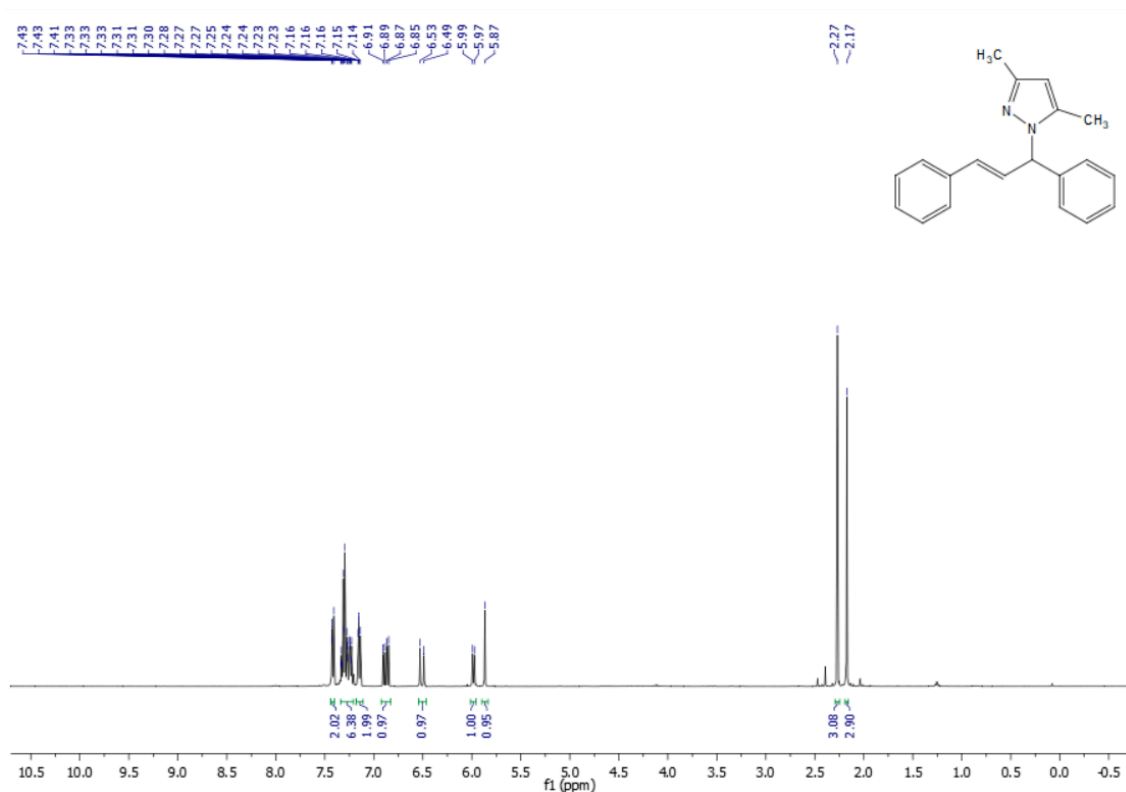


Figure SI.27. ¹H NMR spectrum of (E)-1-(1,3-diphenylallyl)-3,5-dimethyl-1H-pyrazole (15)

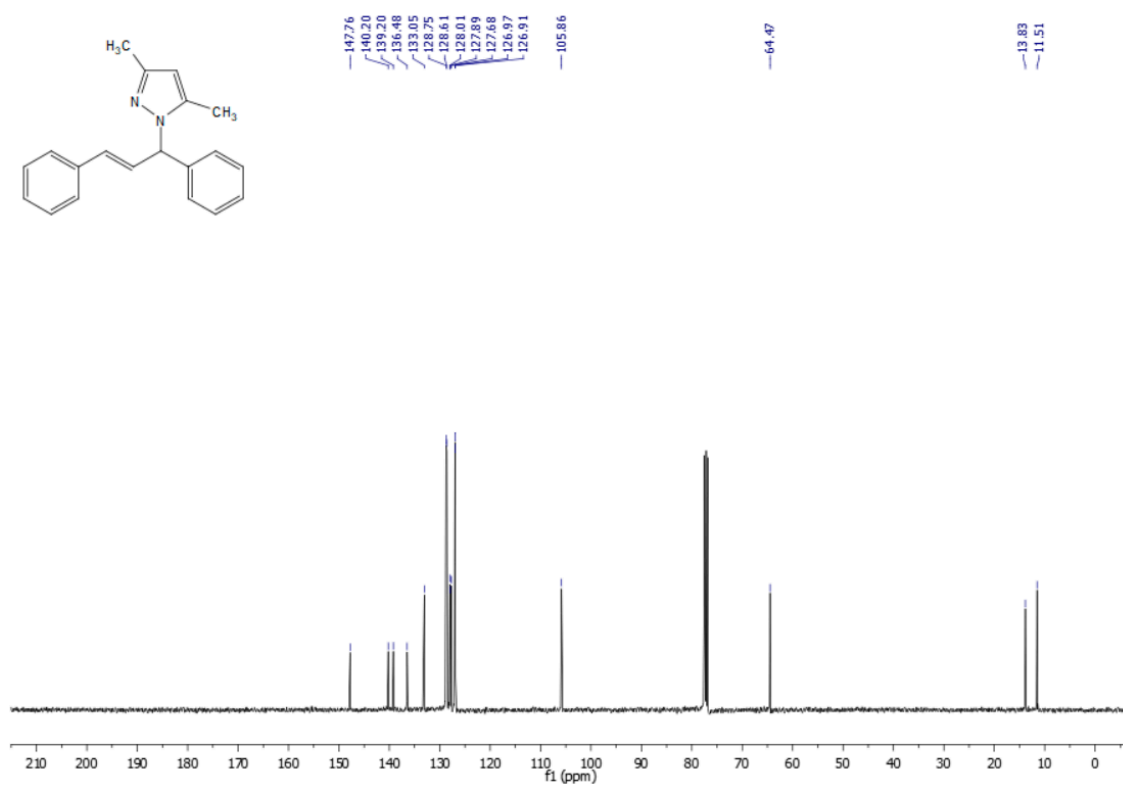


Figure SI.28. ¹³C NMR spectrum of (E)-1-(1,3-diphenylallyl)-3,5-dimethyl-1H-pyrazole (15)

References

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