Electronic Supplementary Material (ESI) for Organic Chemistry Frontiers.

Radical decarboxylative annunlations of alkynoates with 2-oxoacetic acids: Synthesis of 3-acylcoumarins via 5-*exo* cyclization and ester Migration

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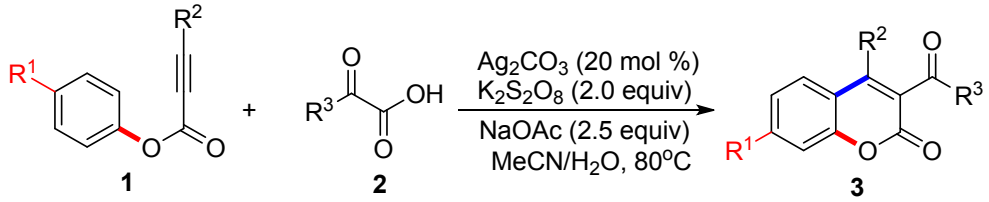
Supporting information

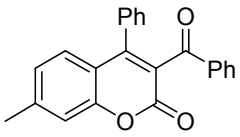
1. General procedure for synthesis of compound **3**.
2. Characterization data of compound **3**.
3. ^{1}H and ^{13}C NMR spectra of compound **3**.

General Materials and Methods: All reactions were performed in reaction tubes under nitrogen atmosphere. Flash column chromatography was performed using silica gel (60-Å pore size, 32–63 μm, standard grade). Analytical thin–layer chromatography was performed using glass plates pre-coated with 0.25 mm 230–400 mesh silica gel impregnated with a fluorescent indicator (254 nm). Thin layer chromatography plates were visualized by exposure to ultraviolet light. Organic solutions were concentrated on rotary evaporators at ~20 Torr (house vacuum) at 25–35 °C. Commercial reagents and solvents were used as received. Nuclear magnetic resonance (NMR) spectra are recorded in parts per million from internal tetramethylsilane on the δ scale.

General procedure for reactions of alkynoates 1 with 2-oxoacetic acids 2:

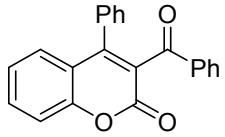


Alkynoates (1 equiv), 2-oxoacetic acid (1.2 equiv), Ag_2CO_3 (20 mol %), $K_2S_2O_8$ (2.0 equiv), and NaOAc (2.5 equiv) were added into the test tube, and then co-solvent MeCN/H_2O (2 mL) was added. The mixture was stirred at 80°C overnight. After completion of reaction as indicated by TLC (6-12 hrs), the mixture was filtrated, and the filtrate was extracted with EtOAc, and dried by anhydrous Na_2SO_4. Evaporation of the solvent followed by purification on silica gel provided the product **3**.

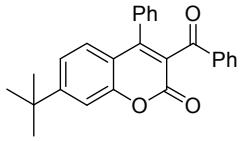


3-benzoyl-7-methyl-4-phenyl-2H-chromen-2-one (**3a**): a yellow solid, mp: 180-182 °C; reaction time: 8 hrs; ^{1}H NMR (400 MHz, $CDCl_3$) δ 2.49 (s, 3H), 7.07 (d, J = 8.2 Hz, 1H), 7.18 (d, J = 8.1 Hz, 1H), 7.25-7.38 (m, 8H), 7.50 (t, J = 7.4 Hz, 1H), 7.80 (d, J = 8.4 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 21.7, 116.9, 117.3, 124.8, 125.9, 127.7, 128.5, 128.5, 128.7, 129.2, 129.4, 132.5, 133.7, 136.3, 144.3, 153.1, 153.8,

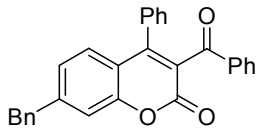
159.0 192.3; HRMS (ESI): *m/z* [M + K]$^+$ calcd for $C_{23}H_{16}KO_3^+$: 379.0731; found: 379.0726.



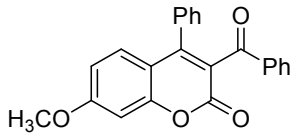
3-benzoyl-4-phenyl-2H-chromen-2-one (**3b**): a yellow solid, mp: 158-159 ^{o}C; reaction time: 8 hrs; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.25-7.39 (m, 9H), 7.49 (t, *J* = 8.4 Hz, 2H), 7.61-7.65 (m, 1H), 7.81 (d, *J* = 8.4 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 117.2, 119.4, 124.6, 125.8, 127.9, 128.5, 128.7, 129.2, 129.5, 132.3, 132.7, 133.8, 136.2, 152.9, 153.7, 158.7, 192.1; HRMS (ESI): *m/z* [M + Na]$^+$ calcd for $C_{22}H_{14}NaO_3^+$: 349.0835; found: 349.0849.



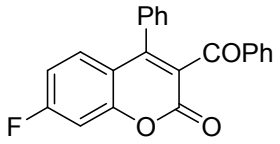
3-benzoyl-7-tert-butyl-4-phenyl-2H-chromen-2-one (**3c**): a yellow solid, mp: 165-167 ^{o}C; reaction time: 8 hrs; ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.39 (s, 9H), 7.23-7.38 (m, 9H), 7.49-7.75 (m, 2H), 7.80 (d, *J* = 8.4 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 31.0, 113.9, 116.9, 122,2, 125.0, 127.5, 128.5, 128.5, 128.6, 129.2, 129.4, 132.5, 133.7, 136.4, 152.9, 153.8, 157.4, 159.1, 192.3; HRMS (ESI): m/z [M + Na]$^+$ calcd for $C_{25}H_{22}NaO_3^+$: 405.1461; found: 405.1467.



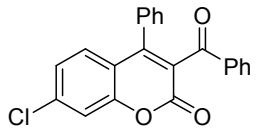
3-benzoyl-7-benzyl-4-phenyl-2H-chromen-2-one (**3d**): a yellow solid, mp: 132-135 ^{o}C; reaction time: 10 hrs; ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.11 (m, 2H), 7.10 (d, *J* = 8.2 Hz, 1H), 7.20-7.39 (m, 14H), 7.51 (t, *J* = 7.4 Hz, 1H), 7.80 (d, *J* = 8.2 Hz, 2H), ^{13}C NMR (100 MHz, $CDCl_3$) δ 42.0, 117.2, 117.5, 125.1, 125.5, 126.7, 127.9, 128.5, 128.5, 128.6, 128.8, 128.9, 129.2, 129.4, 130.1, 132.4, 133.7, 136.3, 139.3, 147.3, 152.9, 153.9, 158.8, 192.2; HRMS (ESI): m/z [M + Na]$^+$ calcd for $C_{29}H_{20}NaO_3^+$: 439.1305; found: 439.1315.



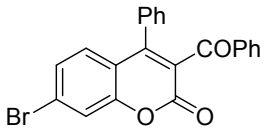
3-benzoyl-7-methoxy-4-phenyl-2H-chromen-2-one (**3e**): a yellow solid, mp: 142-145 ^{o}C; reaction time: 10 hrs; ^{1}H NMR (400 MHz, $CDCl_3$) δ 3.90 (s, 3H), 6.81 (d, J = 8.9, 1H), 6.94 (d, J = 2.4 Hz, 1H), 7.18 (d, J = 8.9 Hz, 1H), 7.23-7.26 (m, 2H), 7.31-7.37 (m, 5H), 7.49 (t, J = 7.2 Hz, 1H), 7.79 (d, J = 7.2 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 55.9, 100.9, 112.9, 122.6, 128.5, 128.6, 129.0, 129.2 129.4, 132.7, 133.6, 136.5, 153.5, 155.6 159.2, 163.5, 192.5; HRMS (ESI): *m/z* $[M + Na]^+$ calcd for $C_{23}H_{16}NaO_4^+$: 379.0941; found: 379.0937.



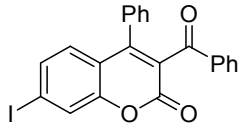
3-benzoyl-7-fluoro-4-phenyl-2H-chromen-2-one (**3f**): a yellow solid, mp: 168-170 ^{o}C; reaction time: 6 hrs; ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.97–7.04 (m, 1H), 7.20 (d, J = 8.8, 1H),7.18-7.39 (m, 8H),7.52 (t, J = 7.4 Hz, 1H), 7.80 (d,J = 8.4 Hz,2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 104.6 (d, $^{2}J_{CF}$ = 22.4 Hz), 112.8 (d, $^{2}J_{CF}$ = 22.4 Hz), 116.2, 128.6, 128.7, 129.2, 129.6, 129.8, 129.9, 132.1, 133.9, 136.1, 152.6, 154.8 (d, $^{3}J_{CF}$ = 12.9 Hz), 158.4, 164.9 (d, $^{1}J_{CF}$ = 254.9 Hz), 191.8; HRMS (ESI): *m/z* $[M + Na]^+$ calcd for $C_{22}H_{13}FNaO_3^+$: 367.0741; found: 367.0740.



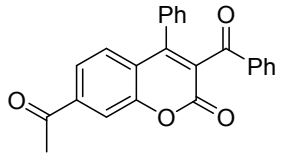
3-benzoyl-7-chloro-4-phenyl-2H-chromen-2-one (**3g**): a yellow solid, mp: 186-187 ^{o}C; reaction time: 8 hrs; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.24-7.28 (m, 4H), 7.33-7.39 (m, 5H), 7.49-7.54 (m, 2H) 7.79 (d, J = 8.4 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 117.4, 118.1, 125.2, 125.8, 128.6, 128.7, 128.9, 129.2, 129.7, 131.9, 133.9, 136.0, 138.7, 152.3, 153.9, 158.1, 191.7; HRMS (ESI): m/z $[M + Na]^+$ calcd for $C_{22}H_{13}ClNaO_3^+$: 383.0445; found: 383.0437.



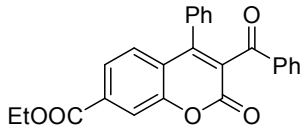
3-benzoyl-7-bromo-4-phenyl-2H-chromen-2-one (**3h**): a yellow solid, mp: 196-197 ^{o}C; reaction time: 8 hrs; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.16 (d, *J* = 8.6 Hz, 1H), 7.24-7.28 (m, 2H), 7.33-7.40 (m, 6H), 7.51 (t, *J* = 7.4 Hz, 1H), 7.64 (d, *J* = 1.8 Hz, 1H), 7.79 (d, *J* = 8.4 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 118.4, 120.3, 126.0, 126.8, 128.1, 128.6, 128.7, 128.9, 129.2, 129.7, 131,.8, 133.9, 136.0, 152.4, 153.8, 158.1, 191.7; HRMS (ESI): m/z $[M + Na]^+$ calcd for $C_{22}H_{13}BrNaO_3^+$: 426.9940; found: 426.9946.



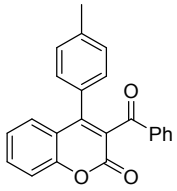
3-benzoyl-7-iodo-4-phenyl-2H-chromen-2-one (**3i**): a yellow solid, mp: 188-189 ^{o}C; reaction time: 8 hrs; ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.97 (d, *J* = 8.4 Hz, 1H), 7.22-7.26 (m, 2H), 7.30-7.38 (m, 5H), 7.50 (t, *J* = 7.5 Hz, 1H), 7.57 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.77 (d, *J* = 8.3 Hz, 2H), 7.85 (d, *J* = 1.5 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 98.6, 119.0, 126.2, 126.8, 128.6, 128.7, 128.8, 129.2, 129.7, 131,.8, 133.9, 136.0, 152.4, 153.4, 157.9, 191.7; HRMS (ESI): m/z $[M + Na]^+$ calcd for $C_{22}H_{13}INaO_3^+$: 474.9802; found: 474.9800.



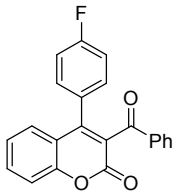
7-acetyl-3-benzoyl-4-phenyl-2H-chromen-2-one (**3j**): a yellow solid, mp: 228-230 ^{o}C; reaction time: 7 hrs; ^{1}H NMR (400 MHz, $CDCl_3$) δ 2.68 (s, 3H), 7.26-7.28 (m, 2H), 7.34-7.41 (m, 6H), 7.52 (t, *J* = 7.4 Hz, 1H), 7.78-7.82 (m, 3H), 7.98 (d, *J* = 1.5 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 26.8, 115.3, 116.9, 122.8, 123.7, 127.8, 128.3, 128.6, 128.6, 128.7, 129.2, 129.8, 130.7, 131.7, 134.0, 135.8, 139.8, 151.8, 153.5, 158.3, 191.6, 196.4; HRMS (ESI): m/z $[M + Na]^+$ calcd for $C_{24}H_{16}NaO_4^+$: 391.0941; found: 391.0932.



ethyl 3-benzoyl-2-oxo-4-phenyl-2H-chromene-7-carboxylate (**3k**): a yellow solid, mp: 230-231 ^{o}C; reaction time: 8 hrs; ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.45 (t, J = 7.1 Hz, 3H), 4.46 (q, J = 7.1 Hz, 2H), 7.26-7.38 (m, 8H), 7.53 (t, J = 7.3 Hz, 1H), 7.80 (d, J = 7.5 Hz, 2H), 7.90 (dd, J = 8.2, 1.4 Hz, 1H), 8.12 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 14.2, 61.8, 118.2, 122.7, 125.1, 127.7, 128.6, 128.7, 129.2, 129.7 131.8, 134.0, 134.0, 135.9, 151.9 153.3, 158.3, 164.9, 191.6; HRMS (ESI): *m/z* $[M + Na]^+$ calcd for $C_{25}H_{18}NaO_5^+$: 421.1046; found: 421.1030.

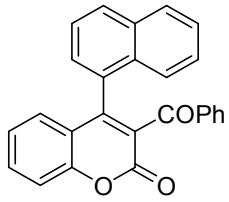


3-benzoyl-4-p-tolyl-2H-chromen-2-one (**3l**): a yellow solid, mp: 167-170 ^{o}C; reaction time: 8 hrs; ^{1}H NMR (400 MHz, $CDCl_3$) δ 2.32 (s, 3H), 7.14-7.19 (m, 4H), 7.27 (d, J = 8.1 Hz, 1H), 7.34-7.40 (m, 3H), 7.46-7.54 (m, 2H), 7.60-7.64 (m, 1H), 7.82 (d, J = 8.4 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 21.3, 117.1, 119.5, 124.6, 125.8, 128.0, 128.4, 128.6, 128.6, 129.3, 130.1, 132.6, 133.6, 133.8, 136.2, 129.6, 153.2, 153.7, 158.8, 192.3; HRMS (ESI): m/z $[M + Na]^+$ calcd for $C_{23}H_{16}NaO_3^+$: 363.0992; found: 363.0997.

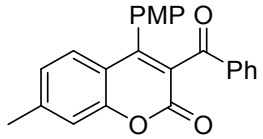


3-benzoyl-4-(4-fluorophenyl)-2H-chromen-2-one (**3m**): a yellow solid, mp: 168-171 ^{o}C; reaction time: 8 hrs; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.05 (t, J = 8.6 Hz, 2H), 7.24 – 7.33 (m, 4H), 7.40 (t, J = 7.7 Hz, 2H),7.49 (d, J = 8.3 Hz, 1H),7.54 (t, J = 7.4 Hz, 1H),7.63-7.67 (m,1H), 7.77 – 7.83 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 115.8 (d, $^{2}J_{CF}$ = 22.0 Hz), 117.3, 119.3, 127.7, 127.6, 128.2 (d, $^{3}J_{CF}$ = 3.6 Hz), 128.5 (d, $^{2}J_{CF}$ = 23.0 Hz), 128.7, 129.2, 130.1, 130.7 (d, $^{3}J_{CF}$ = 8.4 Hz), 132.8, 133.7, 133.9, 136.1,

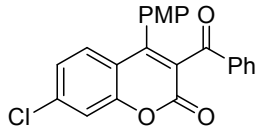
151.9, 153.7, 158.6, 163.1 (d, $^1J_{CF}$ = 249.0 Hz), 192.0; HRMS (ESI): *m/z* $[M + Na]^+$ calcd for $C_{22}H_{13}FNaO_3^+$: 367.0741; found: 367.0736.



3-benzoyl-4-(naphthalen-1-yl)-2H-chromen-2-one (**3n**): a yellow solid, mp: 118-120 ^oC; reaction time: 6 hrs; ^1H NMR (400 MHz, $CDCl_3$) δ 6.91 (dd, *J* = 8.0, 1.4 Hz, 1H), 7.12 (t, *J* = 7.2 Hz, 1H), 7.25 (t, *J* = 7.6 Hz, 2H), 7.35-7.61 (m, 8H), 7.74 (d, *J* = 7.2 Hz, 2H), 7.82-7.85 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 117.1, 119.8, 124.7, 125.0, 125.7, 126.4, 126.8, 127.2, 127.5, 128.2, 128.3, 128.4, 129.0, 129.7, 130.0, 130.1, 130.7, 132.7, 133.1, 133.6, 135.9, 152.6, 153.3, 158.8, 191.7; HRMS (ESI): m/z $[M + H]^+$ calcd for $C_{26}H_{17}O_3^+$: 377.1172; found: 377.1178.

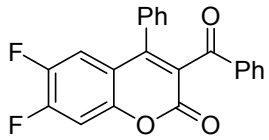


3-benzoyl-4-(4-methoxyphenyl)-7-methyl-2H-chromen-2-one (**3o**): a yellow solid, mp: 142-144 ^oC; reaction time: 8 hrs; ^1H NMR (400 MHz, $CDCl_3$) δ 2.50 (s, 3H), 3.78 (s, 3H), 6.85 (d, *J* = 8.8 Hz, 2H), 7.08 (dd, *J* = 8.2, 1.0 Hz, 1H), 7.20-7.28 (m, 4H), 7.37 (t, *J* = 7.9 Hz, 2H), 7.51 (t, *J* = 7.4 Hz, 1H), 7.82 (d, *J* = 8.4 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 21.7, 55.2, 114.0, 117.2, 117.3, 124.6, 124.6, 127.6, 128.4, 128.5, 129.2, 130.1, 130.3, 133.7, 136.3, 144.1, 152.9, 153.8, 159.1, 160.3, 192.6; HRMS (ESI): m/z $[M + Na]^+$ calcd for $C_{24}H_{18}NaO_4^+$: 393.1097; found: 393.1096.

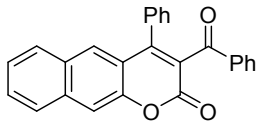


3-benzoyl-7-chloro-4-(4-methoxyphenyl)-2H-chromen-2-one (**3p**): a yellow solid, mp: 128-133 ^oC; reaction time: 8 hrs; ^1H NMR (400 MHz, $CDCl_3$) δ 3.78 (s, 3H), 6.86 (dd, *J* = 8.8, 2.1 Hz, 2H), 7.19-7.33 (m, 4H), 7.38 (td, *J* = 8.0, 3.2 Hz 2H), 7.47-7.54 (m, 2H), 7.80 (d, *J* = 7.8 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 55.2, 144.2, 117.4,

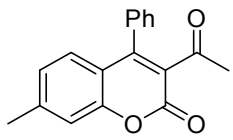
118.3, 124.0, 125.1, 125.5, 128.6, 128.8, 129.2, 130.1, 130.2, 133.6, 133.9, 136.0, 138.6, 152.2, 153.9, 158.2, 160.5, 192.0; HRMS (ESI): m/z $[M + Na]^+$ calcd for $C_{23}H_{15}ClNaO_4^+$: 413.0551; found: 413.0558.



3-benzoyl-6,7-difluoro-4-phenyl-2H-chromen-2-one (**3q**): a yellow solid, mp: 199-201 ^oC; reaction time: 6 hrs; ^1H NMR (400 MHz, $CDCl_3$) δ 7.09-7.14(m, 1H), 7.22 – 7.24 (m, 8H),7.53 (t, J = 7.4 Hz, 1H),7.74 – 7.81 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 106.6 (d, $^2J_{CF}$ = 21.3 Hz), 115.4 (d, $^2J_{CF}$ = 20.5 Hz), 128.4, 128.6, 128.9, 129.2, 129.9, 131.7, 134.0, 135.9, 146.2 (d, $^3J_{CF}$ = 13.4 Hz), 148.6 (d, $^3J_{CF}$ = 13.2 Hz), 150.0, 151.7, 152.7 (d, $^1J_{CF}$ = 257.5 Hz), 152.8 (d, $^1J_{CF}$ = 257.4 Hz), 158.1, 191.4; HRMS (ESI):m/z$[M + Na]^+$ calcd for $C_{22}H_{12}F_2NaO_3^+$: 385.0647; found: 385.0639.

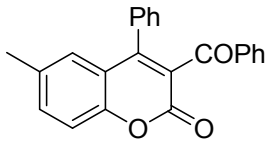


3-benzoyl-4-phenyl-2H-benzo[g]chromen-2-one (**3r**): a yellow solid, mp: 200-202 ^oC; reaction time: 12 hrs; ^1H NMR (400 MHz, $CDCl_3$) δ 7.27 (d, J = 8.8 Hz, 1H), 7.31-7.40 (m, 7H), 7.52 (t, J = 7.4 Hz, 1H), 7.64 (d, J = 8.8 Hz, 1H), 7.69-7.74 (m, 2H), 7.85 (dd, J = 8.5, 1.3 Hz, 2H), 7.89-7.92 (m, 1H), 8.65-8.68 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 106.5, 106.7, 114.6, 115.3, 115.5, 122.7, 122.7, 123.0, 124.4, 125.3, 127.8, 128.6, 128.7, 129.3, 129.3, 129.4, 132.7, 133.8, 134.0, 135.1, 136.3, 151.2, 154.0, 158.8, 192.3; HRMS (ESI): m/z $[M + Na]^+$ calcd for $C_{26}H_{16}NaO_3^+$: 399.0992; found: 399.0996.

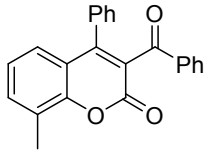


3-acetyl-7-methyl-4-phenyl-2H-chromen-2-one (**3s**): a yellow solid;, mp: 70-72 ^oC; reaction time: 12 hrs; ^1H NMR (400 MHz, $CDCl_3$) δ 2.26 (s, 3H), 2.47 (s, 3H), 7.03 (d, J = 8.2 Hz, 1H), 7.11 (d, J = 8.2 Hz, 1H), 7.22 (s, 1H), 7.30-7.32 (m, 2H), 7.51 (t, J = 3.0 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$), δ 21.7, 31.2, 116.9, 117.1, 125.8, 126.6,

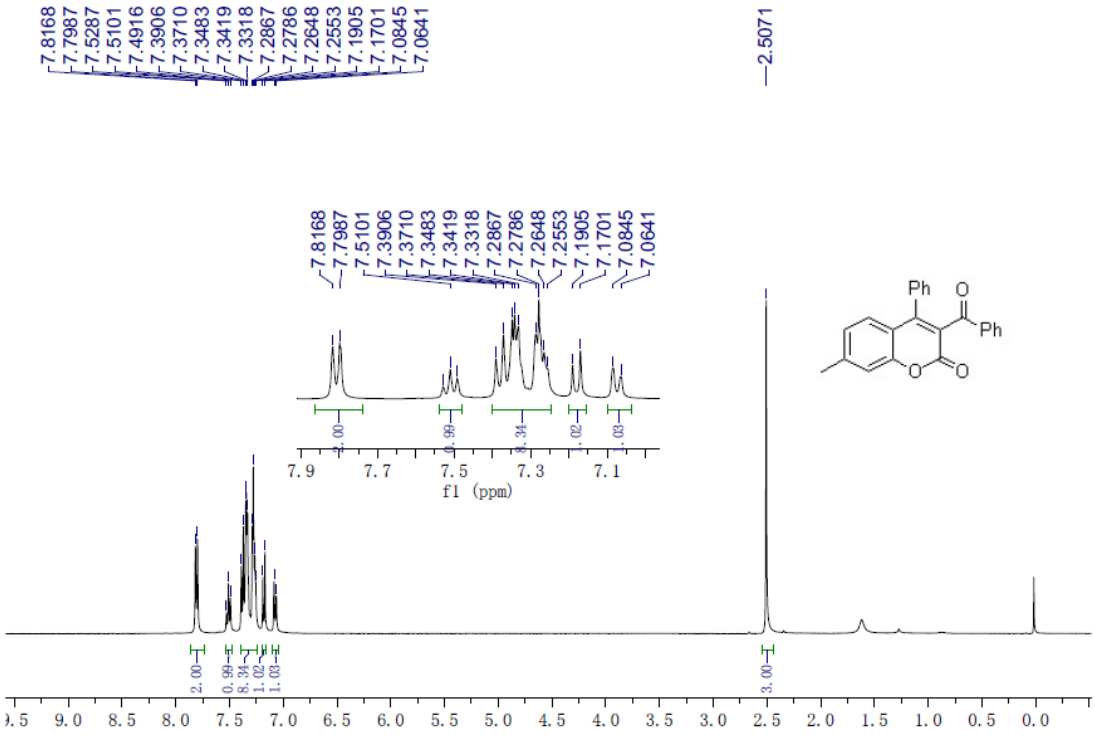
127.9, 128.4, 128.7, 129.5, 132.8, 144.3, 152.1, 153.5, 158.7, 199.3; HRMS (ESI): m/z $[M + Na]^+$ calcd for $C_{18}H_{14}NaO_3^+$: 301.0835; found: 301.0836.



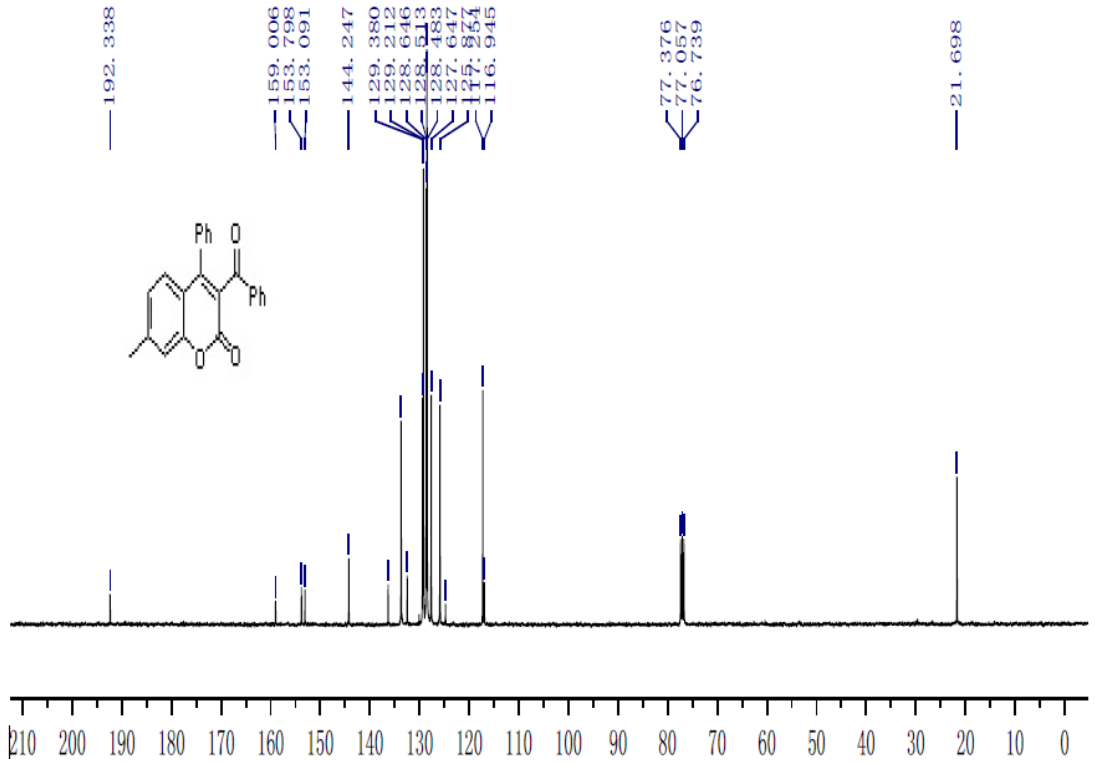
3-benzoyl-6-methyl-4-phenyl-2H-chromen-2-one (**3t**): a yellow solid, mp: 183-185 ^oC; reaction time: 8 hrs; ^1H NMR (400 MHz, $CDCl_3$) δ 2.56 (s, 3H), 7.11-7.16 (m,2H), 7.25-7.39 (m, 7H), 7.47-7.53 (m, 2H), 7.81 (d, J = 8.5 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ15.7, 112.9, 119.2, 124.1, 125.7, 126.6, 128.4, 128.5, 128.7, 129.2, 129.3, 132.6, 133.7, 134.0, 136.3, 152.0, 153.3, 158.8, 192.3; HRMS (ESI): m/z $[M + K]^+$ calcd for $C_{23}H_{16}KO_3^+$: 379.0731; found: 379.0734.



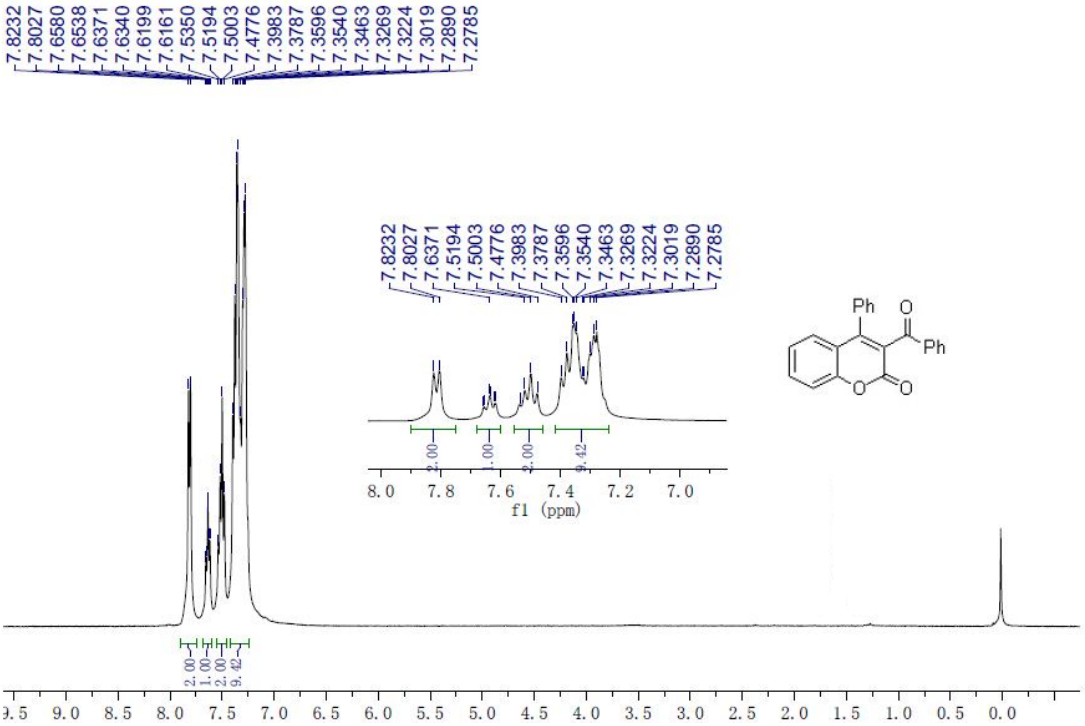
3-benzoyl-8-methyl-4-phenyl-2H-chromen-2-one (**3t'**): a yellow solid, mp: 180-181 ^oC; reaction time: 8 hrs; ^1H NMR (400 MHz, $CDCl_3$) δ 2.34 (s, 3H), 7.05 (d, J = 1.2 Hz, 1H), 7.26-7.29 (m, 2H), 7.34-7.39 (m, 6H), 7.44 (dd, J = 8.4, 1.2 Hz, 1H), 7.50 (t, J = 7.5 Hz, 1H), 7.80 (dd, J = 8.5, 1.4 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 20.9, 116.9, 119.1, 125.9, 127.5, 128.5, 129.2 129.4, 132.4, 133.7, 134.4, 136.2, 151.9, 152.9, 158.9, 192.2; HRMS (ESI): m/z $[M + K]^+$ calcd for $C_{23}H_{16}KO_3^+$: 379.0731; found: 379.0740.



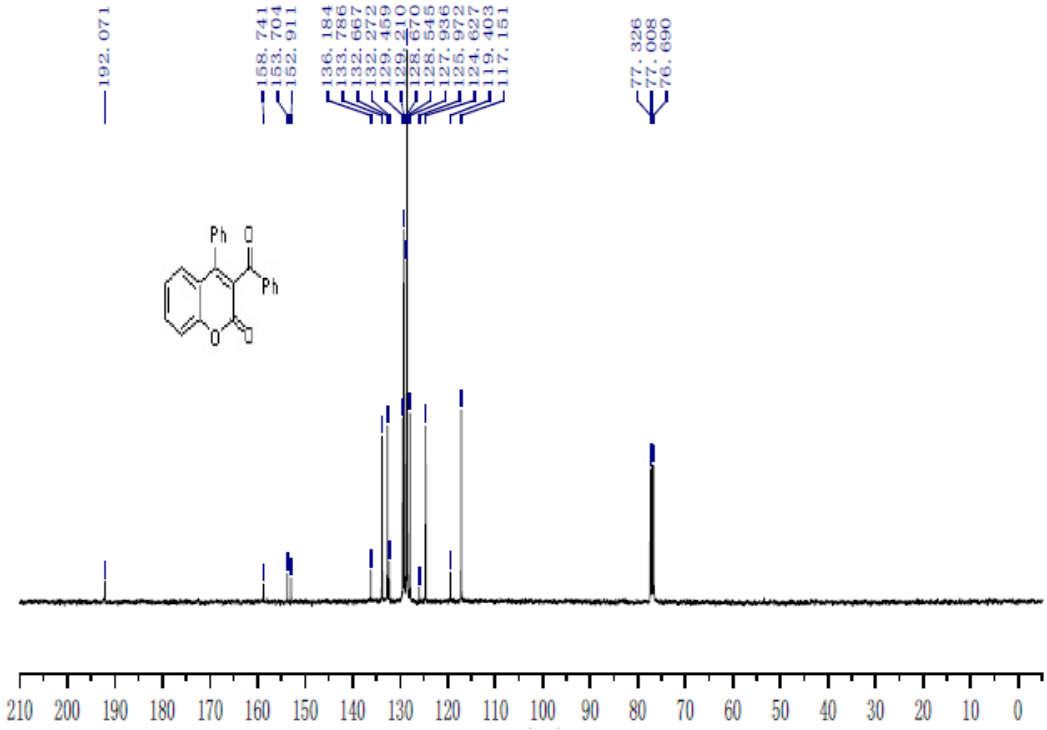
[1]HNMR spectrum of compound **3a**



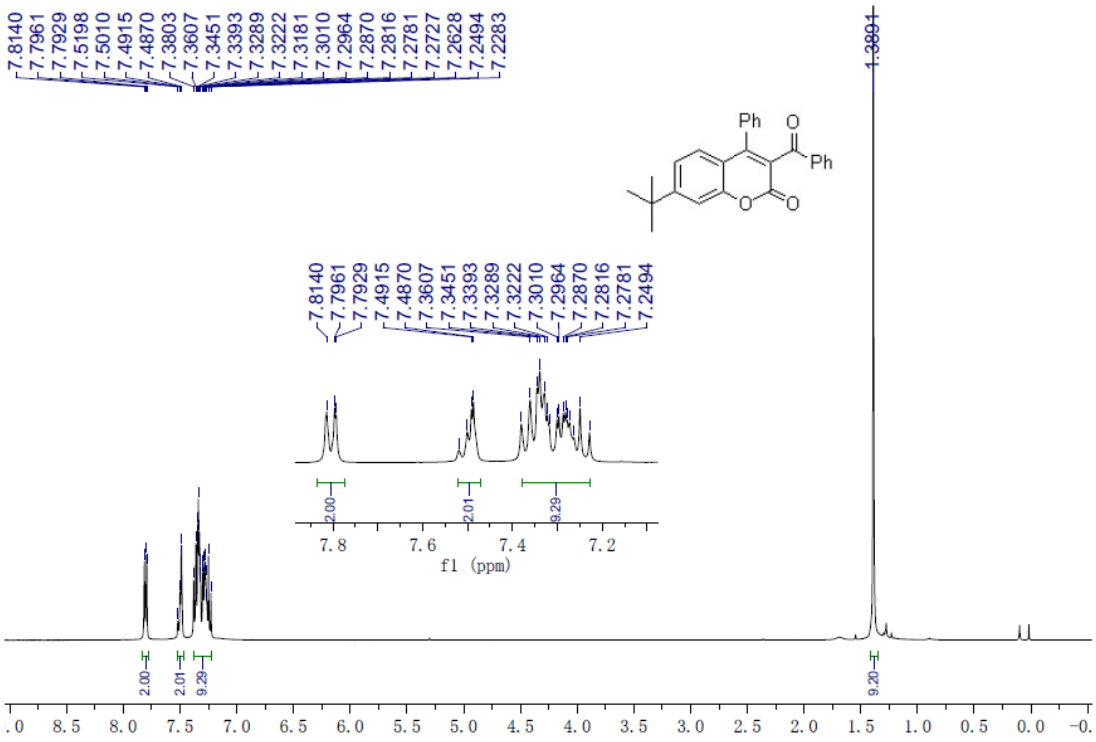
[13]CNMR spectrum of compound **3a**



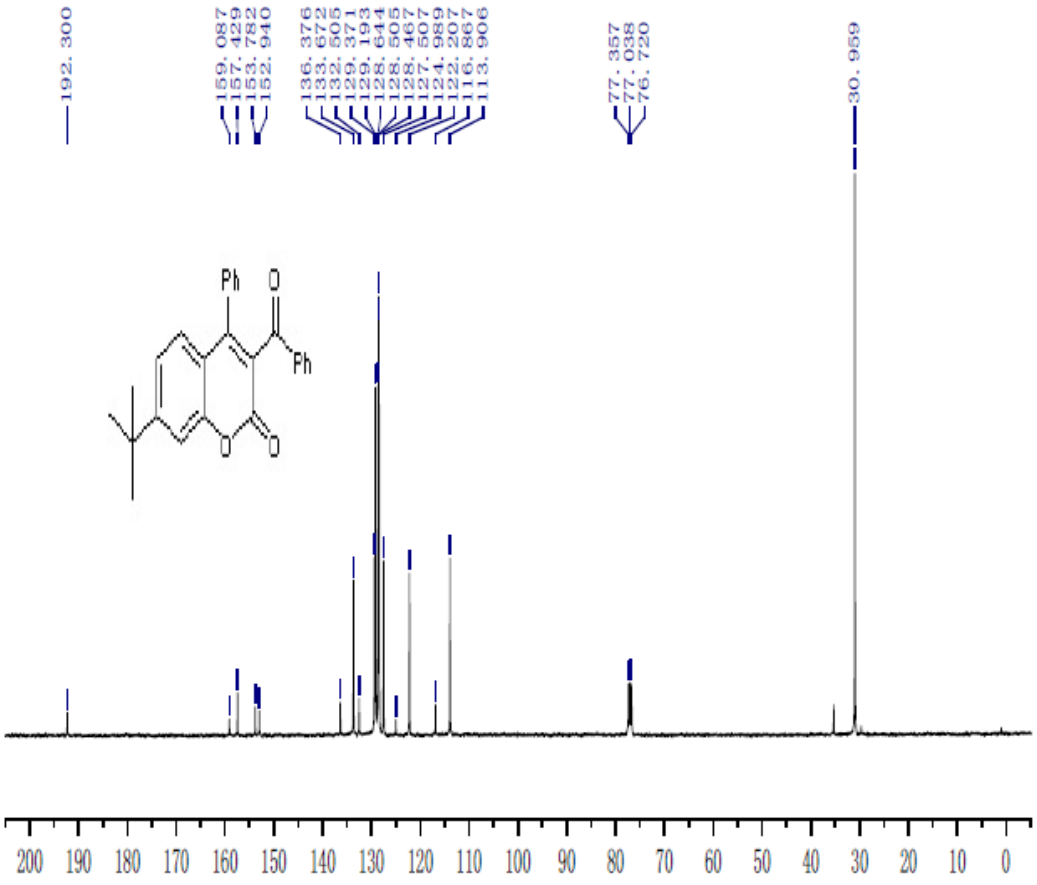
^{1}HNMR spectrum of compound **3b**



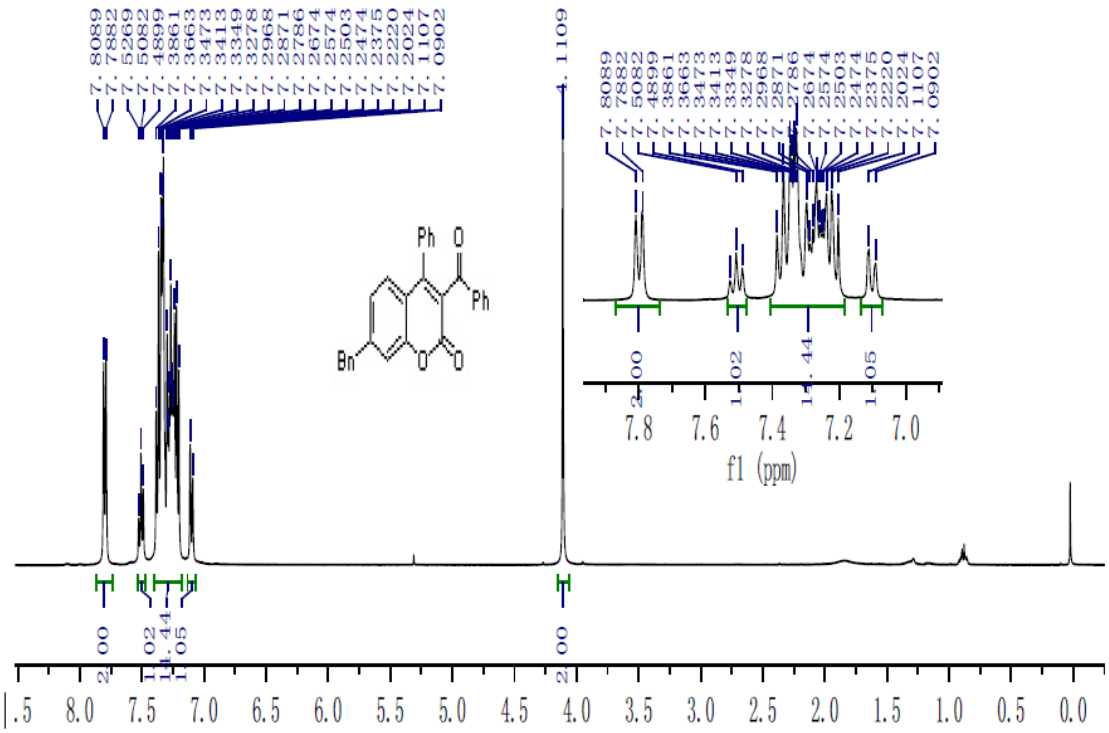
^{13}CNMR spectrum of compound **3b**



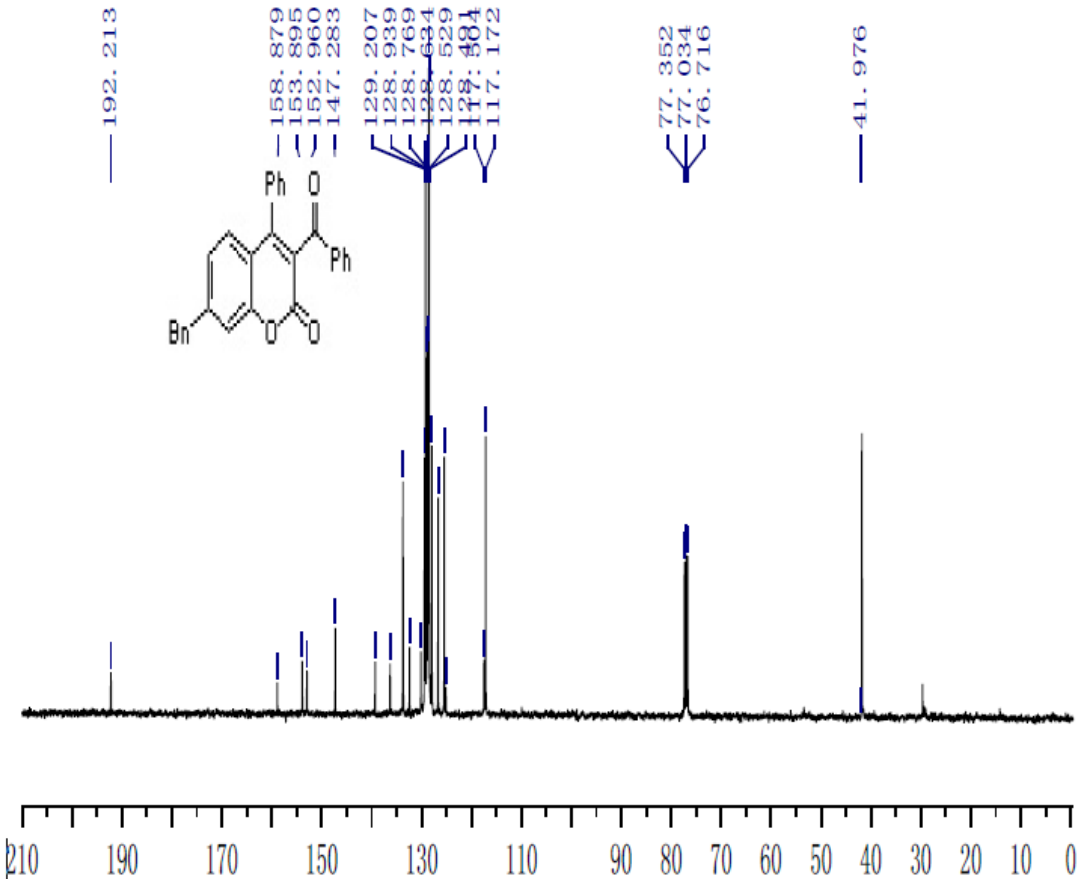
^{1}HNMR spectrum of compound **3c**



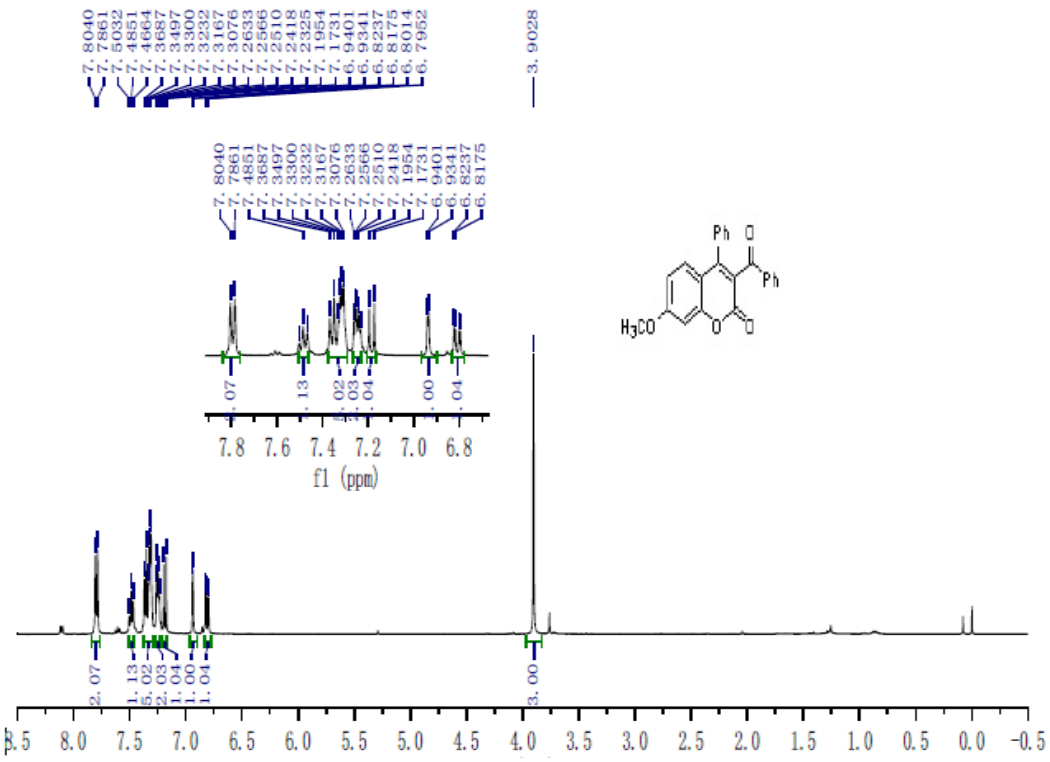
^{13}CNMR spectrum of compound **3c**



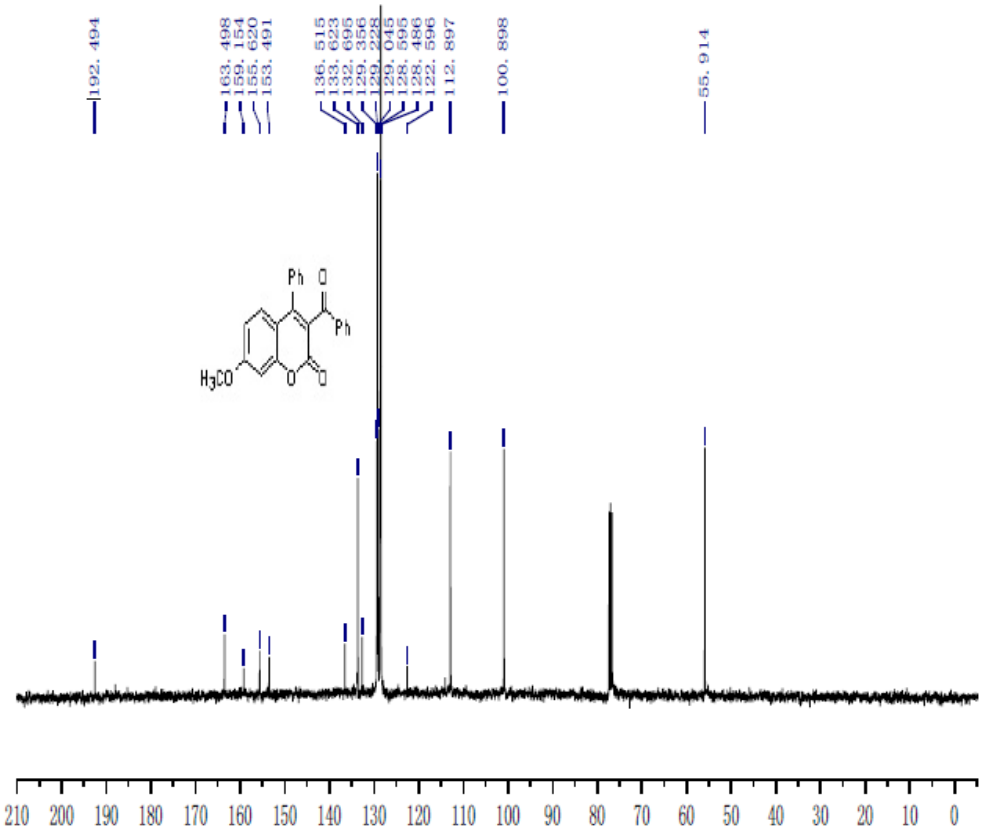
[1]HNMR spectrum of compound **3d**



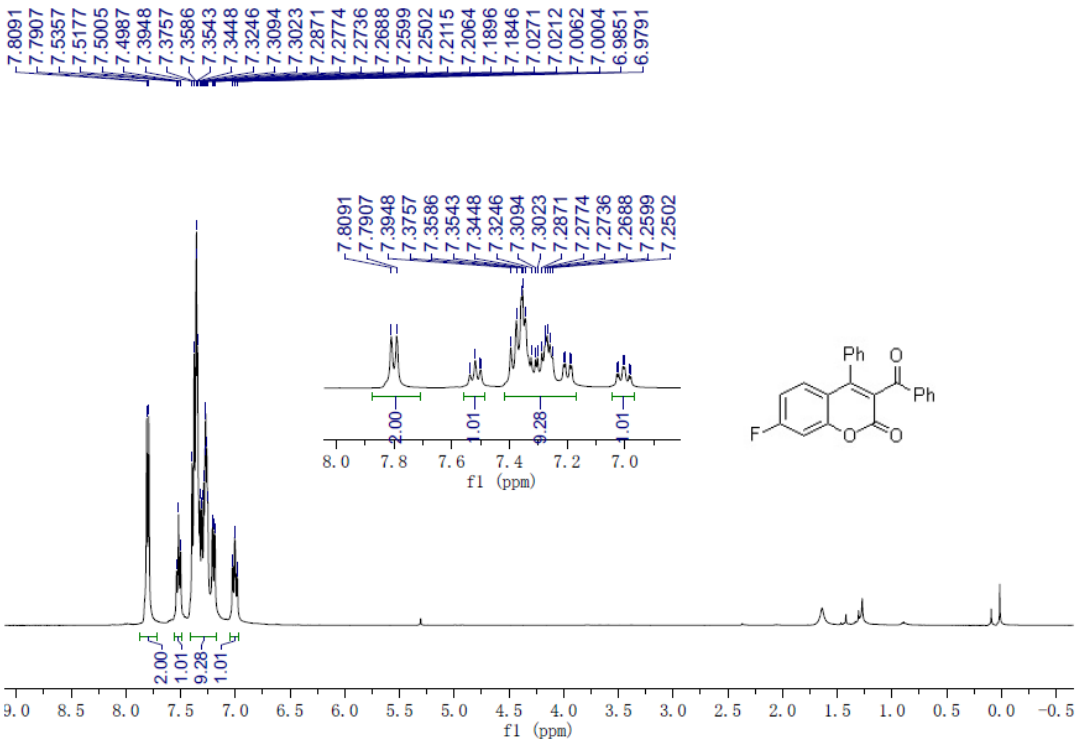
[13]CNMR spectrum of compound **3d**



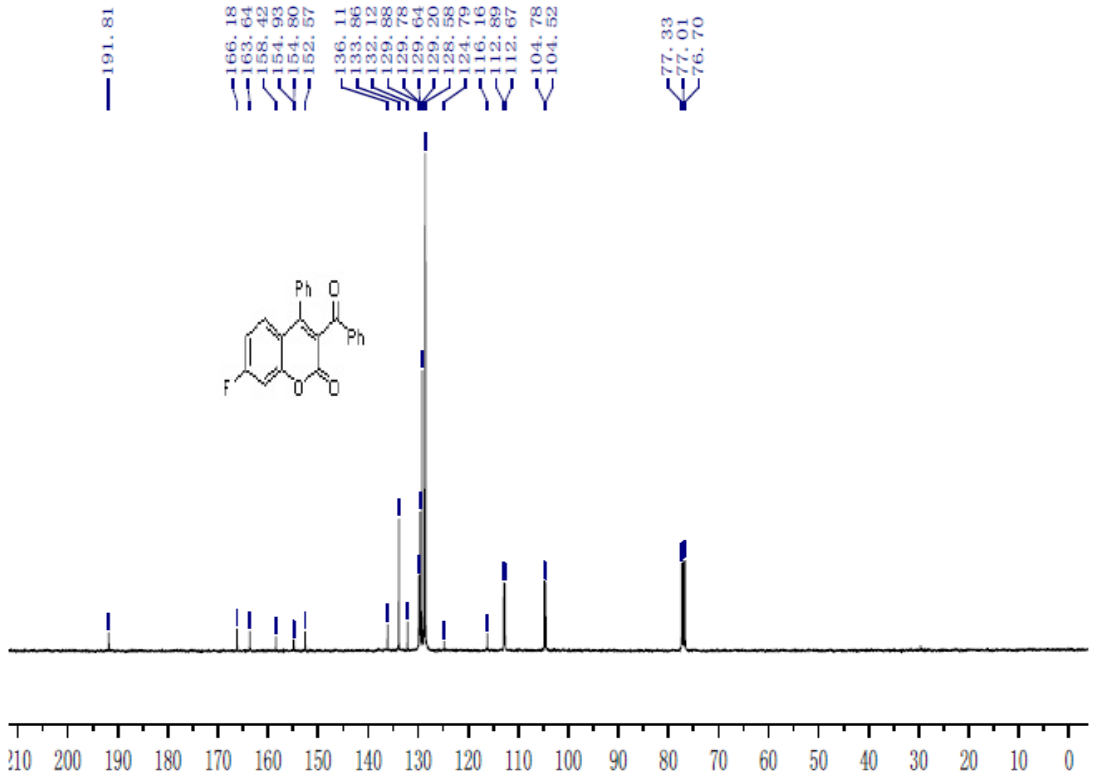
^{1}HNMR spectrum of compound **3e**



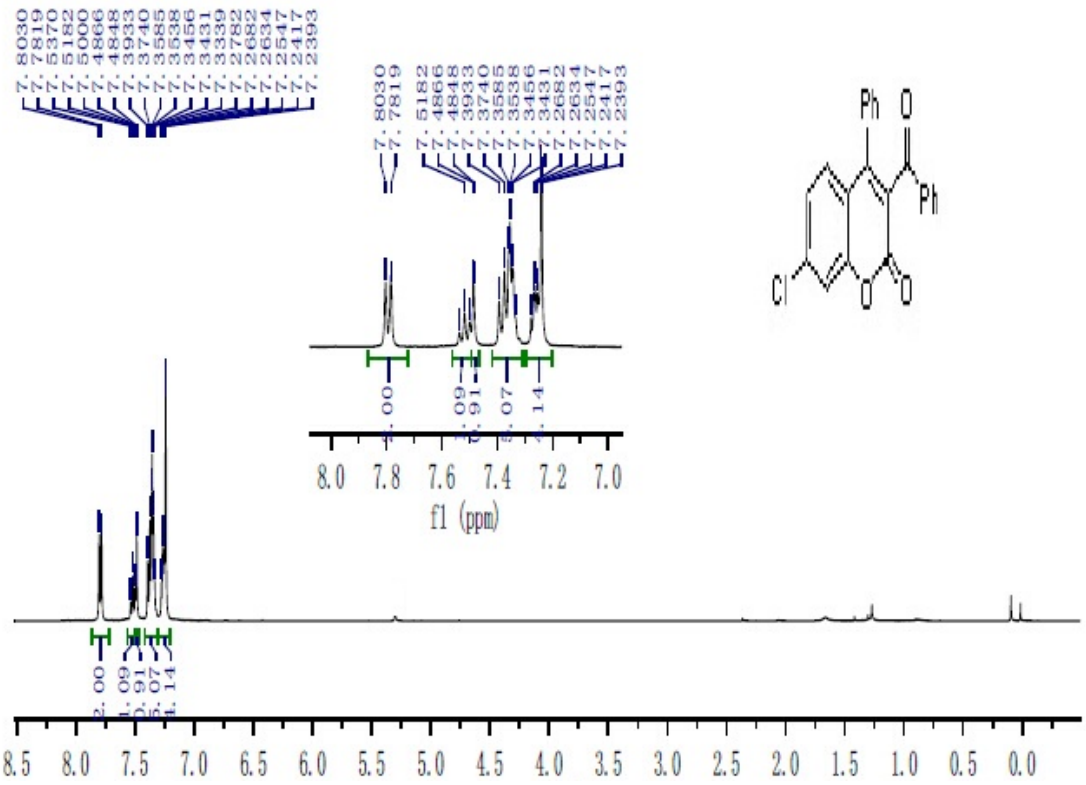
^{13}CNMR spectrum of compound **3e**



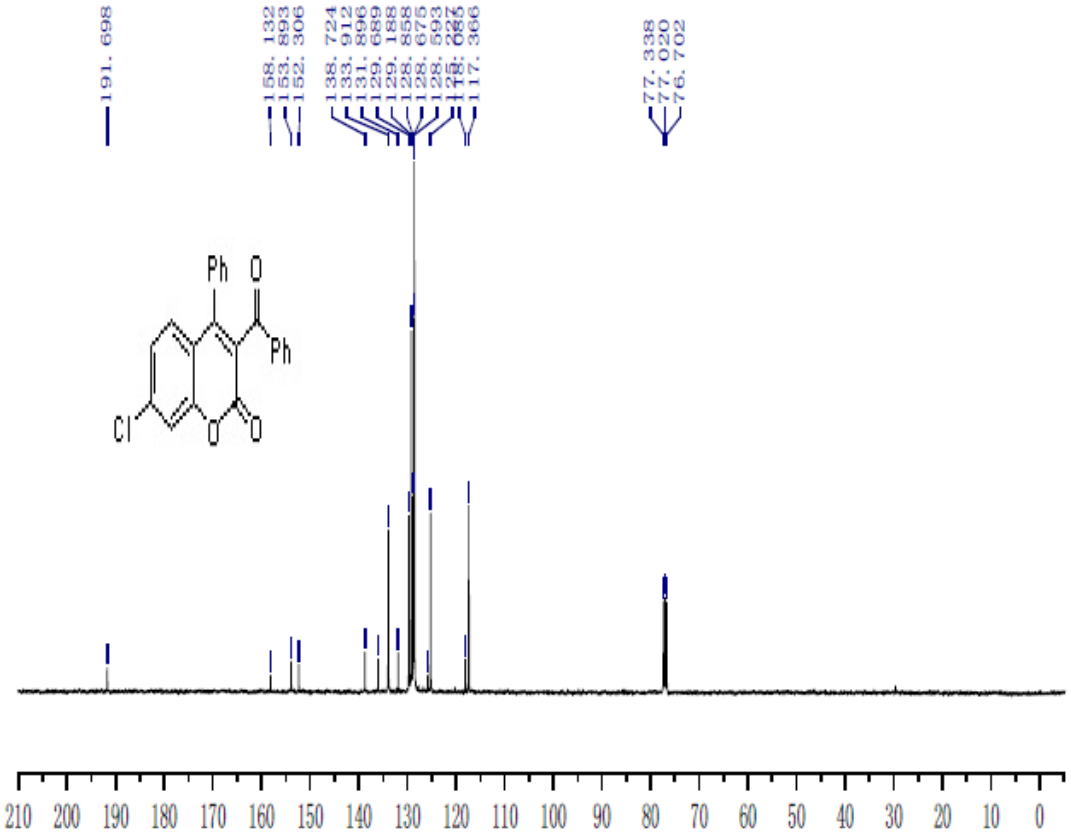
^{1}HNMR spectrum of compound **3f**



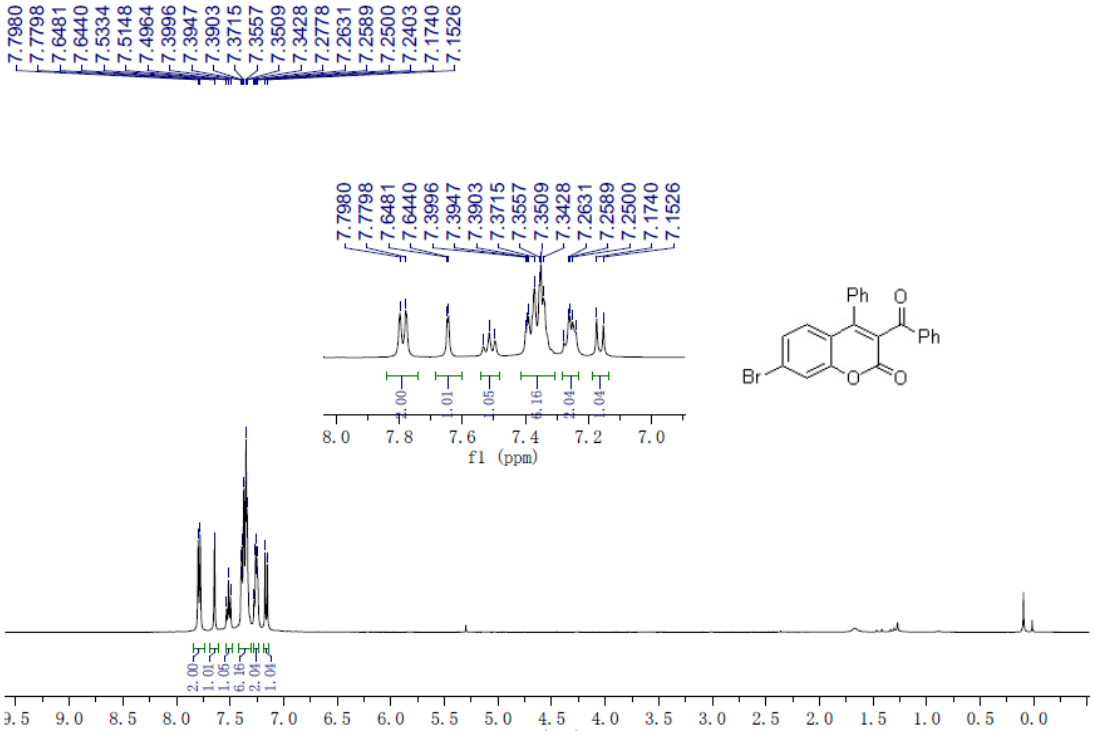
^{13}CNMR spectrum of compound **3f**



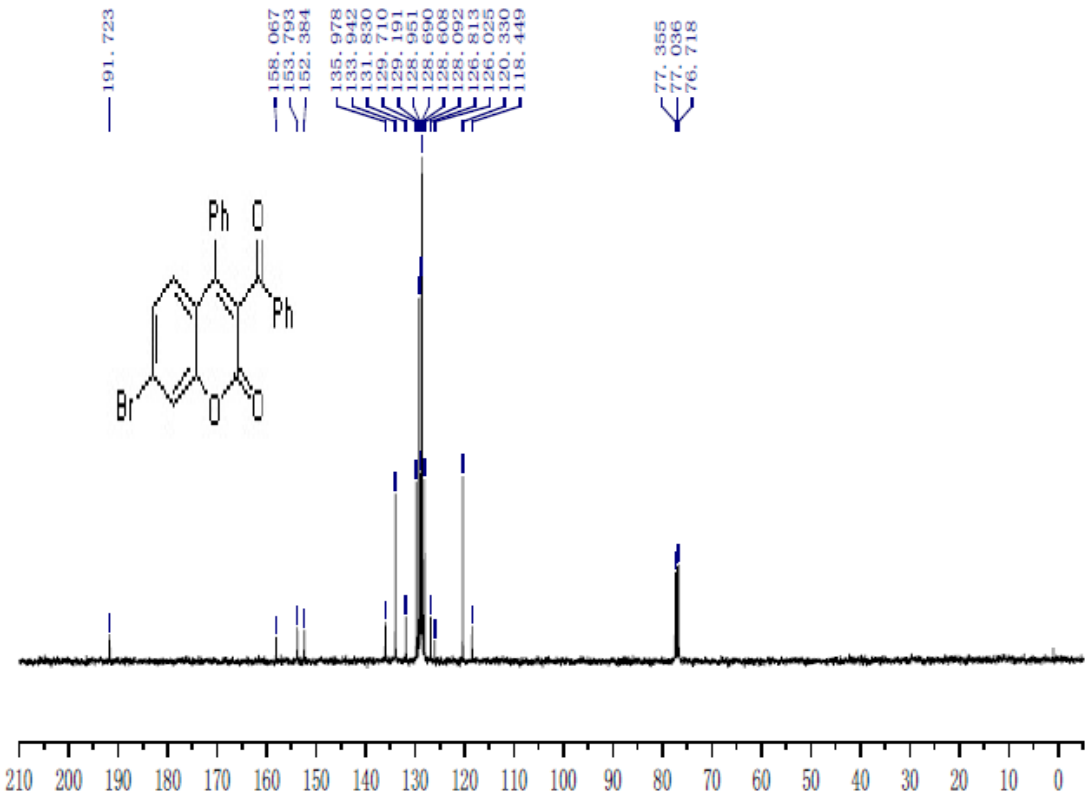
^{1}HNMR spectrum of compound **3g**



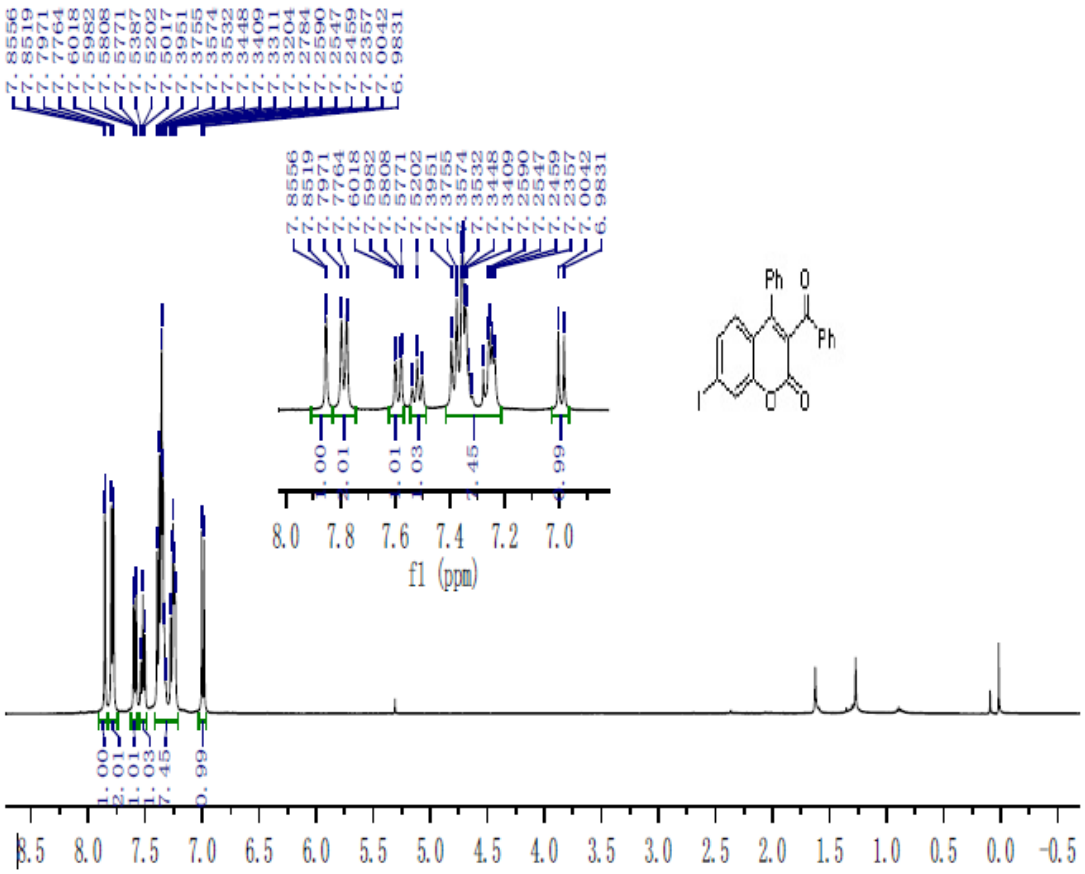
^{13}CNMR spectrum of compound **3g**



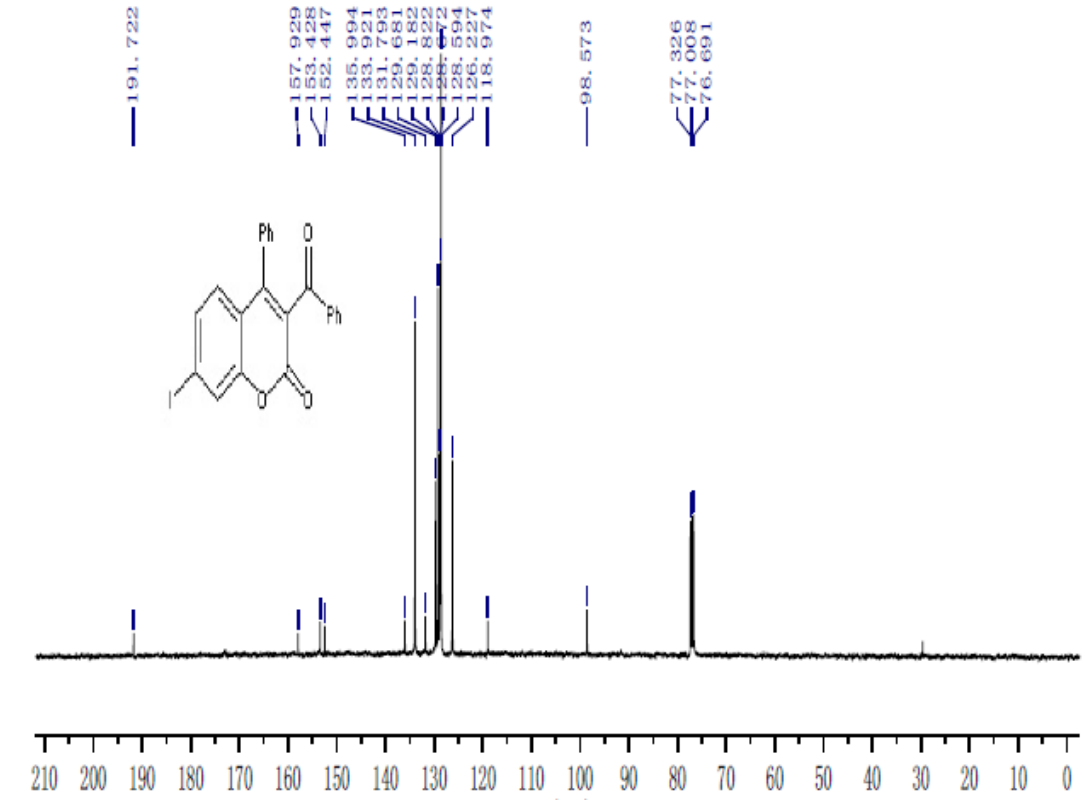
^{1}HNMR spectrum of compound **3h**



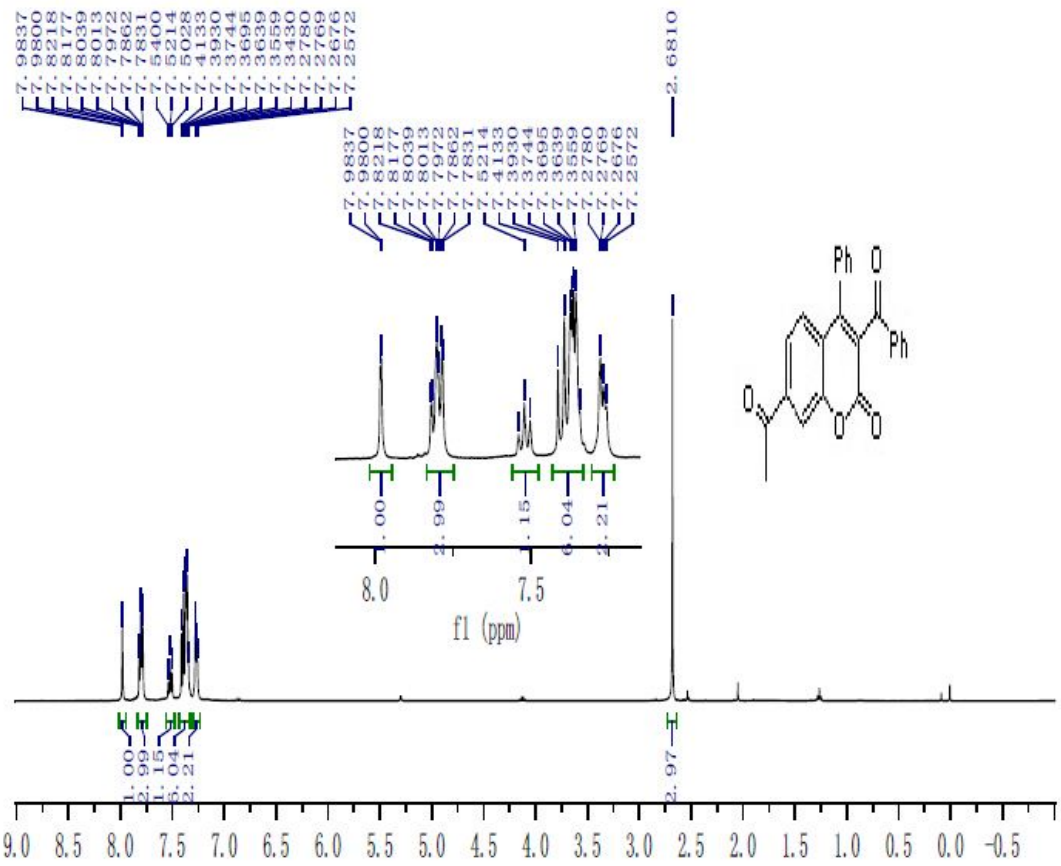
^{13}CNMR spectrum of compound **3h**



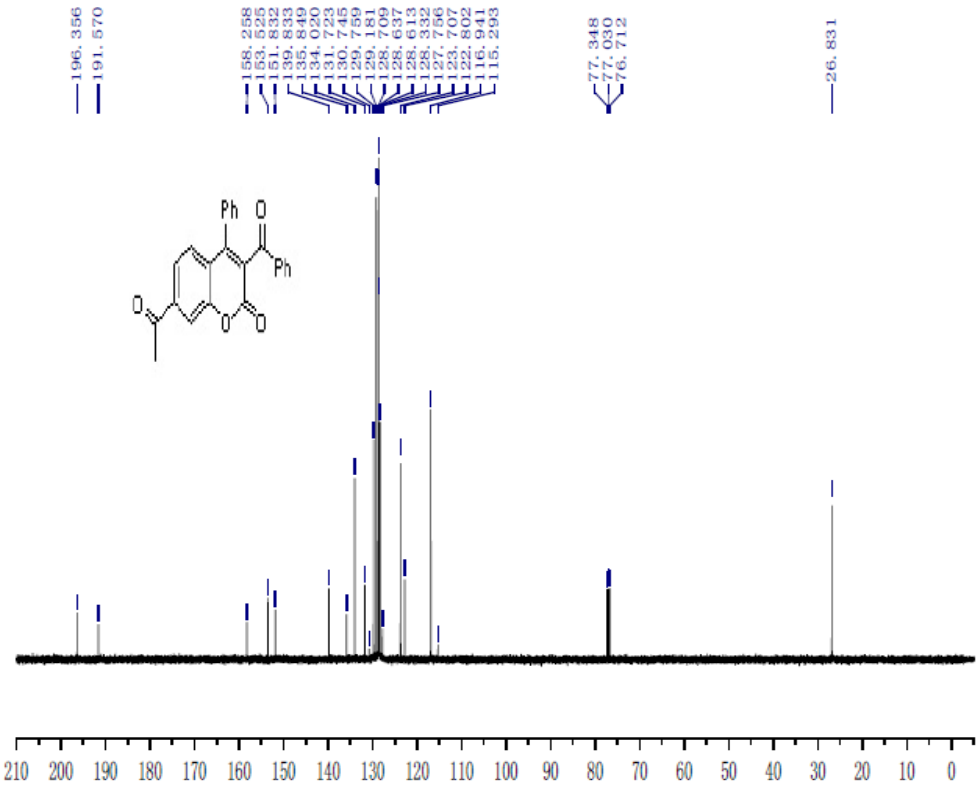
^{1}HNMR spectrum of compound **3i**



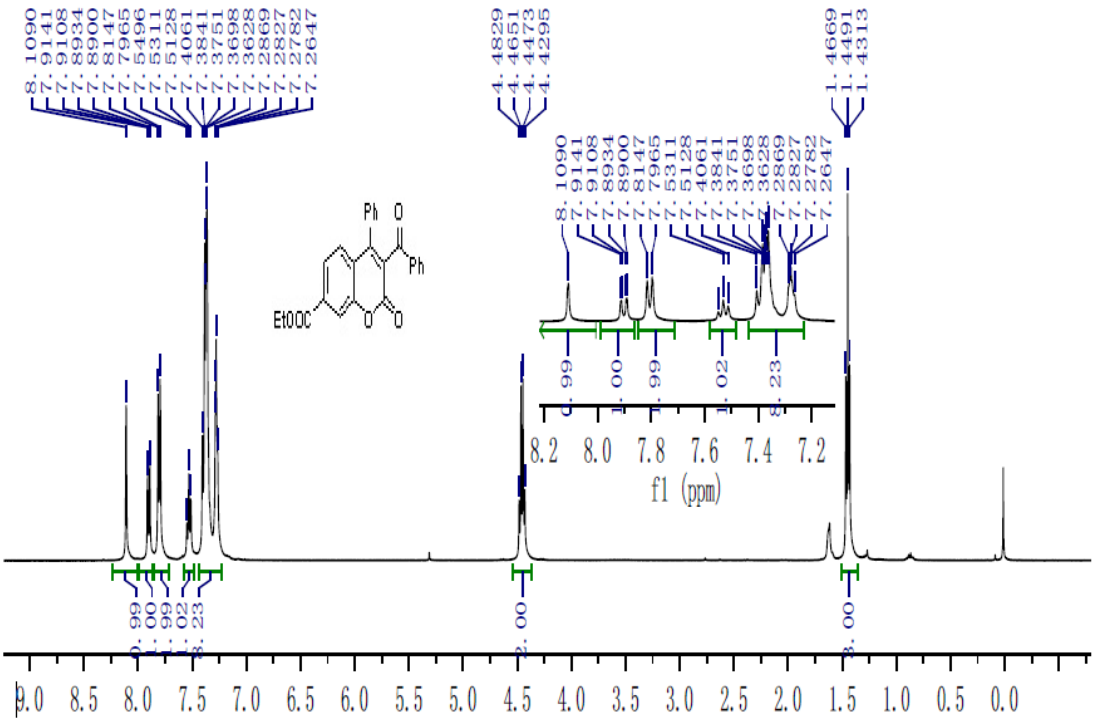
^{13}CNMR spectrum of compound **3i**



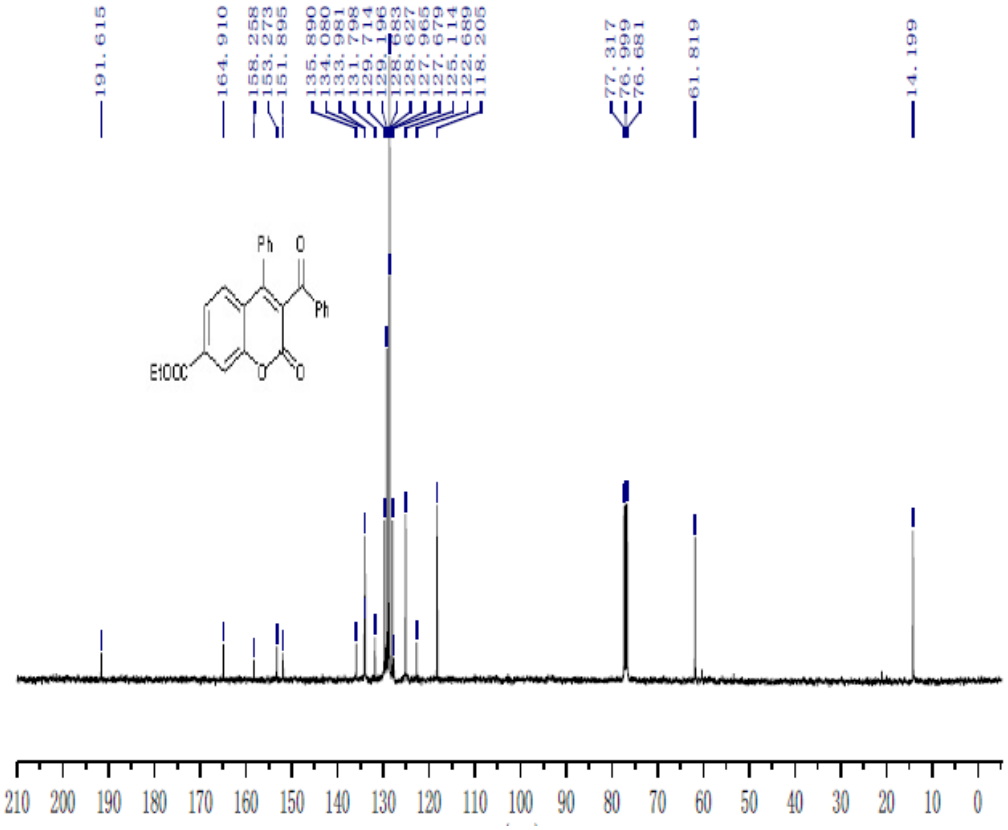
^{1}HNMR spectrum of compound **3j**



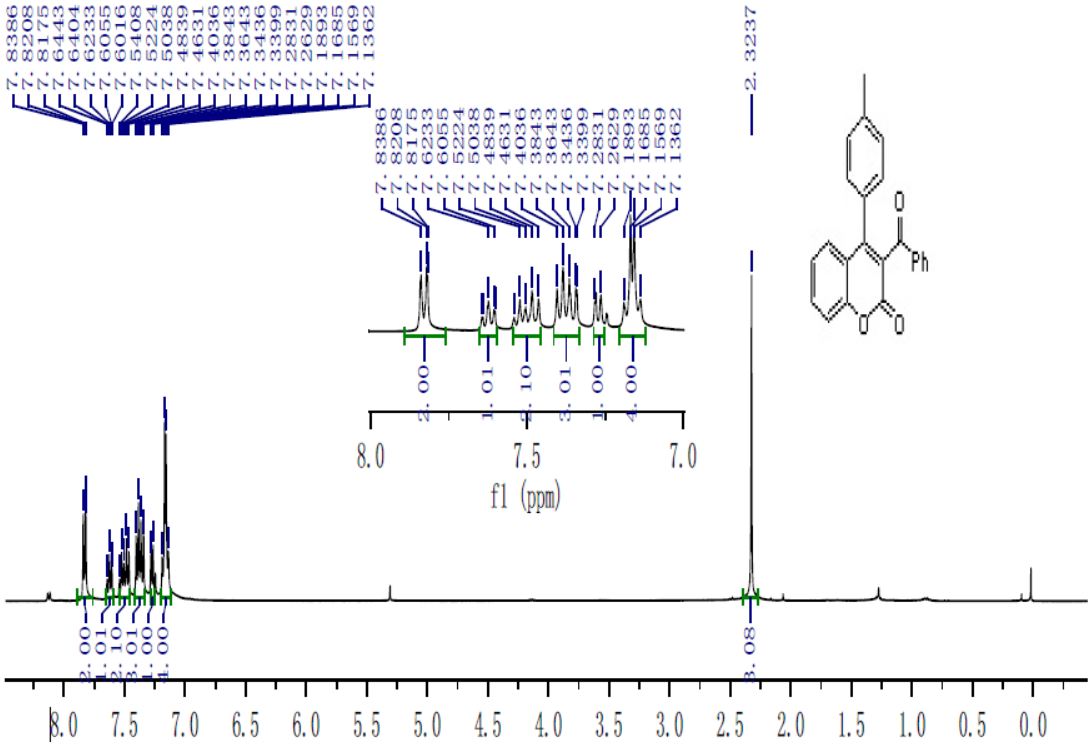
^{13}CNMR spectrum of compound **3j**



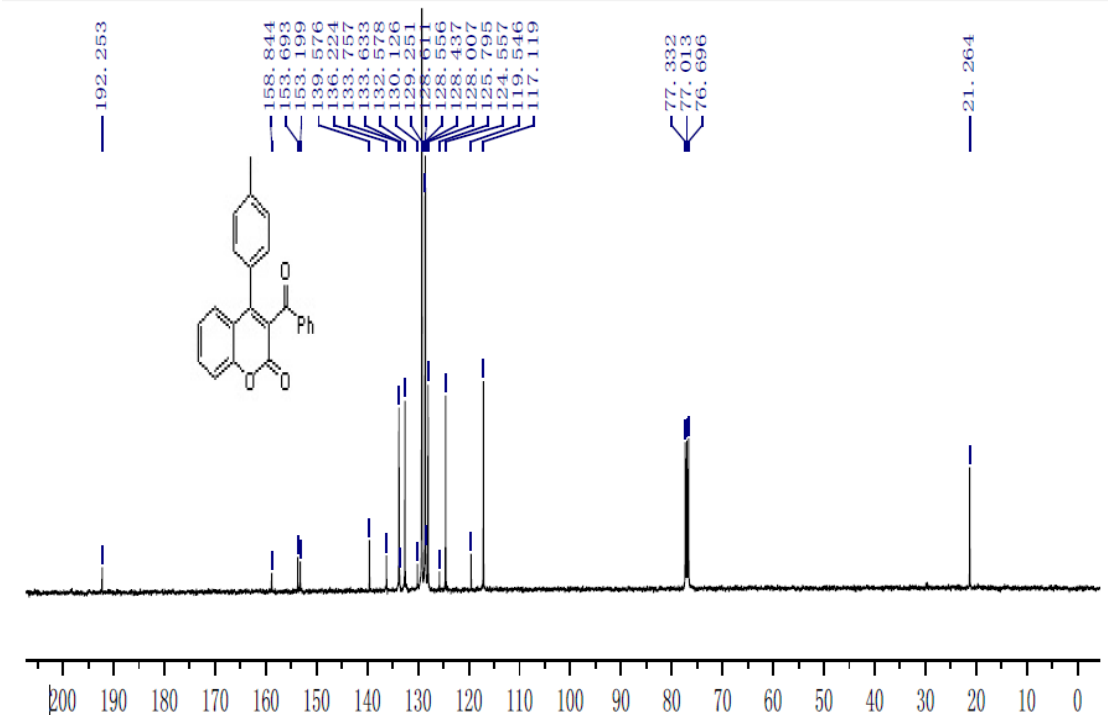
[1]HNMR spectrum of compound **3k**



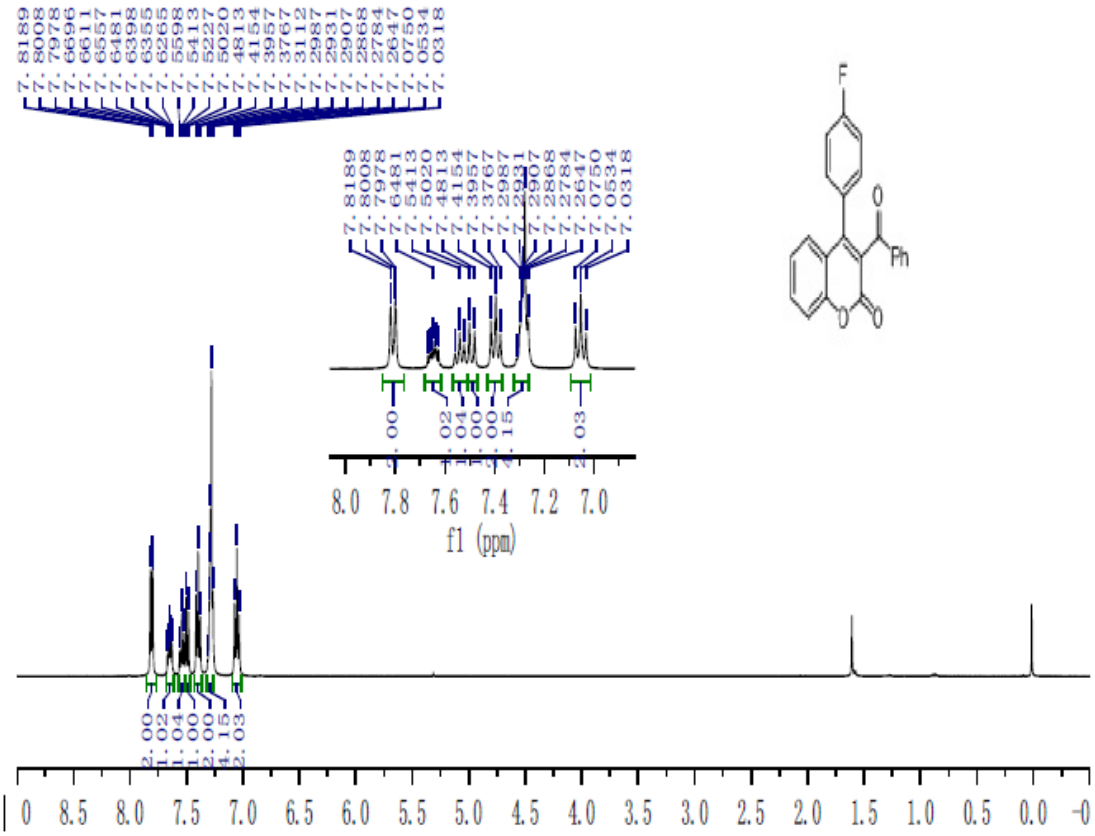
[13]CNMR spectrum of compound **3k**



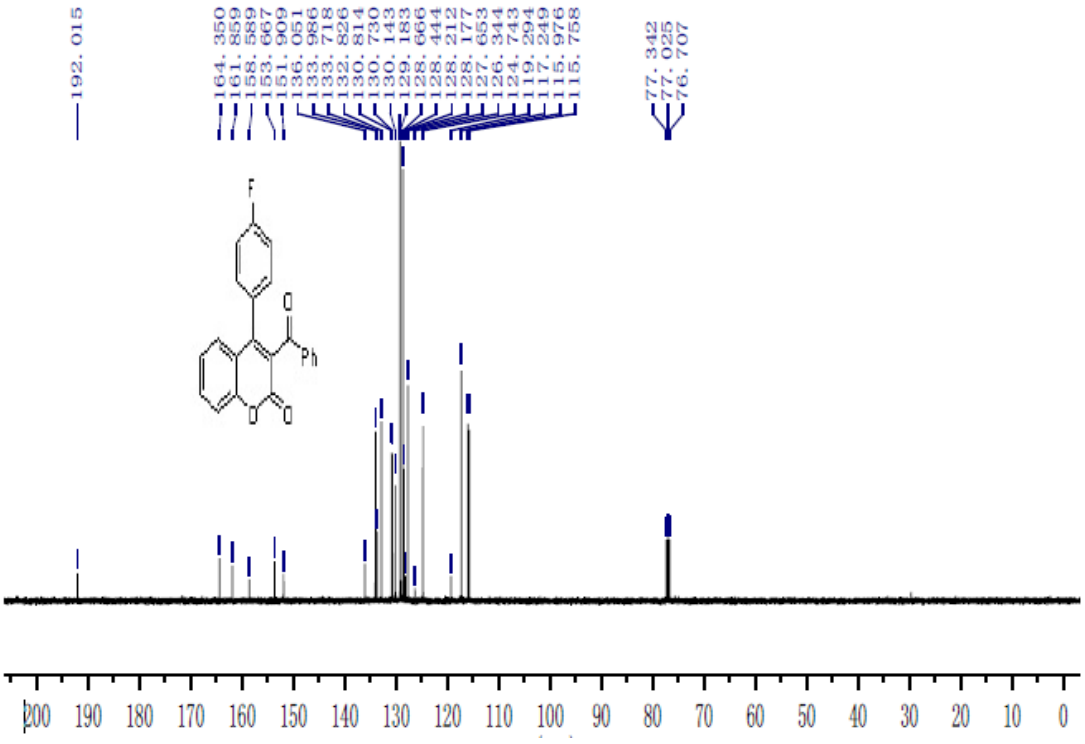
^{1}HNMR spectrum of compound **3l**



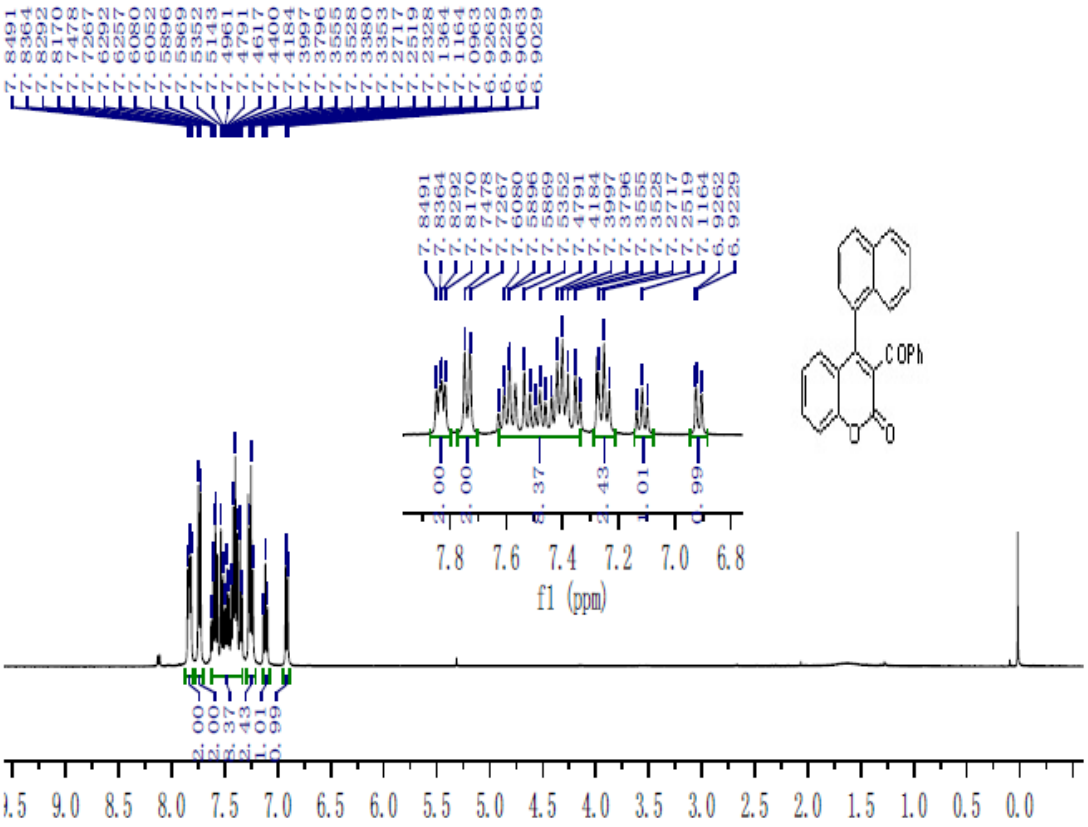
^{13}CNMR spectrum of compound **3l**



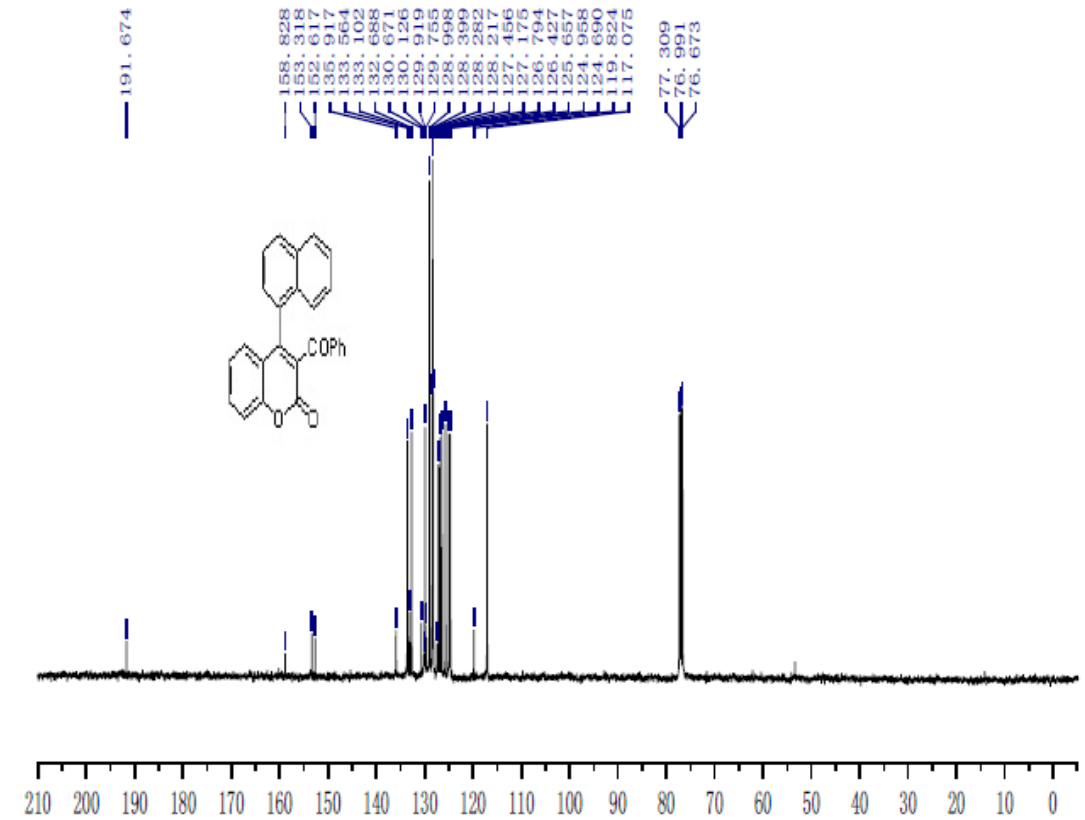
^{1}HNMR spectrum of compound **3m**



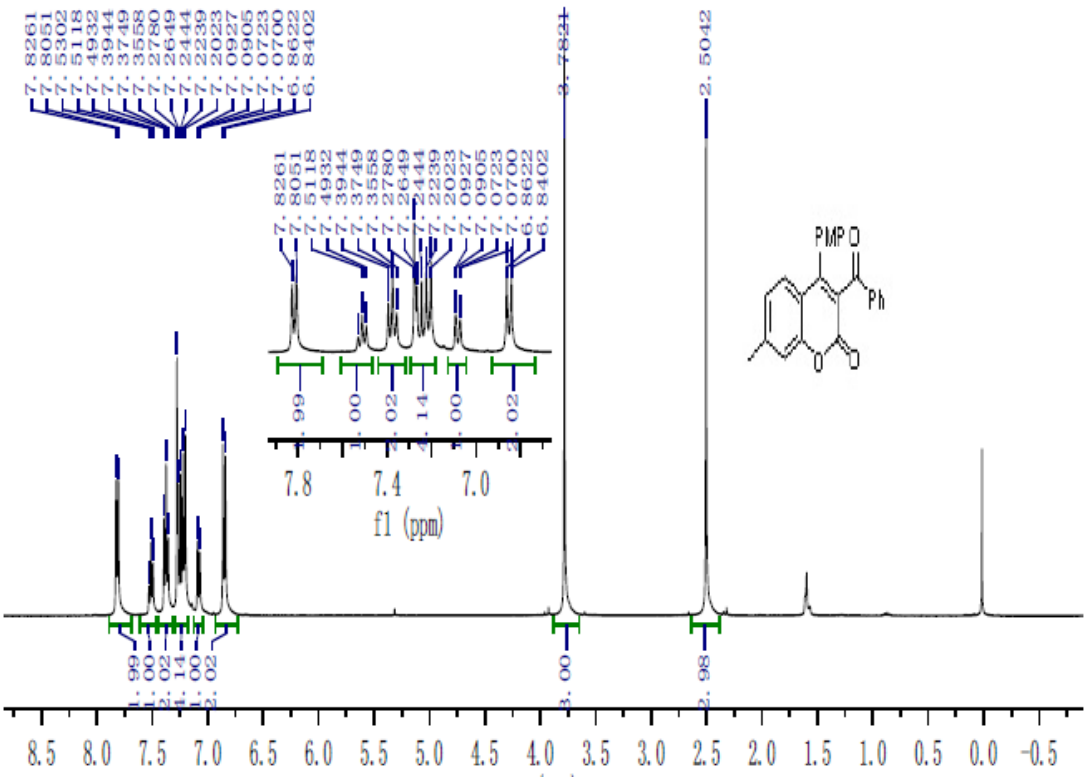
^{13}CNMR spectrum of compound **3m**



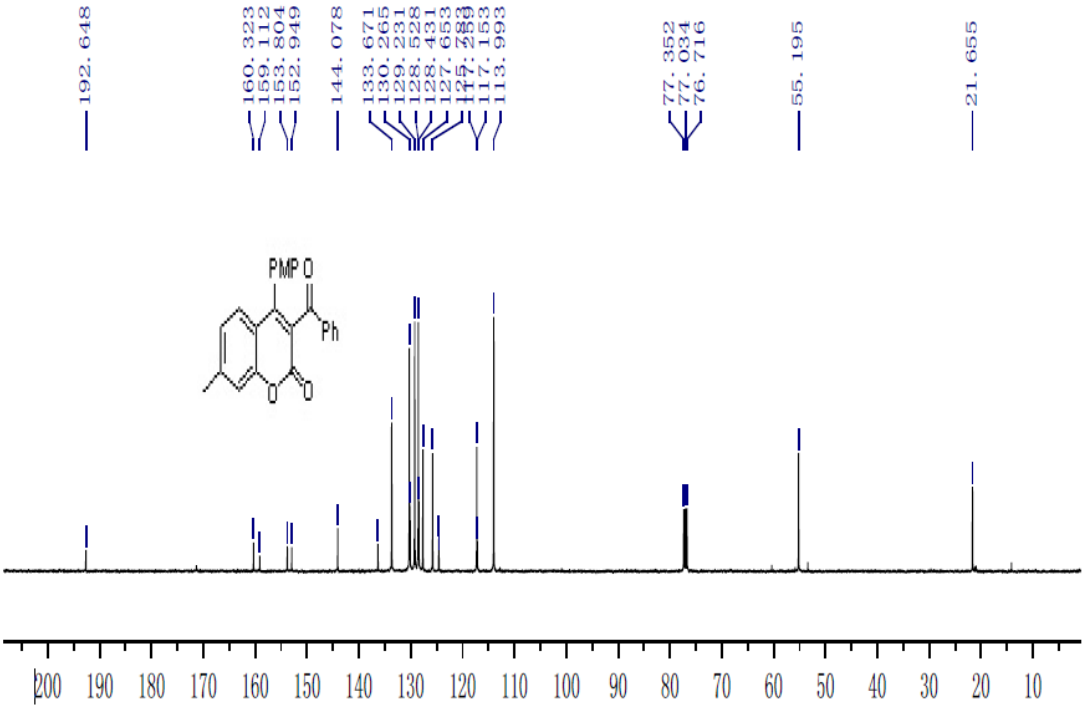
^{1}HNMR spectrum of compound **3n**



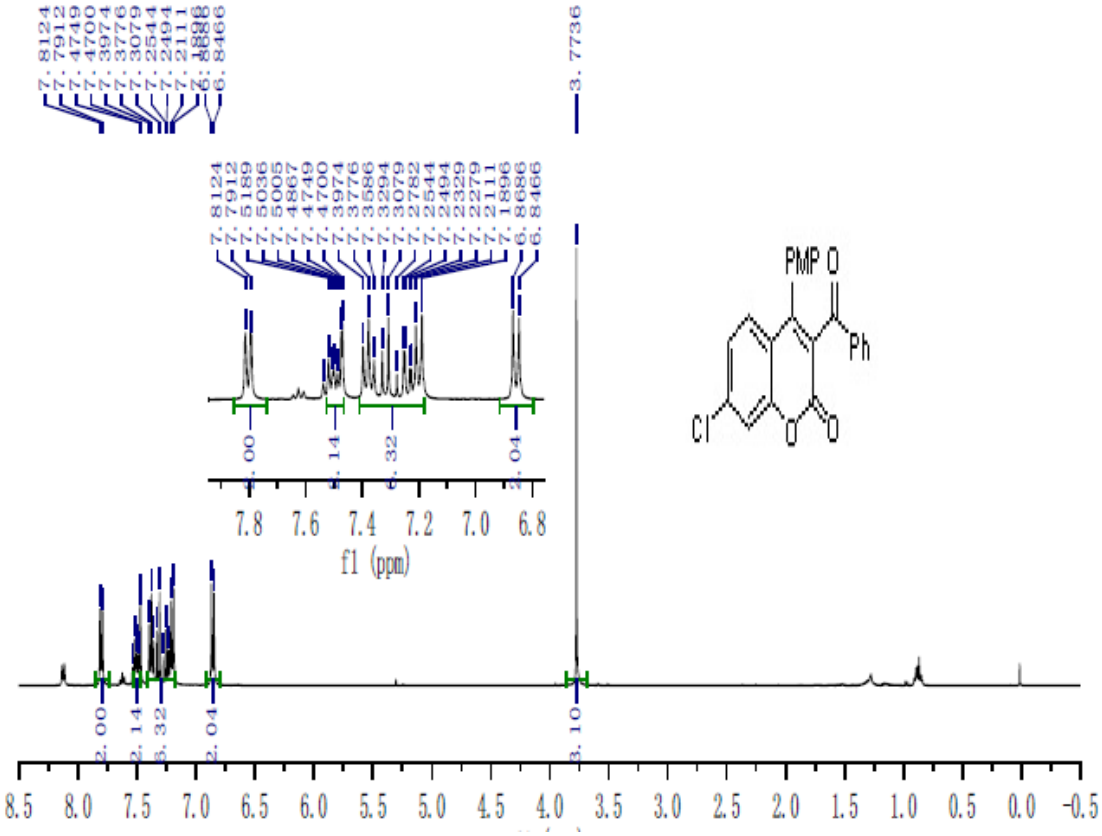
^{13}CNMR spectrum of compound **3n**



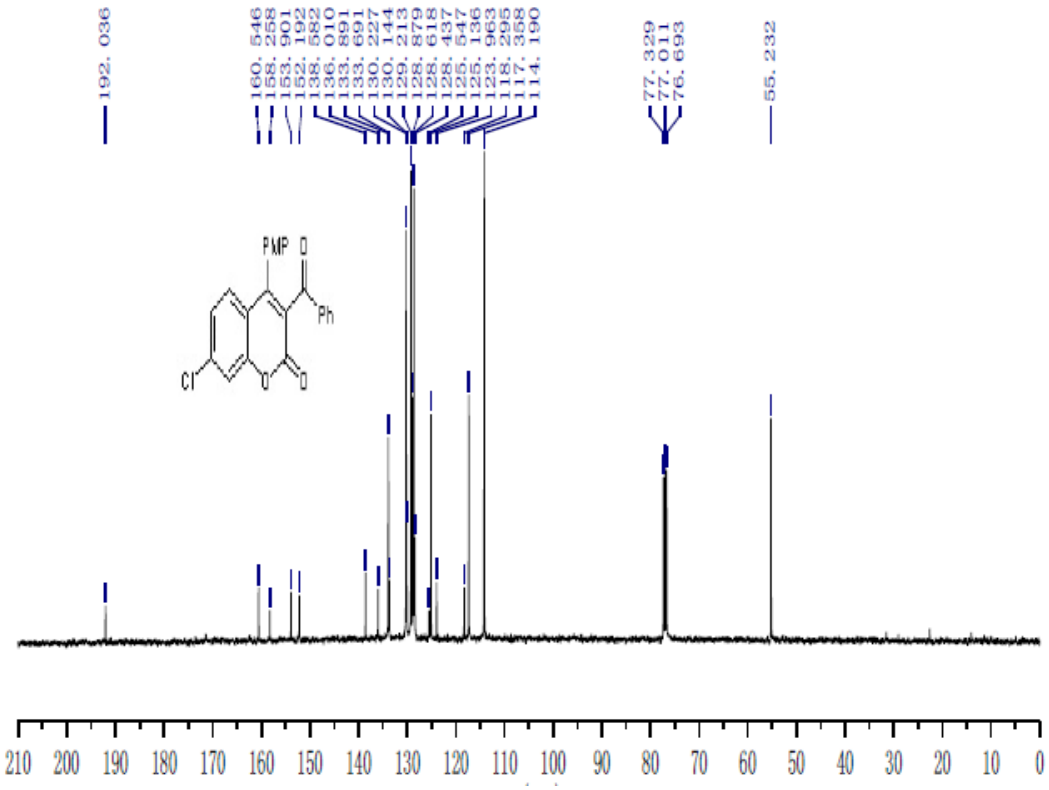
[1]HNMR spectrum of compound **3o**



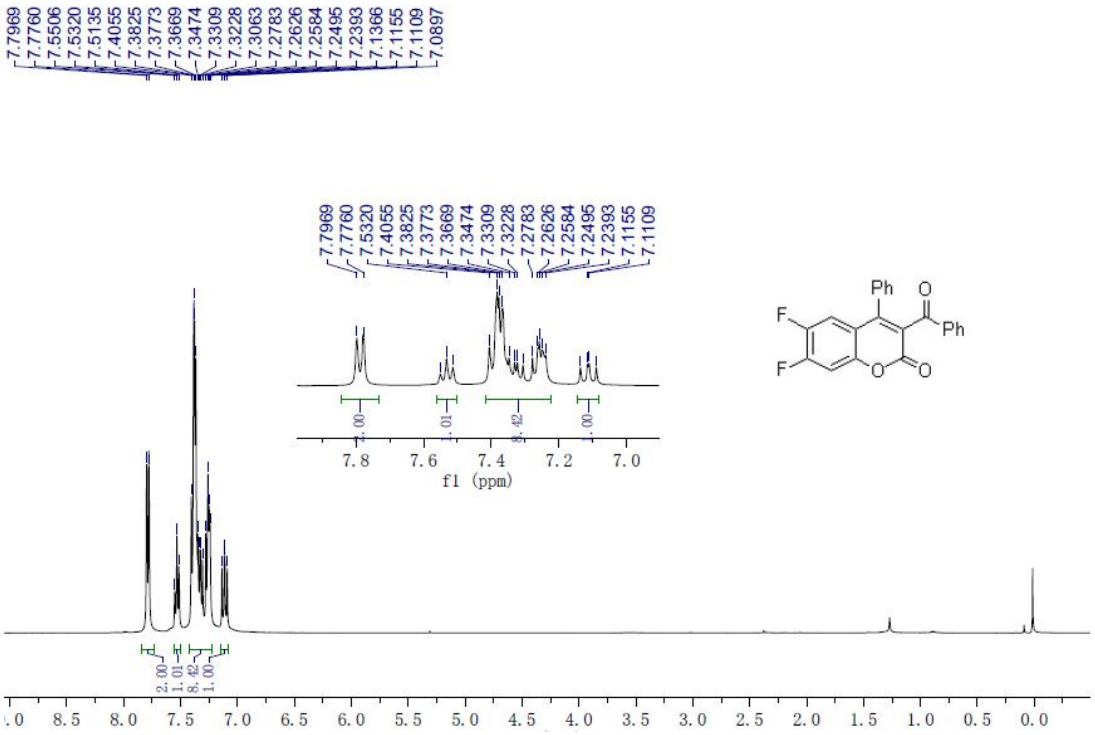
[13]CNMR spectrum of compound **3o**



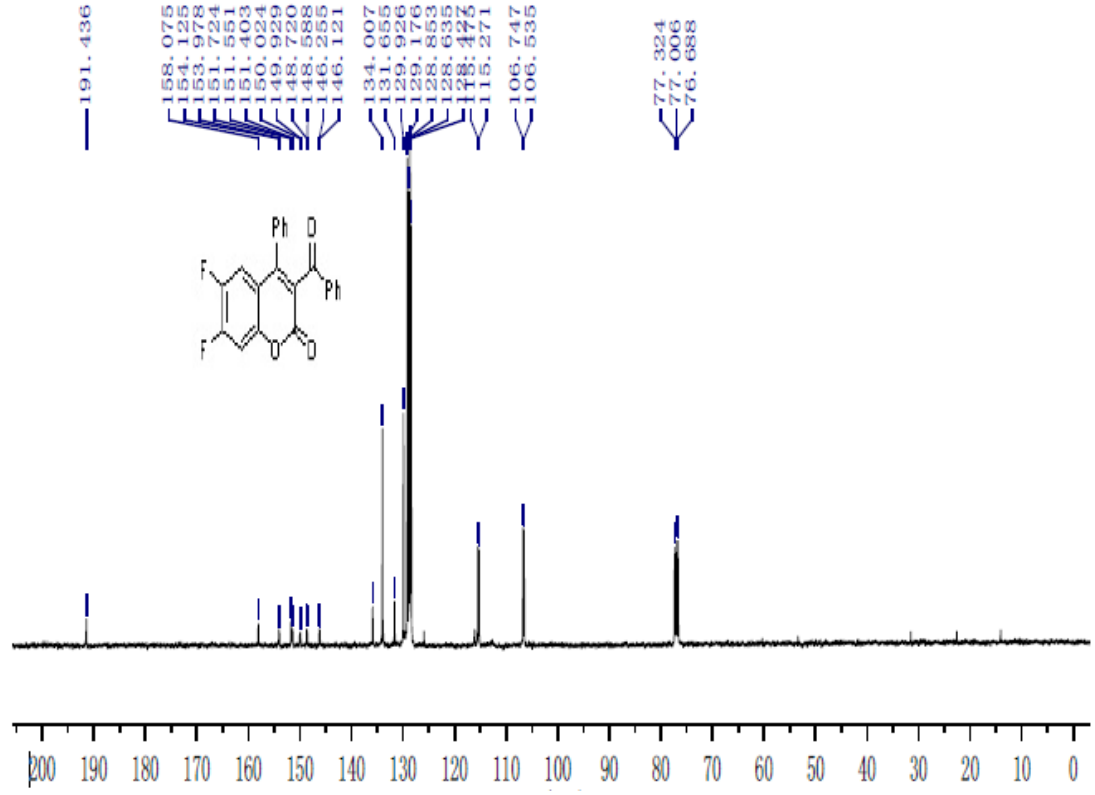
^{1}HNMR spectrum of compound **3p**



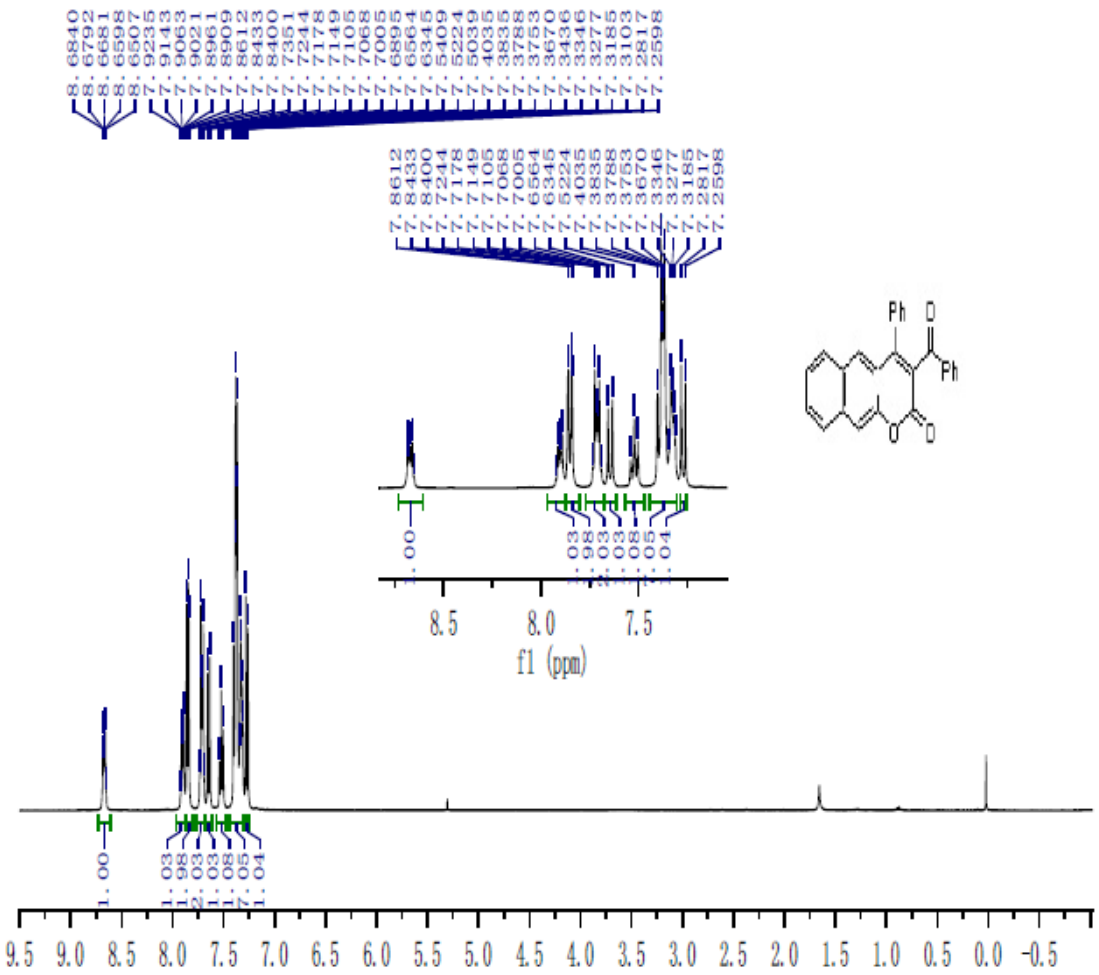
^{13}CNMR spectrum of compound **3p**



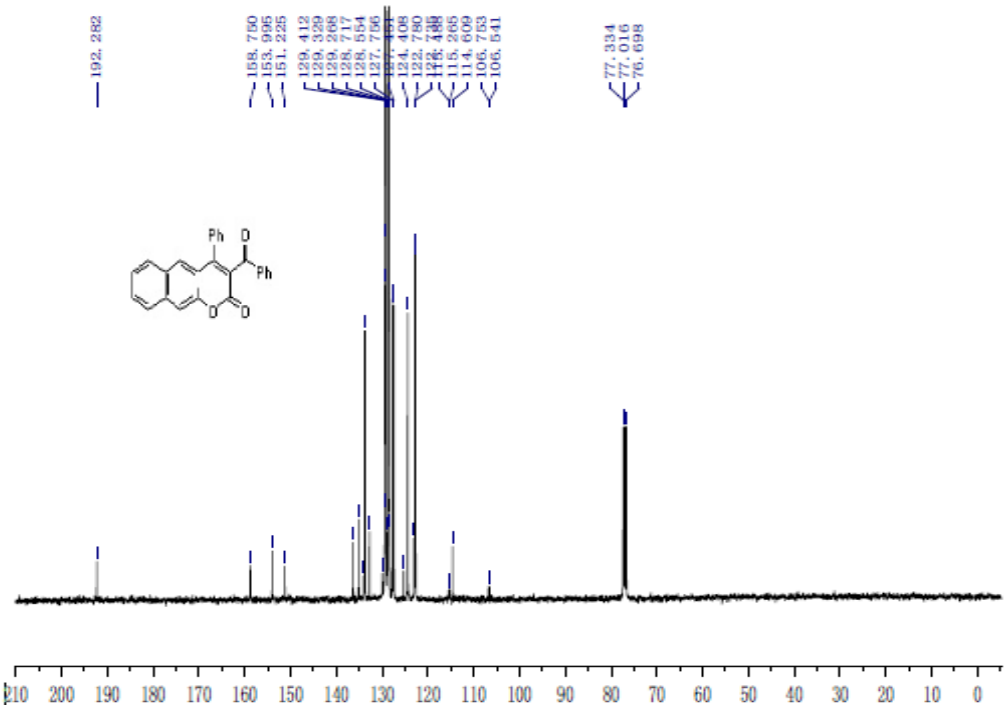
^{1}H NMR spectrum of compound **3q**



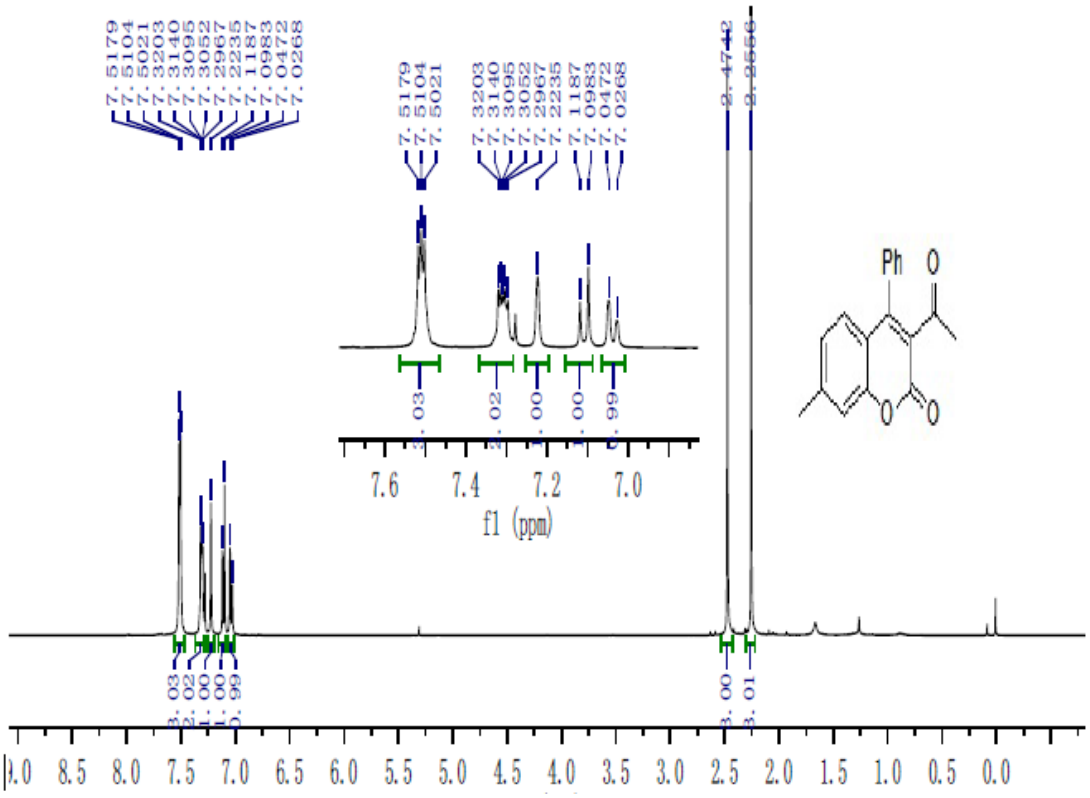
^{13}C NMR spectrum of compound **3q**



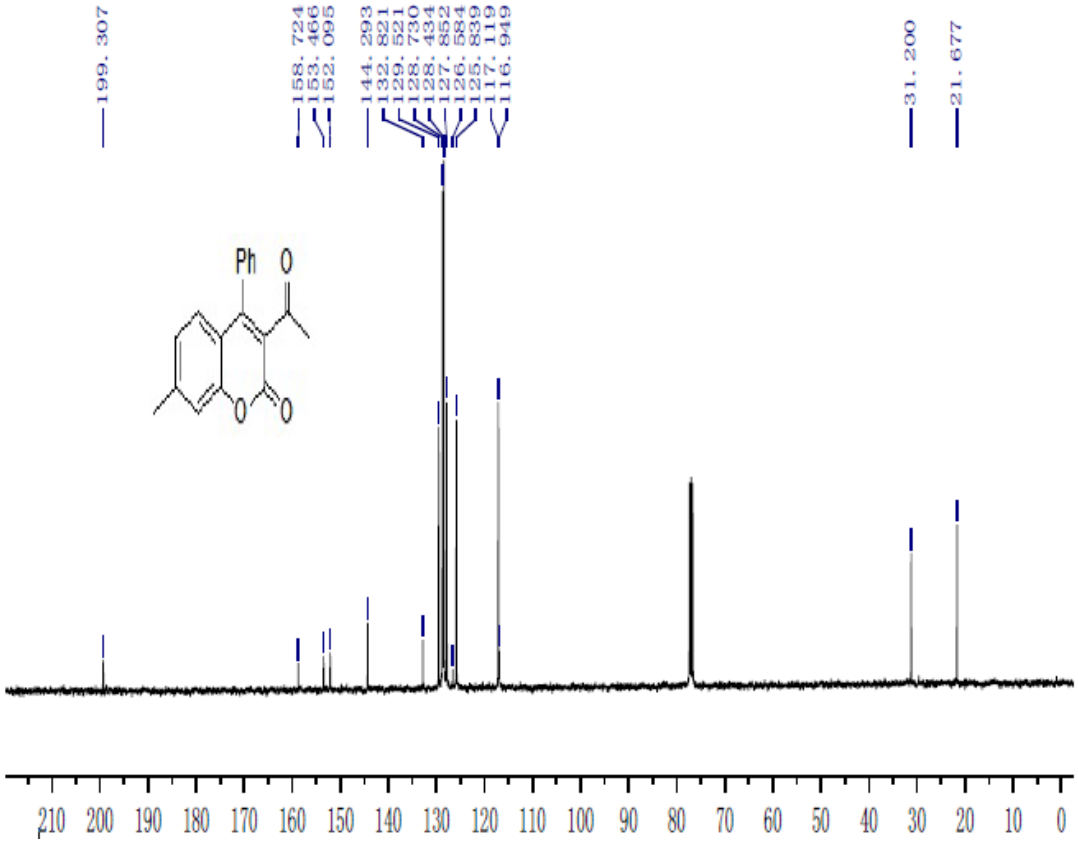
^{1}H NMR spectrum of compound **3r**



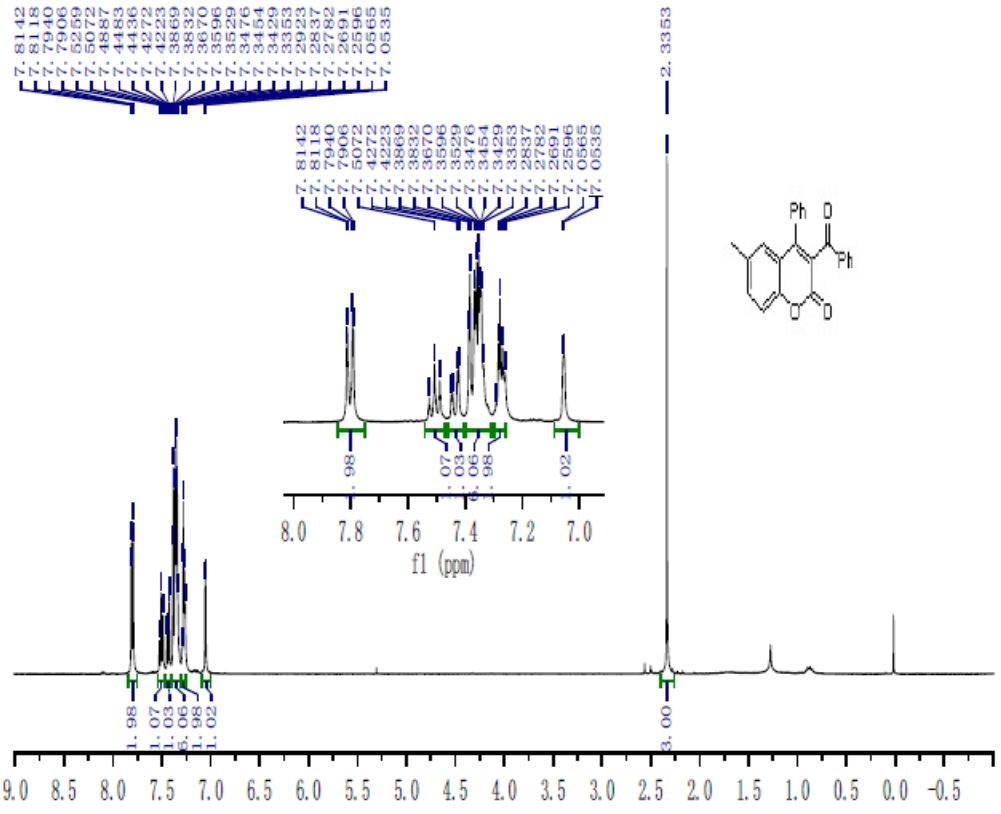
^{13}C NMR spectrum of compound **3r**



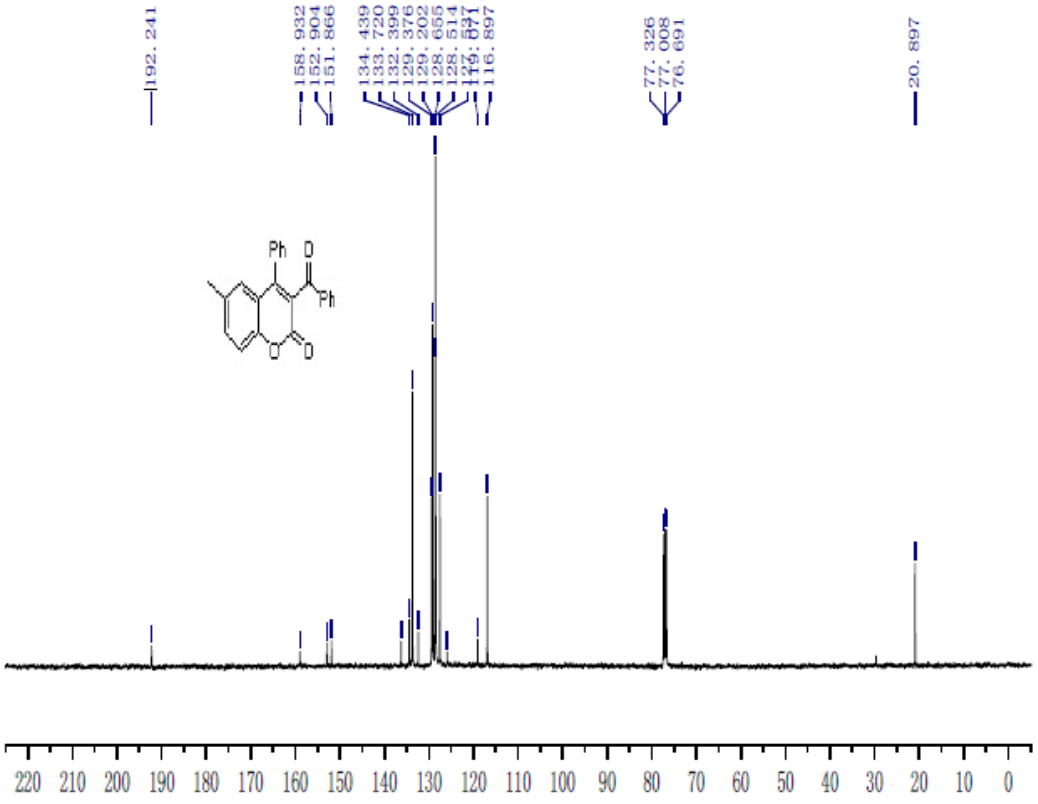
[1]HNMR spectrum of compound **3s**



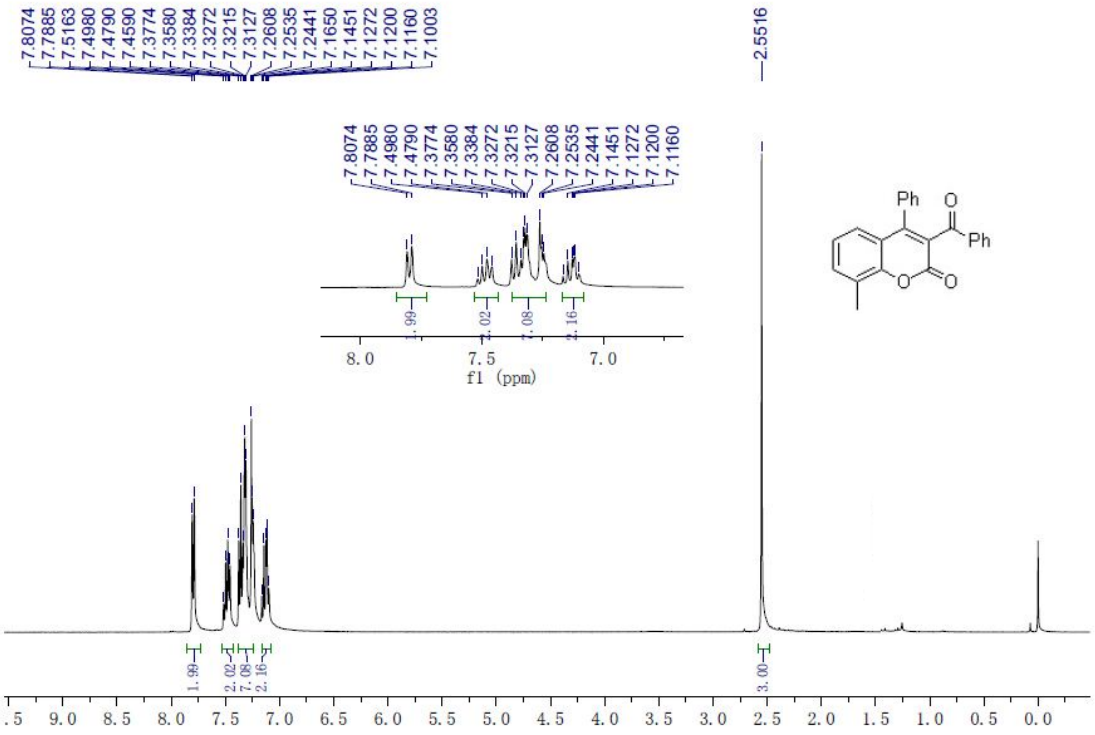
[13]CNMR spectrum of compound **3s**



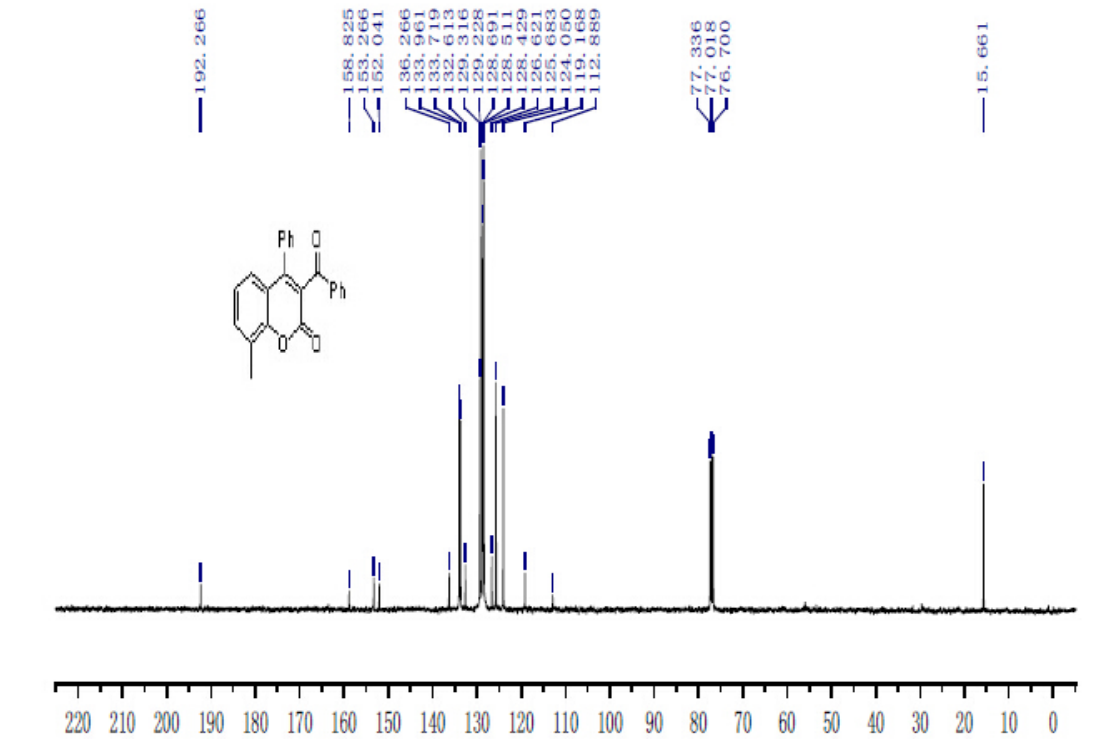
^{1}H NMR spectrum of compound **3t**



^{13}C NMR spectrum of compound **3t**



^{1}H NMR spectrum of compound **3t'**



^{13}C NMR spectrum of compound **3t'**