Supporting Information

Visible light-induced g-C_3N_4 Catalyzed C-H acylation and trifluoromethylation of quinoxalinones: an efficient and recyclable approach

Linzhao Li, Zongjie Ma, Cong Li, Gaoli Chen, Taiping Gao,* and Xiaoxiao Chu*

School of Chemistry and Materials Science, Ludong University, Yantai 264025, P.R. China
Email: gaotp@ldu.edu.cn

contents

1. General information

1.1 Materials and instruments

All glassware was thoroughly oven-dried. Chemicals and solvents were either purchased from commercial suppliers or purified by standard techniques. Thin-layer chromatography plates were visualized by exposure to ultraviolet light and/or staining with phosphomolybdic acid followed by heating on a hot plate. Flash chromatography was carried out using silica gel (200-300 mesh). Transmission electron microscope (TEM) images were gained with a JEM-100SX (Japan Electronics, Japan) transmission electron microscope under an acceleration voltage of 200kV. Powder X-ray diffraction measurements were recorded by a PAN analytical X'Pert Pro X-ray diffractometer. Scanning electron microscope (SEM) images were recorded on Field Emission Scanning Electron Microscopy (Hitachi SU8010). ^{1}H NMR, ^{13}C NMR and ^{19}F NMR spectra were recorded on a Bruker AM-400 (500 MHz). The spectra were recorded in $CDCl_3$ as solvent at room temperature, ^{1}H NMR, ^{13}C NMR and ^{19}F NMR chemical shifts are reported in ppm relative to the residual solvent peak. The residual solvent signals were used as references and the chemical shifts were converted to the TMS scale ($CDCl_3$: δ_H = 7.27 ppm, δ_C = 77.00 ppm). Data for ^{1}H NMR are reported as follows: chemical shift (δ ppm), multiplicity (s = singlet, d = doublet, t = triplet, m = multiplet, dd = doublet), integration, coupling constant (Hz) and assignment. HRMS were performed on a Bruker Apex II mass instrument (ESI). The quinoxalin-2(1*H*)-ones[1] were prepared according to the references.

1. (*a*) Messaoudi, S.; Alami, M. *Org. Lett.*, **2013**, *15*, 5606-5609; (*b*) Chen, D.; Bao, W. *Adv. Synth. Catal.*, **2010**, *352*, 955-960.

1.2 Devices for the photocatalytic reactions.

The Photocatalytic reaction was carried out in a custom-fabricated reactor under 6W blue LEDs irradiation. The reaction temperature was adjusted by regulating the flow rate of circulating water. The maximum emission wavelength and half-peak breadth of the blue LED's is 450 nm and 40 nm, respectively.

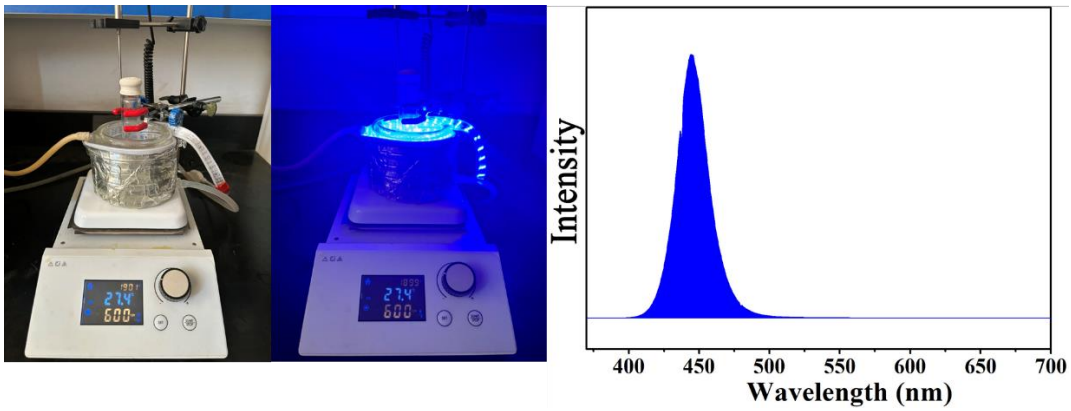


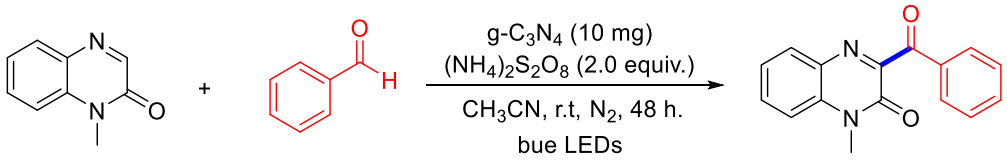
Figure S1. Devices for the reactions and the emission spectrum of blue LEDs.

2. General procedure for the synthesis of g-C_3N_4 and C-H functionalization of quinoxalin-2(1*H*)-ones

2.1 General procedure for the synthesis of g-C_3N_4.

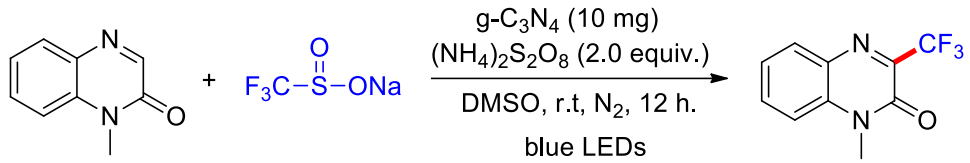
The g-C_3N_4 was synthesized by thermal polymerization of melamine. Specifically, melamine (10.0 g) was added into a crucible, which was capped with a cover. Gradually heated the crucible to the temperature of 550 ℃ at a heating rate of 2℃/min and maintained at this temperature for 4 hours. Once the heating process is complete, allow the crucible to cool down naturally to room temperature to obtain the g-C_3N_4 catalyst as yellow powder.

2.2 C-H functionalization of quinoxalin-2(1*H*)-ones



1a **2a** **3a**

Under N_2 atmosphere, a reaction tube (10 mL) equipped with a magnetic stirrer bar was charged with quinoxalin-2(1*H*)-ones (**1a**, 0.2 mmol), benzaldehyde (**2a**, 0.4 mmol), g-C_3N_4 (10 mg), $(NH_4)_2S_2O_8$ (0.4 mmol), CH_3CN (1.0 mL). The reaction mixture was stirred with a 6 W blue LEDs irradiation at room temperature for 48 h. After completion of the reaction, the crude mixture was concentrated, further purified by chromatography on silica gel (elute: PE/EA = 5:1) to give the desired product **3a**.



1a **4** **5a**

Under N_2 atmosphere, a reaction tube (10 mL) equipped with a magnetic stirrer bar was charged with quinoxalin-2(1*H*)-ones (**1a**, 0.3 mmol), CF_3SO_2Na (**4a**, 0.36 mmol), g-C_3N_4 (10 mg), $(NH_4)_2S_2O_8$ (0.6 mmol), DMSO (1.0 mL). The reaction mixture was stirred with a 6 W blue LEDs irradiation at room temperature for 12 h. After disappearance of quinoxalin-2(1H)-ones, the resulting mixture was added with water, and extracted with ethyl acetate for three times. The combined organic layers were dried over Na_2SO_4, filtered and evaporated under reduced pressure. The residue was purified by chromatography on silica gel (elute: PE/EA = 5:1) to give the desired product **5a**.

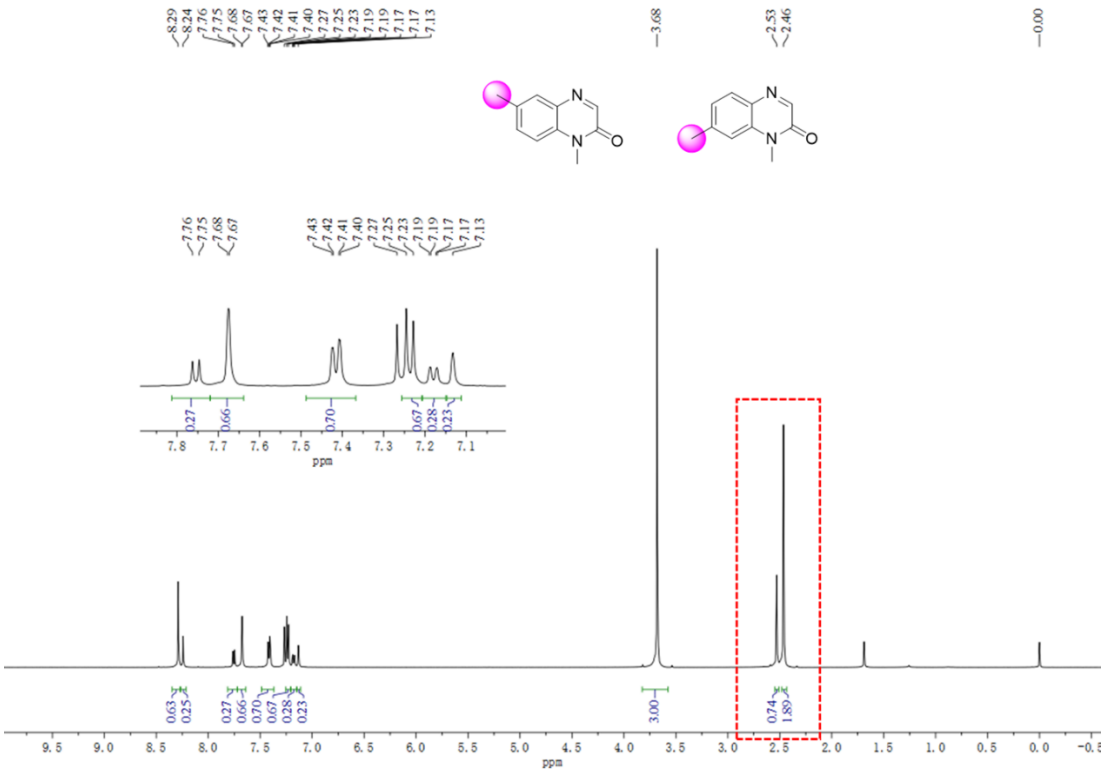
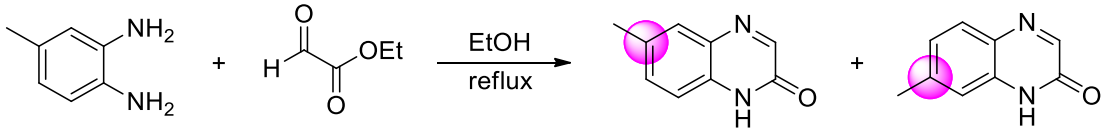


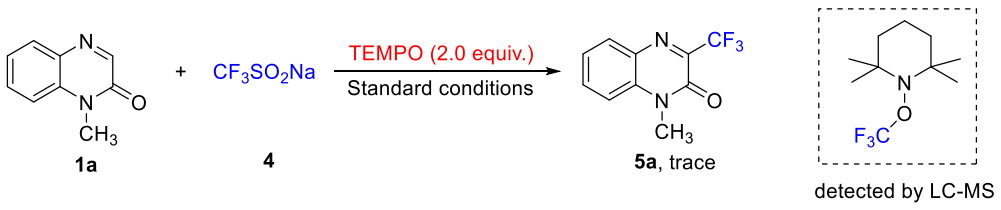
Figure S2 the ^{1}H NMR spectrum of **1m**.



Two region isomers were obtained in the reaction between 4-methyl-*o*-phenylene diamine and ethyl glycolate, and the two isomers cannot be separated by column chromatography.

3. Control experiments

Two equivalents of TEMPO (2,2,6,6-tetramethylpiperidinoxy) or BHT (Butylated Hydroxytoluene) were added to the reaction of **1a** with **4** under the standard conditions. The reaction mixture was then stirred under the irradiation with 6 W blue LEDs for 24 h. The desired product **5a** was not detected in the reaction system. Note that, the radical trapping product can be found through LC-MS analysis. The results were shown in Figures S3 and S4.



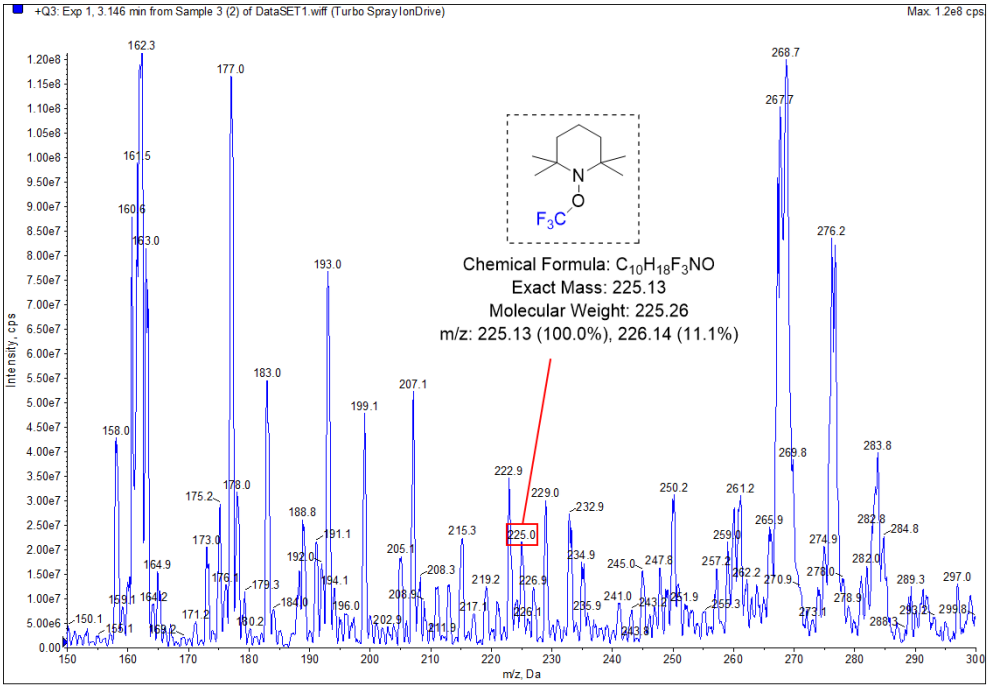
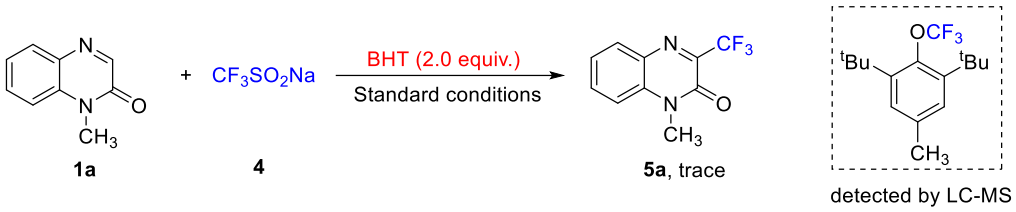


Figure S3. LC-MS analysis of the adduct of TEMPO and trifluoromethyl radical.



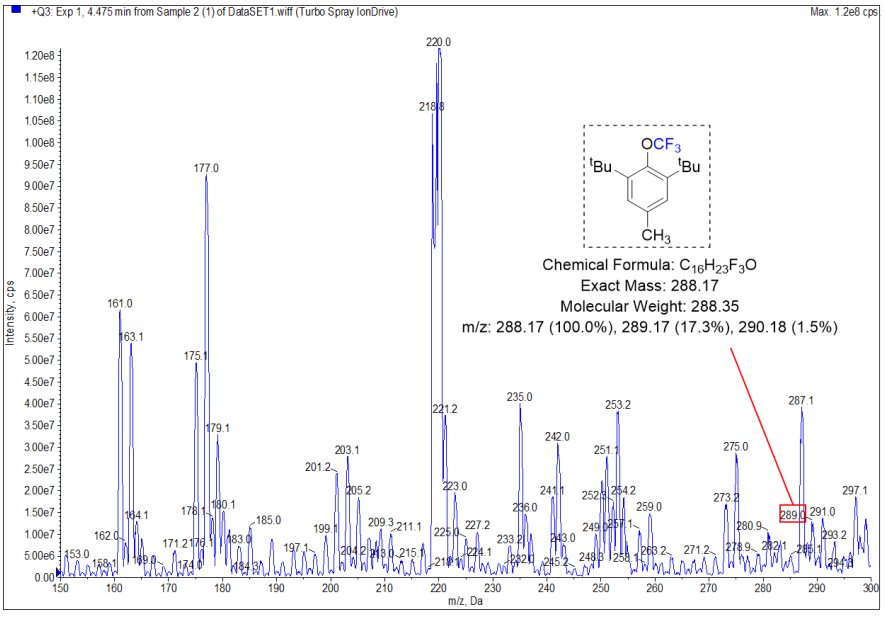


Figure S4. LC-MS analysis of the adduct of BHT and trifluoromethyl radical.

4. Light on/off experiments

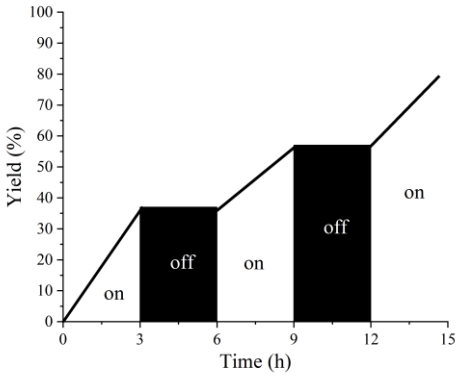


Figure S5. Light on/off experiments.

5. Control experiments and mechanism study of acylation reaction of quinoline-2(1*H*)-one

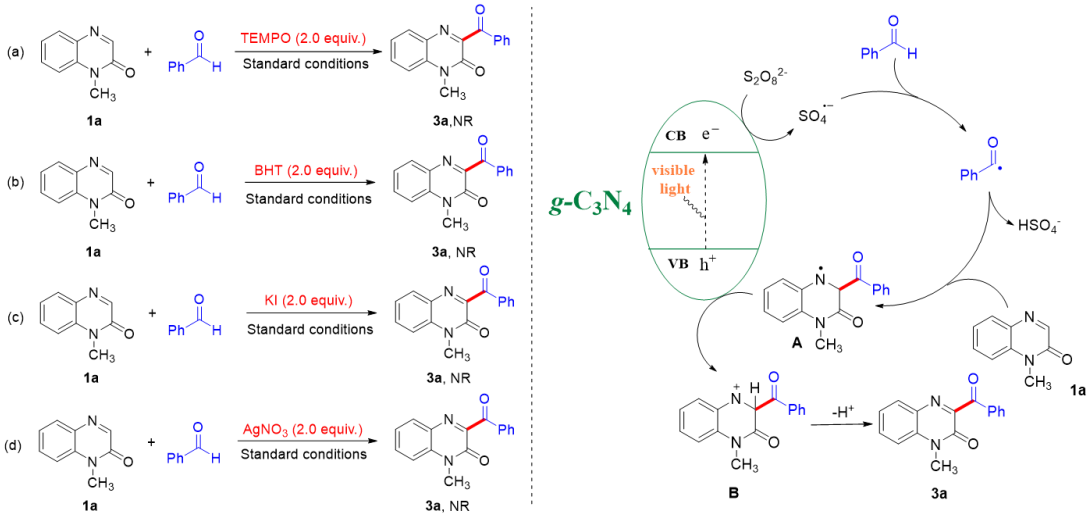


Figure S6. Control experiments and mechanism study of acylation reaction.

The acylation reaction was significantly suppressed by adding 2.0 equivalents of either TEMPO or BHT as radical scavengers under standard conditions, suggesting that the reaction likely proceeds through a radical-mediated pathway. Additionally, when potassium iodide (KI) and silver nitrate ($AgNO_3$) were introduced into the reaction system as hole and electron scavengers, respectively, the photocatalytic activity was completely suppressed. This observation indicates that both photo-generated holes and electrons play a critical role in facilitating the C-H acylation process. Based on the control experiments, a plausible photocatalytic reaction mechanism for the C-H acylation is proposed. Under visible light irradiation, g-C_3N_4 absorbs photons, generating electron-hole pairs. The persulfate anion ($S_2O_8^{2-}$) is reduced by the electrons (e^-) in the CB to produce the sulfate radicals ($SO_4^{\bullet-}$). These radicals abstract a hydrogen

atom from benzaldehyde, forming an acyl radical. The acyl radical adds to the C-3 position of **1a**, forming a nitrogen-centered radical intermediate **A**. Subsequently, intermediate **A** quenches the photogenerated holes (h^+) via a single electron transfer (SET) process, generating a nitrogen cation intermediate **B**. Finally, intermediate **B** undergoes deprotonation to afford the final product 3a.

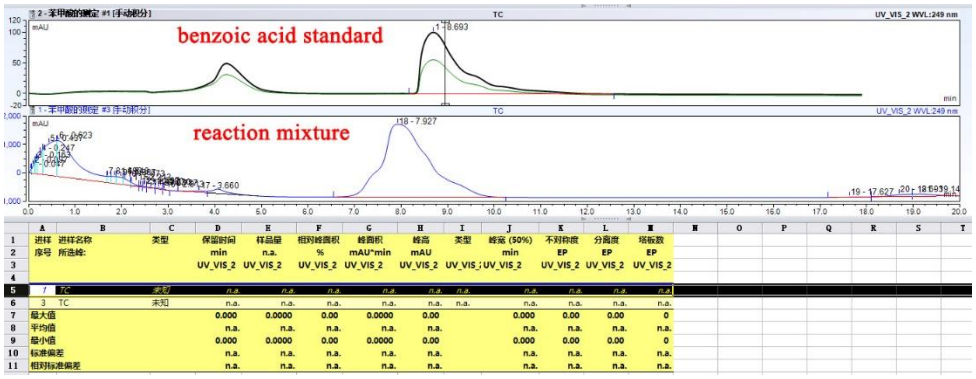
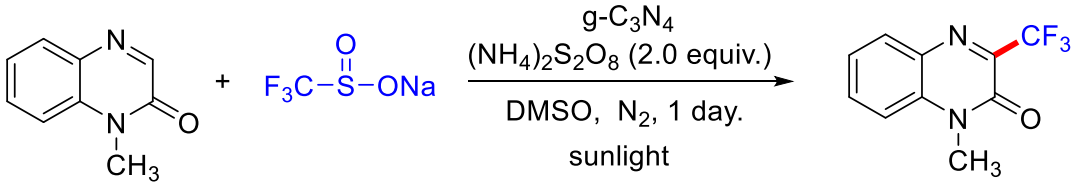


Figure S7 The analysis of benzoic acid by HPLC (mobile phase: MeOH/H_2O = 0.5/0.5, 1mL/min, λ = 230 nm).

6. Natural sunlight irradiation experiments

To a 10 mL reaction tube was added quinoxalin-2(1*H*)-ones (0.3 mmol), CF_3SO_2Na (0.36 mmol), g-C_3N_4 (10 mg), $(NH_4)_2S_2O_8$ (0.6 mmol), DMSO (1.0 mL) and degassed with N_2. The reaction mixture was exposed to natural sunlight for 1 day at ambient temperature (about 26 ° C). After the completion of the reaction as indicated by TLC, the solution was concentrated in vacuo. Then the residue was purified by silica gel flash column chromatography (PE/EA = 5/1) to afford product **5a** (65%).



1a **4** **5a**

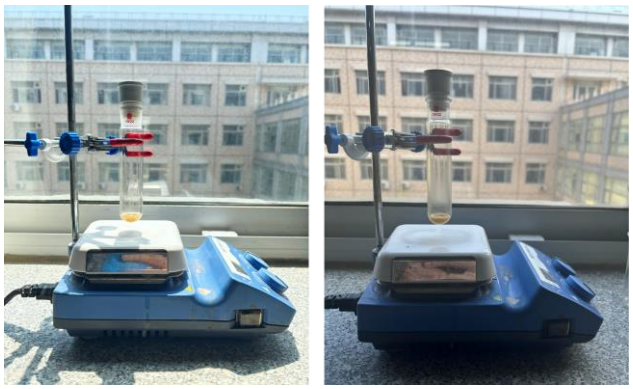


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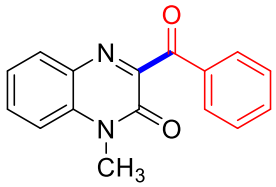
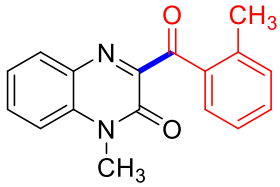
Figure S8. Natural sunlight irradiation experiments.

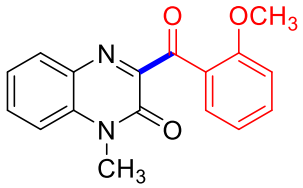
7. Characterization of the products



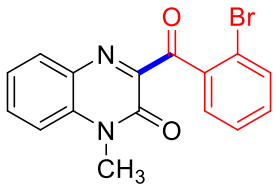
3-benzoyl-1-methylquinoxalin-2(1*H*)-one (**3a**): yellow solid, 45 mg, 85% yield, m.p. = 157-159 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.98 (d, J = 5.0 Hz, 2H), 7.92 (d, J = 10.0 Hz, 1H), 7.69-7.65 (m, 1H), 7.63-7.60 (m, 1H), 7.49-7.46 (m, 2H), 7.42-7.39 (m, 2H), 3.74 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 191.77, 154.71, 153.37, 134.86, 134.26, 133.92, 133.71, 132.25, 132.08, 131.06, 130.19, 130.05, 128.71, 124.25, 114.00, 29.10; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{16}H_{13}N_2O_2$ 265.0899, found 265.0896.



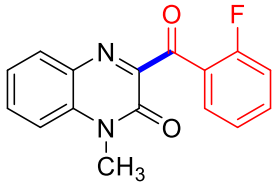
1-methyl-3-(2-methylbenzoyl)quinoxalin-2(1*H*)-one (**3b**): yellow solid, 48 mg, 86% yield, m.p. = 164-165 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.93-7.91 (m, 1H), 7.68-7.65 (m, 1H), 7.61-7.60 (m, 1H), 7.45-7.39 (m, 3H), 7.33 (d, J = 10.0 Hz, 1H), 7.24-7.21 (m, 1H), 3.74 (s, 3H), 2.69 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 194.02, 155.72, 153.35, 140.79, 134.24, 133.87, 132.93, 132.27, 132.01, 131.89, 131.02, 125.63, 124.18, 113.93, 29.10, 21.76; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{17}H_{15}N_2O_2$ 279.1055, found 279.1057.



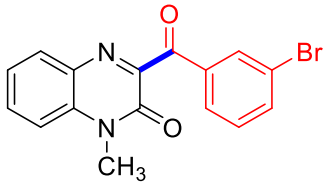
3-(2-methoxybenzoyl)-1-methylquinoxalin-2(1*H*)-one (**3c**): yellow solid, 52 mg, 88% yield, m.p. = 160-161 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.07 (d, J = 10.0 Hz, 1H), 7.89 (d, J = 5.0 Hz, 1H), 7.63-7.60 (m, 1H), 7.56-7.53 (m, 1H), 7.39-7.37 (m, 2H), 7.10-7.09 (m, 1H), 6.91 (d, J = 10.0 Hz, 1H), 3.73 (s, 3H), 3.56 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 191.19, 160.09, 157.39, 153.43, 135.66, 133.60, 132.51, 131.13, 130.96, 130.73, 123.92, 121.30, 113.77, 112.15, 109.49, 107.59, 56.09, 28.73; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{17}H_{15}N_2O_3$ 295.1004, found 295.1001.



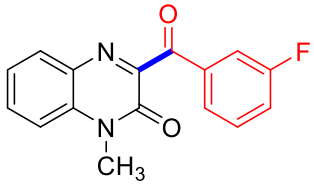
3-(2-bromobenzoyl)-1-methylquinoxalin-2(1*H*)-one (**3d**): yellow solid, 43 mg, 63% yield, m.p. = 119-120 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.89 (d, J = 10.0 Hz, 1H), 7.83 (d, J = 10.0 Hz, 1H), 7.69-7.65 (m, 1H), 7.59 (d, J = 5.0 Hz, 1H), 7.48-7.45 (m, 1H), 7.42-7.37 (m, 3H), 3.73 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 192.22, 153.30, 153.16, 138.37, 134.21, 133.55, 133.34, 132.53, 132.34, 131.78, 131.40, 127.66, 114.00, 29.04; HRMS (ESI-TOF) *m/z* $[M + H]^+$ calcd for $C_{16}H_{12}BrN_2O_2$ 343.0007, found 343.0006.



3-(2-fluorobenzoyl)-1-methylquinoxalin-2(1*H*)-one (**3e**): yellow solid, 37 mg, 66% yield, m.p. = 113-114 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.09-8.06 (m, 1H),7.90 (d, J = 5.0 Hz, 1H), 7.66-7.57 (m, 2H), 7.39-7.36 (m, 2H), 7.32-7.28 (m, 1H),7.09-7.05 (m, 1H), 3.72 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 189.03, 163.64, 161.60, 155.34, 153.32, 153.29, 136.05, 135.98, 133.92, 132.42, 132.05, 130.99, 130.97, 124.79, 124.76, 124.25, 124.19, 116.55, 116.37, 114.07, 28.94; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{16}H_{12}FN_2O_2$ 283.0805, found 283.0806.

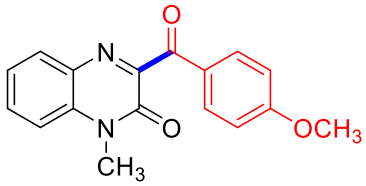


3-(3-bromobenzoyl)-1-methylquinoxalin-2(1*H*)-one (**3f**): yellow solid, 50 mg, 74% yield, m.p. = 138-139 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.10 (s, 1H), 7.91 (t, J = 20.0 Hz, 2H), 7.73-7.67 (m, 2H), 7.43-7.40 (m, 2H), 7.37-7.33 (m, 1H), 3.75 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 190.37, 153.65, 153.29, 137.01, 136.69, 136.49, 133.95, 133.08, 132.70, 132.49, 132.14, 131.10, 130.30, 130.06, 128.69, 128.62, 124.41, 122.96, 114.14, 29.18; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{16}H_{12}BrN_2O_2$ 343.0004, found 343.0006.

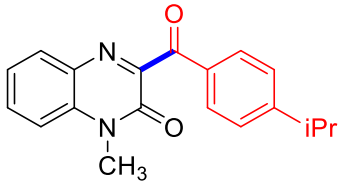


3-(3-fluorobenzoyl)-1-methylquinoxalin-2(1*H*)-one (**3g**): yellow solid, 43 mg, 78% yield, m.p. = 134-135 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.93 (d, J = 5.0 Hz, 1H), 7.75 (d, J = 5.0 Hz, 1H), 7.71-7.68 (m, 2H), 7.46-7.42 (m, 3H), 7.32-7.29 (m, 1H), 3.76 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 190.47, 190.45, 163.73, 161.76, 153.82, 153.30, 133.94, 132.43, 132.14, 131.09, 130.47, 130.40, 125.99, 125.96, 124.39, 121.37, 121.20, 116.51, 116.33, 114.12, 29.15; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for

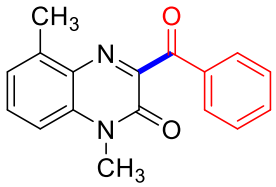
$C_{16}H_{12}FN_2O_2$ 283.0805, found 283.0806.



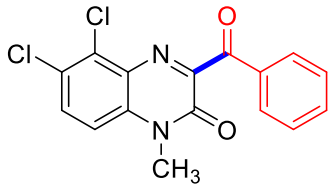
3-(4-methoxybenzoyl)-1-methylquinoxalin-2(1*H*)-one (**3h**): yellow solid, 39 mg, 67% yield, m.p. = 204-205 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.89-7.92 (m, 3H), 7.65 (t, J = 10.0 Hz, 1H), 7.42-7.39 (m, 2H), 6.95 (d, J = 10.0 Hz, 2H), 3.88 (s, 3H), 3.75 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 189.21, 163.48, 157.39, 153.97, 152.33, 132.82, 131.46, 131.17, 130.83, 129.90, 126.89, 123.10, 112.98, 112.89, 54.54, 28.02; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{17}H_{15}N_2O_3$ 295.1004, found 295.1007.



3-(4-isopropylbenzoyl)-1-methylquinoxalin-2(1*H*)-one (**3i**): yellow solid, 51 mg, 69% yield, m.p. = 200-202 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.94-7.91 (m, 3H), 7.69-7.66 (m, 1H), 7.43-7.40 (m, 2H), 7.33 (d, J = 5.0 Hz, 2H), 3.76 (s, 3H), 3.00-2.95 (m, 1H), 1.26 (d, J = 5.0 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 191.43, 156.05, 155.04, 153.38, 133.90, 132.69, 132.27, 131.95, 131.01, 130.34, 126.91, 124.19, 113.97, 34.48, 29.07, 23.62; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{19}H_{19}N_2O_2$ 307.1368, found 307.1366.

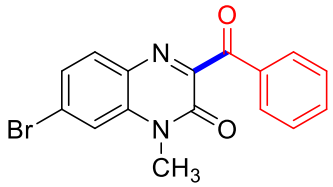


3-benzoyl-1,5-dimethylquinoxalin-2(1*H*)-one (**3j**): yellow solid, 43 mg, 77% yield, m.p. = 157-158 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.05 (d, J = 10.0 Hz, 2H), 7.56-7.53 (m, 2H), 7.42-7.39 (m, 3H), 7.20-7.16 (m, 1H), 3,67 (s, 3H), 2.56 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 194.02, 155.72, 153.35, 140.79, 134.24, 133.87, 132.93, 132.27, 132.01, 131.89, 131.02, 125.63, 124.18, 113.93, 29.10, 21.76; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{17}H_{15}N_2O_2$ 279.1055, found 279.1056.

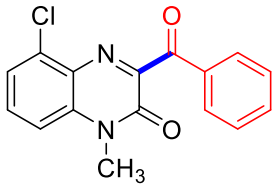


3-benzoyl-5,6-dichloro-1-methylquinoxalin-2(1*H*)-one (**3k**): yellow solid, 50 mg, 48% yield, m.p. = 244-246 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.07-7.96 (m, 2H), 7.66-7.63 (m, 1H), 7.55-7.48 (m, 3H), 7.15-7.12 (m, 1H), 3.73 (s, 3H); ^{13}C NMR (100 MHz,

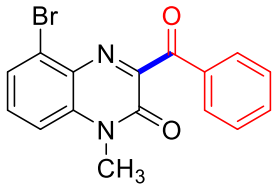
$CDCl_3$): δ 190.00, 155.82, 152.77, 147.71, 147.46, 145.75, 145.28, 134.59, 134.41, 131.26, 130.02, 128.81, 123.25, 120.14, 120.66, 108.83, 108.78, 108.73, 29.51; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{16}H_{11}Cl_2N_2O_2$ 332.0119, found 332.0117.



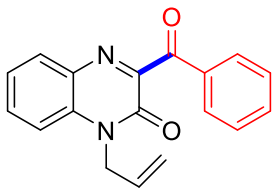
3-benzoyl-7-bromo-1-methylquinoxalin-2(1*H*)-one (**3l**): yellow solid, 49 mg, 71% yield, m.p. = 199-200 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.07 (d, J = 5.0 Hz, 1H), 7.97 (d, J = 10.0 Hz, 2H), 7.76 (d, J = 10.0 Hz, 1H), 7.66-7.63 (m, 1H), 7.51-7.48 (m, 2H), 7.30-7.28 (m, 1H), 3.73 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 191.21, 155.75, 152.96, 134.76, 134.55, 134.43, 133.27, 133.01, 132.92, 130.00, 128.75, 116.81, 115.43, 29.24; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{16}H_{12}BrN_2O_2$ 343.0077, found 343.0079.



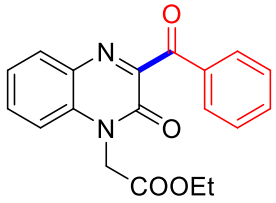
3-benzoyl-5-chloro-1-methylquinoxalin-2(1*H*)-one (**3m**): yellow solid, 44 mg, 74% yield, m.p. = 199-200 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.11-8.02 (m, 2H), 7.65-7.57 (m, 2H), 7.51-7.48 (m, 3H), 7.33-7.31 (m, 1H), 3.75 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 191.06, 154.50, 152.98, 136.08, 135.46, 134.73, 134.33, 133.73, 132.01, 130.18, 129.05, 128.70, 128.50, 125.16, 112.83, 29.55; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{16}H_{12}ClN_2O_2$ 299.0509, found 299.0509.



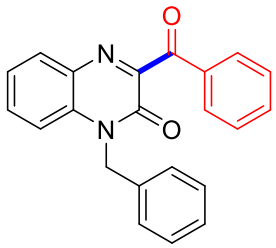
3-benzoyl-5-bromo-1-methylquinoxalin-2(1*H*)-one (**3n**): yellow solid, 50 mg, 73% yield, m.p. = 241-242 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.11 (d, J = 10.0 Hz, 1H), 8.04 (d, J = 10.0 Hz, 1H), 7.70-7.68 (m, 1H), 7.63-7.62 (m, 1H), 7.51-7.48 (m, 3H), 7.37-7.35 (m, 1H), 3.74 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 190.89, 171.53, 154.50, 152.99, 135.32, 134.74, 134.31, 133.76, 132.33, 130.22, 129.97, 128.69, 128.48, 126.69, 113.62, 29.54; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{16}H_{12}BrN_2O_2$ 343.0047, found 343.0049.



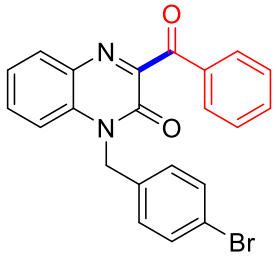
1-allyl-3-benzoylquinoxalin-2(1*H*)-one (**3o**): yellow solid, 45 mg, 77% yield, m.p. = 168-169 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.10 (d, J = 5.0 Hz, 1H), 7.99 (d, J = 5.0 Hz, 2H), 7.95-7.93 (m, 1H), 7.64-7.59 (m, 2H), 7.50-7.47 (m, 2H), 7.41-7.39 (m, 2H), 5.99-5.92 (m, 1H), 5.33-5.24 (m, 2H), 4.95 (d, J = 5.0 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 191.73, 154.72, 152.95, 134.90, 134.26, 133.68, 133.19, 132.41, 131.98, 131.18, 131.13, 130.33, 130.18, 130.02, 128.72, 128.48, 124.22, 118.82, 114.59, 44.53; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{18}H_{15}N_2O_2$ 291.1055, found 291.1057.



ethyl 2-(3-benzoyl-2-oxoquinoxalin-1(2*H*)-yl)acetate (**3p**): yellow solid, 53 mg, 79% yield, m.p. = 188-189 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.10-8.08 (m, 1H), 7.99-7.93 (m, 2H), 7.65-7.59 (m, 2H), 7.49-7.46 (m, 2H), 7.42-7.39 (m, 1H), 7.18 (d, J = 5.0 Hz, 1H), 5.06 (s, 2H), 4.25 (q, J = 5.0 Hz, 2H), 1.27 (t, J = 5.0 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 191.62, 166.98, 154.64, 153.19, 135.05, 134.57, 133.92, 133.61, 133.34, 133.27, 132.55, 131.57, 130.40, 130.29, 129.68, 129.02, 128.98, 128.72, 128.33, 124.78, 113.82, 62.53, 43.60, 14.34; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{19}H_{17}N_2O_4$ 337.1110, found 337.1113.

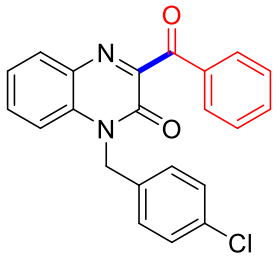


3-benzoyl-1-benzylquinoxalin-2(1H)-one (**3q**): yellow solid, 56 mg, 82% yield, m.p. = 128-129 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.11 (d, J = 10.0 Hz, 2H), 8.02 (d, J = 10.0 Hz, 2H), 7.92 (d, J = 10.0 Hz, 1H),7.64-7.58 (m, 2H), 7.53-7.45 (m, 4H), 7.37-7.32 (m, 3H), 5.52 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 191.77, 172.04, 154.78, 153.55, 134.92, 134.88, 134.33, 133.80, 133.27, 132.53, 132.09, 131.15, 130.22, 130.07, 129.42, 129.07, 128.77, 128.51, 127.98, 127.17, 124.32, 114.87, 45.94.; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{22}H_{17}N_2O_2$ 341.1212, found 341.1213.

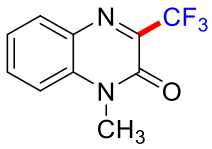


3-benzoyl-1-(4-bromobenzyl)quinoxalin-2(1*H*)-one (**3r**): yellow solid, 55 mg, 66% yield, m.p. = 196-199 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.09 (d, J = 5.0 Hz, 2H), 8.02-

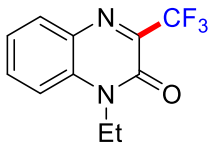
8.00 (m, 1H), 7.95-7.87 (m, 1H), 7.65-7.62 (m, 1H), 7.58-7.50 (m, 4H), 7.48-7.44 (m, 1H), 7.39-7.30 (m, 1H), 7.19 (d, J = 5.0 Hz, 2H), 5.47 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 191.54, 170.97, 154.67, 153.39, 134.81, 134.37, 133.90, 133.68, 133.04, 132.48, 132.20, 132.14, 132.13, 131.45, 131.38, 131.31, 131.31, 130.17, 130.05, 128.96, 128.77, 128.48, 124.45, 121.98, 114.59, 114.54, 45.37; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{22}H_{16}BrN_2O_2$ 419.0371, found 419.0370.



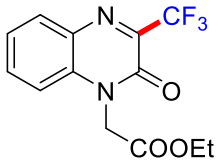
3-benzoyl-1-(4-chlorobenzyl)quinoxalin-2(1*H*)-one (**3s**): yellow solid, 44 mg, 59% yield, m.p. = 208-209 ºC; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.02-7.93 (m, 3H), 7.65-7.62 (m, 1H), 7.58-7.55 (m, 1H), 7.52-7.48 (m, 2H), 7.39-7.36 (m, 1H), 7.33-7.31 (m, 3H), 7.30-7.24 (m, 2H), 5.49 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 177.43, 140.58, 139.28, 120.70, 120.23, 119.80, 119.54, 119.25, 118.94, 118.37, 118.00, 117.27, 117.25, 116.05, 115.92, 115.15, 115.13, 115.02, 114.64, 114.53, 114.35, 110.31, 100.54, 100.41, 31.19; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{22}H_{16}ClN_2O_2$ 375.0822, found 375.0824.



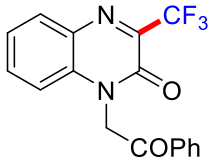
1-methyl-3-(trifluoromethyl)quinoxalin-2(1*H*)-one (**5a**): white solid, 57 mg, 82% yield, m.p. = 134-135 ºC; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.01 (, J = 5.0 Hz, 1H), 7.76-7.72 (m, 1H), 7.47-7.40 (m, 2H), 3.77 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 150.59, 143.01, 142.74, 133.56, 132.51, 130.76, 129.88, 123.49, 112.99, 28.15; ^{19}F NMR (376 MHz, $CDCl_3$): δ -70.13; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{10}H_8F_3N_2O$ 229.0510, found 229.0511.



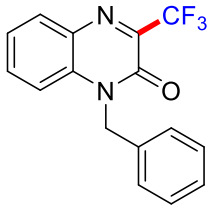
1-ethyl-3-(trifluoromethyl)quinoxalin-2(1*H*)-one (**5b**): pale yellow solid, 57 mg, 78% yield, m.p. = 100-101 ºC; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.01 (d, J = 5.0 Hz, 1H), 7.75-7.72 (m, 1H), 7.46-7.42 (m, 2H), 4.38 (q, J = 5.0 Hz, 2H), 1.43 (t, J = 10.0 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 151.17, 144.42, 144.05, 143.79, 143.52, 133.66, 133.48, 132.03, 131.23, 124.30, 123.26, 121.06, 118.86, 116.66, 113.85, 37.66, 12.35; HRMS (ESI-TOF) m/z $[M+H]^+$ calcd for $C_{11}H_{10}F_3N_2O$ 243.0667, found 243.0667.



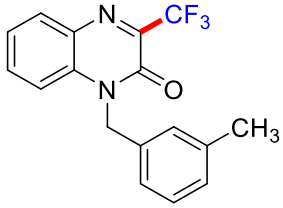
ethyl 2-(2-oxo-3-(trifluoromethyl)quinoxalin-1(2*H*)-yl)acetate (**5c**): pale yellow solid, 67 mg, 74% yield, m.p. = 152-154 ºC; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.02 (d, J = 10.0 Hz, 1H), 7.72-7.68 (m, 1H), 7.45 (t, J = 15.0 Hz, 1H), 7.16 (d, J = 10.0 Hz, 1H), 5.06 (s, 2H), 4.27 (q, J = 5.0 Hz, 2H), 1.29 (t, J = 5.0 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 166.37, 151.18, 144.26, 143.99, 143.44, 133.83, 133.69, 132.09, 131.02, 123.05, 120.86, 118.66, 116.46, 113.56, 62.42, 43.42, 14.08; HRMS (ESI-TOF) m/z $[M+H]^+$ calcd for $C_{13}H_{12}F_3N_2O_3$ 301.0726, found 301.0727.



1-(2-oxo-2-phenylethyl)-3-(trifluoromethyl)quinoxalin-2(1*H*)-one (**5d**): white solid, 68 mg, 68% yield, m.p. = 149-150 ºC; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.07 (d, J = 10.0 Hz, 2H), 8.03 (d, J = 10.0 Hz, 1H), 7.71-7.68 (m, 1H), 7.63-7.55 (m, 3H), 7.44-7.41 (m, 1H), 7.04 (d, J = 10.0 Hz, 1H), 5.78 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 190.28, 151.40, 144.12, 143.85, 143.31, 134.62, 134.28, 134.16, 133.56, 132.01, 129.18, 128.21, 124.64, 123.15, 120.95, 118.75, 116.55, 114.00, 48.33; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{17}H_{12}F_3N_2O_2$ 333.0773, found 333.0775.

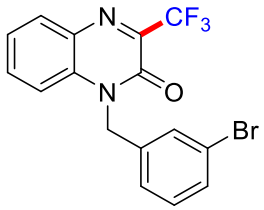


1-benzyl-3-(trifluoromethyl)quinoxalin-2(1*H*)-one (**5e**): yellow solid, 57 mg, 62% yield, m.p. = 100-101 ºC; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.92 (d, J = 10.0 Hz, 1H), 7.54-7.51 (m, 1H), 7.33-7.29 (m, 1H), 7.28-7.24 (m, 3H),7.22-7.18 (m, 3H), 5.45 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 150.71, 143.4, 142.87, 142.60, 133.39, 132.95, 132.45, 130.83, 130.14, 128.05, 127.03, 126.00, 123.50, 113.77, 44.99; ^{19}F NMR (376 MHz, $CDCl_3$): δ -70.21; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{16}H_{12}F_3N_2O$ 305.0823, found 305.0826.

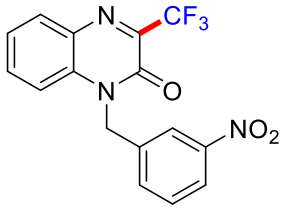


1-(3-methylbenzyl)-3-(trifluoromethyl)quinoxalin-2(1H)-one (**5f**): pale yellow solid, 68 mg, 71% yield, m.p. = 154-155 ºC; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.99 (d, J = 5.0 Hz,1H), 7.62-7.59 (m, 1H), 7.41-7.36 (m, 2H), 7.26-7.20 (m, 1H),7.10-7.04 (m, 3H),

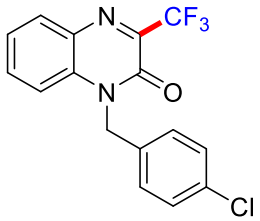
5.49 (s, 2H), 2.31 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 151.79, 144.50, 144.23, 143.96, 138.97, 134.41, 134.10, 133.48, 131.86, 131.22, 128.96, 128.87, 127.64, 124.51, 124.07, 123.25, 121.06, 118.86, 114.90; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{17}H_{14}F_3N_2O$ 319.0980, found 319.0981.



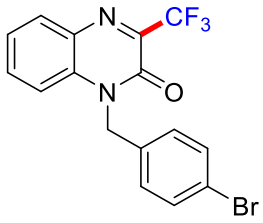
1-(3-bromobenzyl)-3-(trifluoromethyl)quinoxalin-2(1*H*)-one (**5g**): pale yellow solid, 84 mg, 73% yield, m.p. = 92-93 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.02 (d, J = 10.0 Hz, 1H), 7.65-7.62 (m, 1H), 7.44-7.41 (m, 3H), 7.31-7.29 (m, 1H),7.22-7.17 (m, 2H), 5.49 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 151.67, 144.46, 144.18, 143.91, 143.64, 136.71, 133.80, 133.70, 132.07, 131.38, 131.21, 130.71, 130.04, 125.66, 124.79, 123.18, 114.54, 45.50; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{16}H_{11}BrF_3N_2O$ 382.9929, found 382.9930.



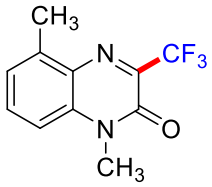
1-(3-nitrobenzyl)-3-(trifluoromethyl)quinoxalin-2(1*H*)-one (**5h**): pale yellow solid, 61 mg, 58% yield, m.p. = 132-133 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.18 (d, J = 10.0 Hz, 2H), 8.06 (d, J = 10.0 Hz, 1H), 7.68-7.65 (m, 1H), 7.61-7.60 (m, 1H), 7.56-7.53 (m, 1H),7.48-7.45 (m, 1H),7.31-7.29 (m, 1H), 5.62 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 151.62, 148.64, 136.57, 133.86, 133.61, 132.35, 131.25, 130.38, 125.03, 123.33, 122.18, 114.12, 45.43; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{16}H_{11}F_3N_3O_3$ 350.0674, found 350.0673.



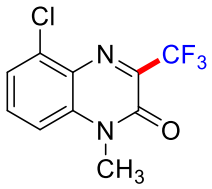
1-(4-chlorobenzyl)-3-(trifluoromethyl)quinoxalin-2(1*H*)-one (**5i**): pale yellow solid, 65 mg, 64% yield, m.p. = 135-137 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.01 (d, J = 10.0 Hz, 1H), 7.64-7.61 (m, 1H), 7.44-7.41 (m, 1H), 7.32-7.30 (m, 3H), 7.23-7.22 (m, 2H), 5.49 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 151.68, 144.50, 144.23, 143.69, 134.08, 133.82, 133.58, 132.97, 132.06, 131.22, 129.32, 128.56, 124.71, 123.17, 120.97, 118.7, 116.57, 45.46; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{16}H_{11}ClF_3N_2O$ 339.0434, found 339.0434.



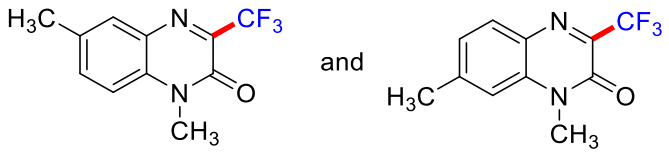
1-(4-bromobenzyl)-3-(trifluoromethyl)quinoxalin-2(1*H*)-one (**5j**): pale yellow solid, 80 mg, 70% yield, m.p. = 138-140 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.01 (d, J = 10.0 Hz, 1H), 7.64-7.61 (m, 1H), 7.47-7.41 (m, 3H), 7.32-7.30 (m, 1H), 7.16 (d, J = 10.0 Hz, 2H), 5.47 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 151.68, 144.4, 144.20,143.93, 143.65, 133.80, 133.62, 133.49, 132.28, 132.06, 131.21, 128.86, 124.75, 122.13, 120.97, 118.77, 114.54, 45.52; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{16}H_{11}BrF_3N_2O$ 382.9929, found 382.9930.



1,5-dimethyl-3-(trifluoromethyl)quinoxalin-2(1*H*)-one (**5k**): pale yellow solid, 59 mg, 81% yield, m.p. = 167-168 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.62-7.59 (m, 1H), 7.30-7.27 (m, 1H), 7.23-7.21 (m, 1H), 3.74 (s, 3H), 2.71 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 151.62, 142.33, 142.06, 141.79, 141.52, 141.22, 134.09, 133.34, 129.71, 125.69, 121.17, 118.97, 111.79, 29.30, 17.30; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{11}H_{10}F_3N_2O$ 243.0667, found 243.0667.

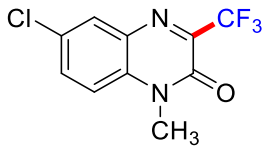


5-chloro-1-methyl-3-(trifluoromethyl)quinoxalin-2(1*H*)-one (**5l**): pale yellow solid, 62 mg, 79% yield, m.p. = 112-114 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.00 (s, 1H), 7.69 (d, J = 10.0 Hz, 1H), 7.36 (d, J = 10.0 Hz, 1H), 3.75 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 151.24, 145.56, 145.29, 145.02, 144.75, 133.59, 133.28, 131.30, 130.89, 130.02, 122.95, 120.75, 118.55, 116.35, 115.25, 29.41; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{10}H_7ClF_3N_2O$ 263.0121, found 263.0120.

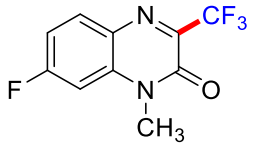


1,6-dimethyl-3-(trifluoromethyl)quinoxalin-2(1*H*)-one and 1,7-dimethyl-3-(trifluoromethyl)quinoxalin-2(1*H*)-one (**5m+5m'**): pale yellow solid, 57 mg, 78% yield; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.87-7.86 (d, J = 5.0 Hz, 0.54H), 7.80-7.79 (d, J = 5.0

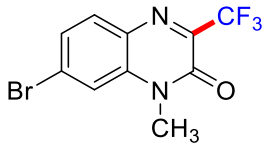
Hz, 0.45H), 7.56-7.54 (m, 0.47H), 7.30-7.29 (m, 1.32H), 7.18 (s, 0.53H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 151.83, 151.61, 145.06, 134.85, 134.59, 132.47, 131.46, 131.40, 130.90, 129.24, 125.98, 114.02, 113.73, 29.15, 29.07, 22.45, 20.57.



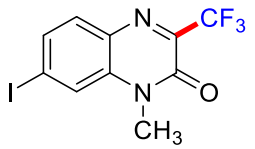
6-chloro-1-methyl-3-(trifluoromethyl)quinoxalin-2(1*H*)-one (**5n**): pale yellow solid, 60 mg, 76% yield, m.p. = 116-118 ºC; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.64 (t, J = 10.0 Hz, 1H), 7.53 (d, J = 10.0 Hz, 1H), 7.31 (d, J = 10.0 Hz, 1H), 3.76 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 151.26, 144.14, 137.02, 136.22, 133.48, 127.91, 125.43, 120.81, 118.61, 112.80, 29.65; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{10}H_7ClF_3N_2O$ 263.0121, found 263.0122.



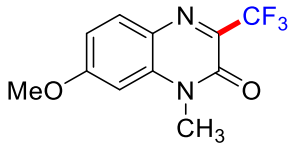
7-fluoro-1-methyl-3-(trifluoromethyl)quinoxalin-2(1*H*)-one (**5o**): pale yellow solid, 50 mg, 67% yield, m.p. = 168-170 ºC; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.70 (d, J = 10.0 Hz, 1H), 7.53-7.49 (m, 1H), 7.41-7.38 (m, 1H), 3.77 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 159.86, 157.90, 151.24, 145.73, 145.46, 144.92, 131.39, 121.75, 121.56, 120.80, 118.60, 117.00, 116.82, 115.38, 29.48; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{10}H_7F_4N_2O$ 247.0416, found 247.0417.



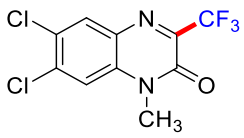
7-bromo-1-methyl-3-(trifluoromethyl)quinoxalin-2(1*H*)-one (**5p**): pale yellow solid, 61 mg, 66% yield, m.p. = 150-152 ºC; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.15 (d, J = 5.0 Hz, 1H), 7.81(d, J = 5.0 Hz, 1H), 7.30-7.27 (m, 1H), 3.74 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 151.21, 145.48, 145.20, 144.93, 144.66, 136.28, 133.98, 133.71, 131.58, 117.12, 115.47, 29.37; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{10}H_7BrF_3N_2O$ 306.9616, found 306.9614.



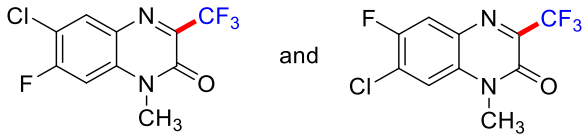
7-iodo-1-methyl-3-(trifluoromethyl)quinoxalin-2(1*H*)-one (**5q**): pale yellow solid, 70 mg, 66% yield, m.p. = 180-183 ºC; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.36 (s, 1H), 7.98-7.96(m, 1H), 7.15 (d, J = 10.0 Hz, 1H), 3.73 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 141.81, 140.17, 134.35, 131.82, 115.63, 86.94, 29.28; HRMS (ESI-TOF) *m/z* $[M + H]^+$ calcd for $C_{10}H_7FI_3N_2O$ 354.9477, found 354.9478.



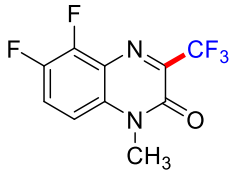
7-methoxy-1-methyl-3-(trifluoromethyl)quinoxalin-2(1*H*)-one (**5r**): white solid, 62 mg, 80% yield, m.p. = 85-87 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.90 (d, J = 10.0 Hz, 1H), 7.01-7.03 (m, 1H), 6.75-6.74 (m, 1H), 3.98 (s, 3H), 3.71 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 163.87, 152.05, 136.61,133.36, 125.93, 121.37, 119.18, 112.31, 97.72, 56.05, 29.17; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{11}H_{10}F_3N_2O_2$ 259.0616, found 259.0617.



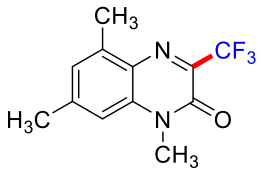
6,7-dichloro-1-methyl-3-(trifluoromethyl)quinoxalin-2(1*H*)-one (**5s**): pale yellow solid, 64 mg, 72% yield, m.p. = 138-140 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.29 (s, 1H), 8.05 (s, 1H), 3.64 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 151.41, 144.90, 144.64, 144.38, 144.12, 136.65, 135.25, 131.79, 130.13, 126.83, 121.36, 119.16, 117.68, 40.47, 40.31, 40.14, 39.97, 39.80, 39.64, 39.47, 30.11; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{10}H_6Cl_2F_3N_2O$ 296.9731, found 296.9733.



6-chloro-7-fluoro-1-methyl-3-(trifluoromethyl)quinoxalin-2(1*H*)-one and 7-chloro-6-fluoro-1-methyl-3-(trifluoromethyl)quinoxalin-2(1*H*)-one **(5t+5t')**: white solid, 64 mg, 72% yield. ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.08 (d, J = 10.0 Hz, 0.57H), 7.77 (d, J = 5.0 Hz, 0.91H), 7.47 (d, J = 10.0 Hz, 0.96H), 7.19 (d, J = 10.0 Hz, 0.62H), 3.74 (s, 3H), 3.71 (s, 1.78H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 161.57, 159.52, 155.41, 153.43, 151.07, 150.97, 145.39, 145.12, 134.91, 133.36, 133.34, 131.82, 129.81, 129.73, 128.03, 127.87, 127.72, 117.89, 117.72, 115.71, 102.21, 101.99, 29.65, 29.60.

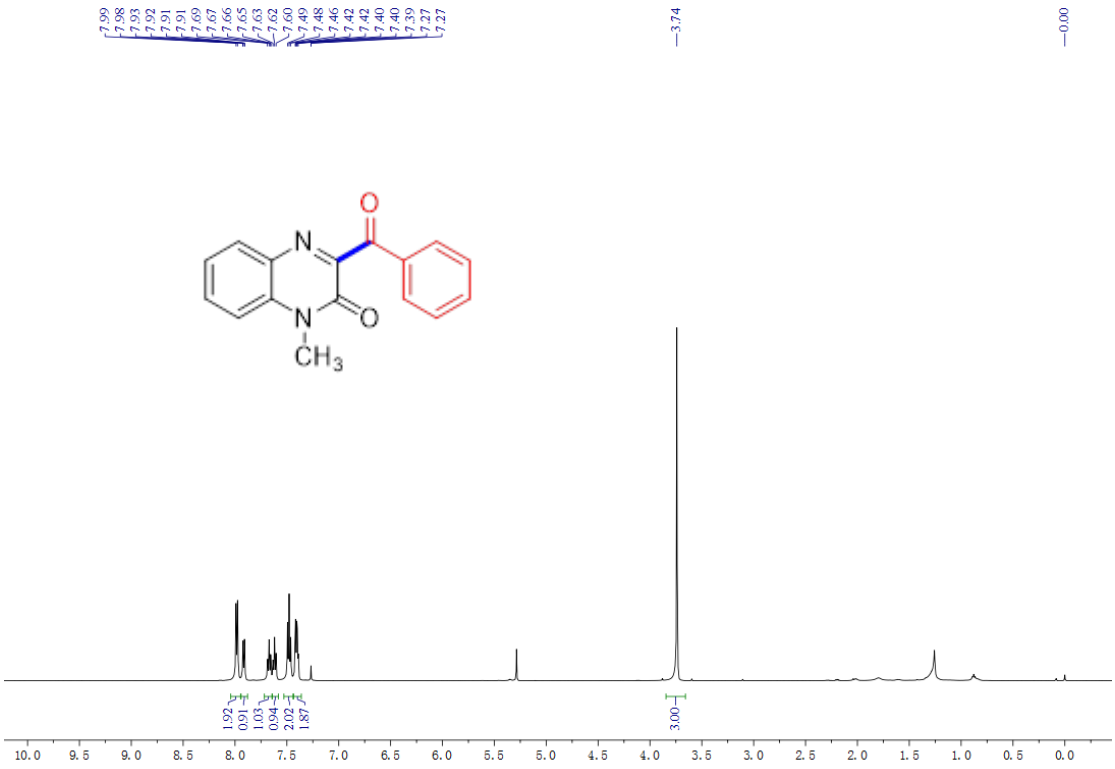


5,6-difluoro-1-methyl-3-(trifluoromethyl)quinoxalin-2(1*H*)-one (**5u**): pale yellow solid, 51 mg, 64% yield, m.p. = 145-147 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.64-7.59 (m, 1H), 7.17-7.14 (m, 1H), 3.76 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 150.94, 147.75, 147.68, 147.65, 145.64, 145.54, 145.42, 131.98, 122.52, 120.60, 118.40, 116.20, 108.83, 29.64; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{10}H_6F_5N_2O$ 265.0322, found 265.0322.

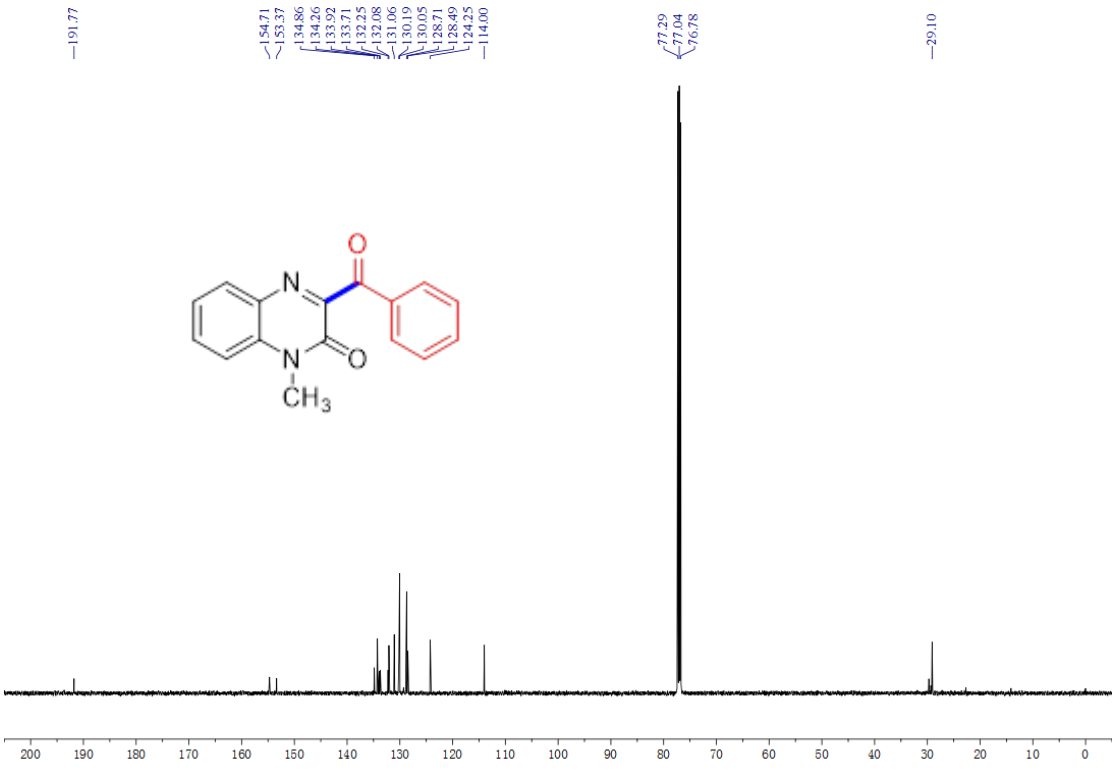


1,5,7-trimethyl-3-(trifluoromethyl)quinoxalin-2(1*H*)-one (**5v)**: pale yellow solid, 52 mg, 68% yield, m.p. = 145-147 ^{o}C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.10 (s, 1H), 6.98 (s, 1H), 3.71 (s, 3H), 2.64 (s, 3H), 2.51 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 151.78, 144.78, 140.65, 134.86, 128.01, 127.17, 121.34, 119.15, 115.03, 111.83, 29.16, 22.40, 17.14; HRMS (ESI-TOF) *m/z* $[M+H]^+$ calcd for $C_{12}H_{12}F_3N_2O$ 257.0823, found 257.0824.

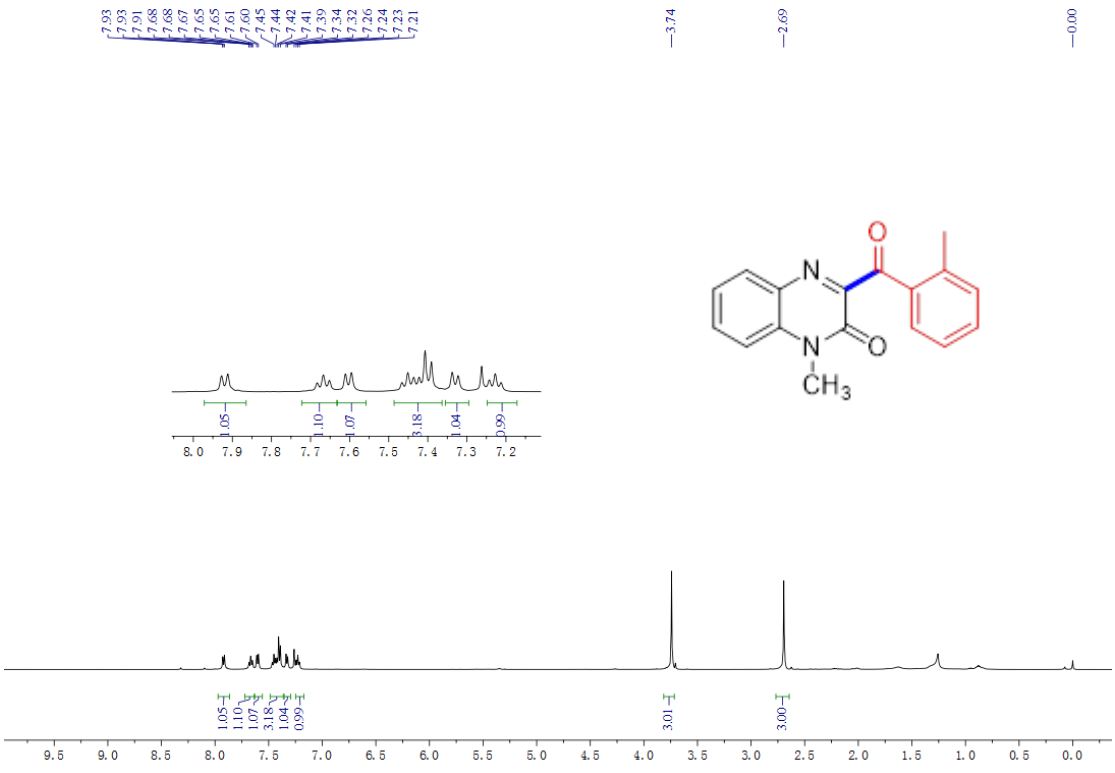
8. Copies of ^{1}H, ^{13}C and ^{19}F NMR spectra



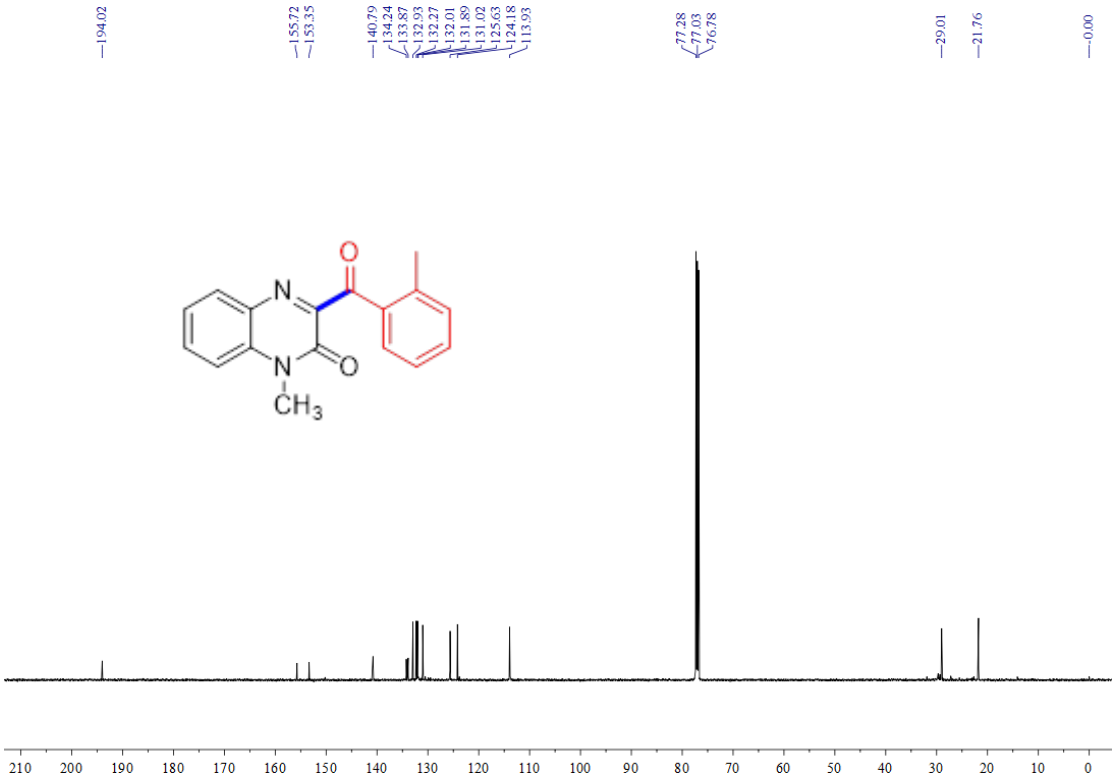
^{1}H NMR spectrum of compound 3a



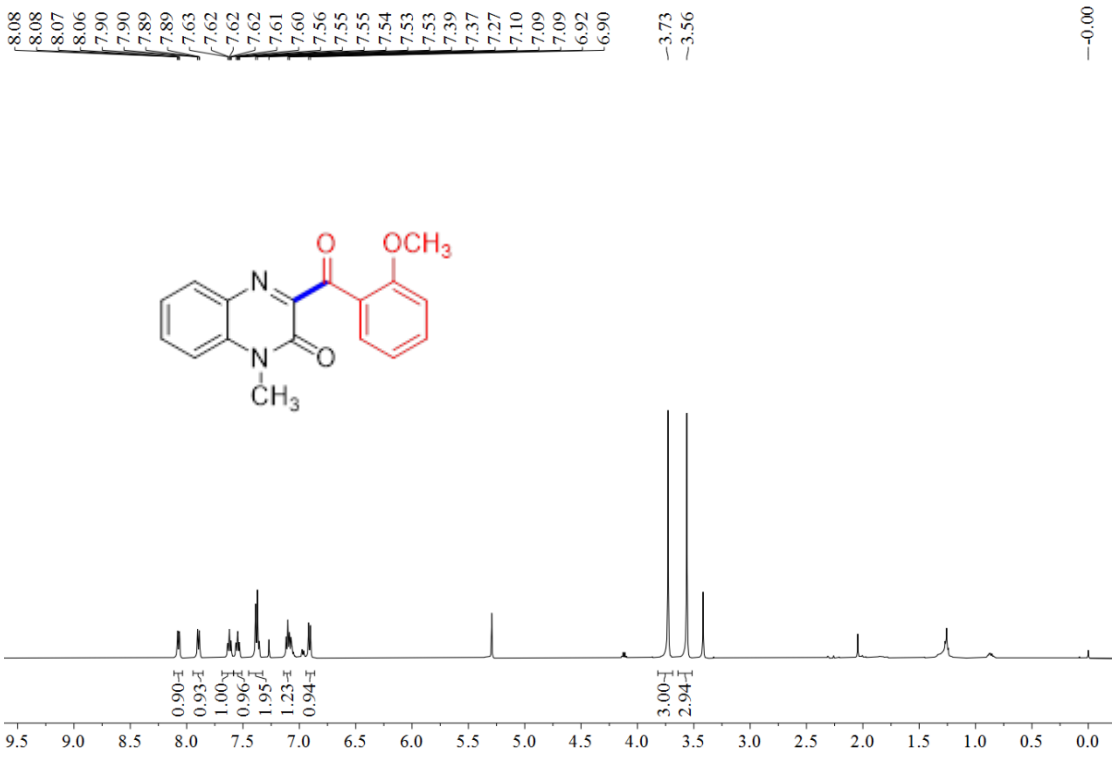
^{13}C NMR spectrum of compound 3a



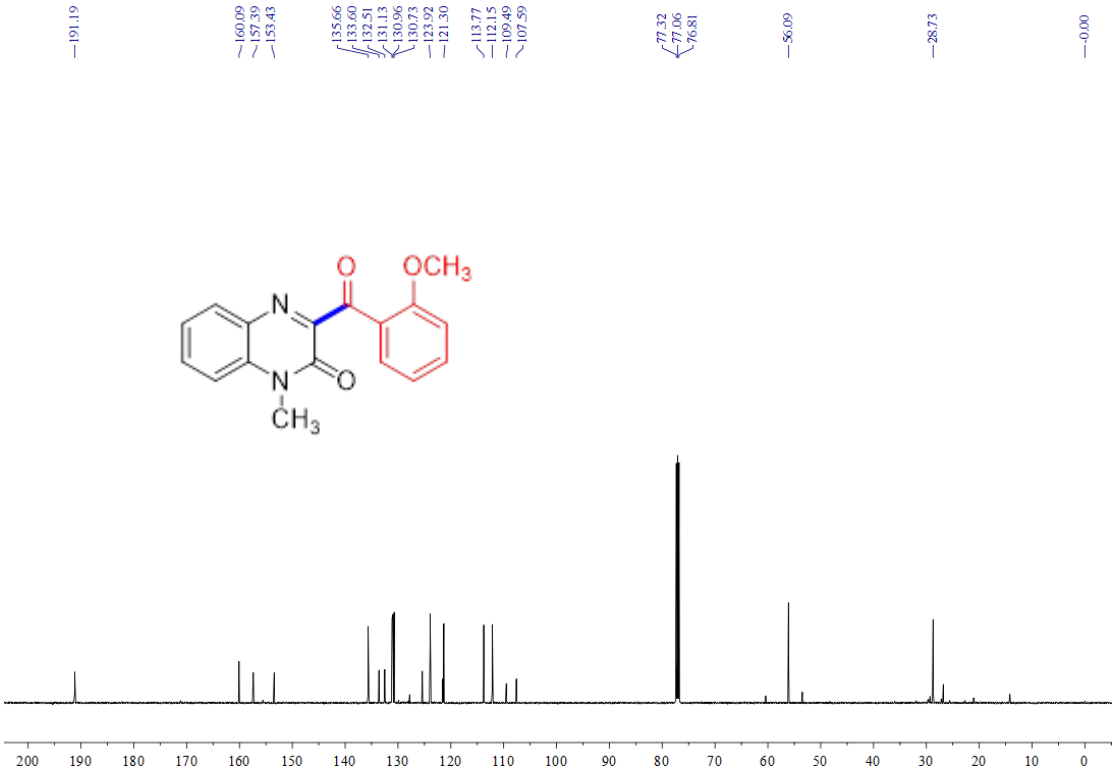
^{1}H NMR spectrum of compound 3b



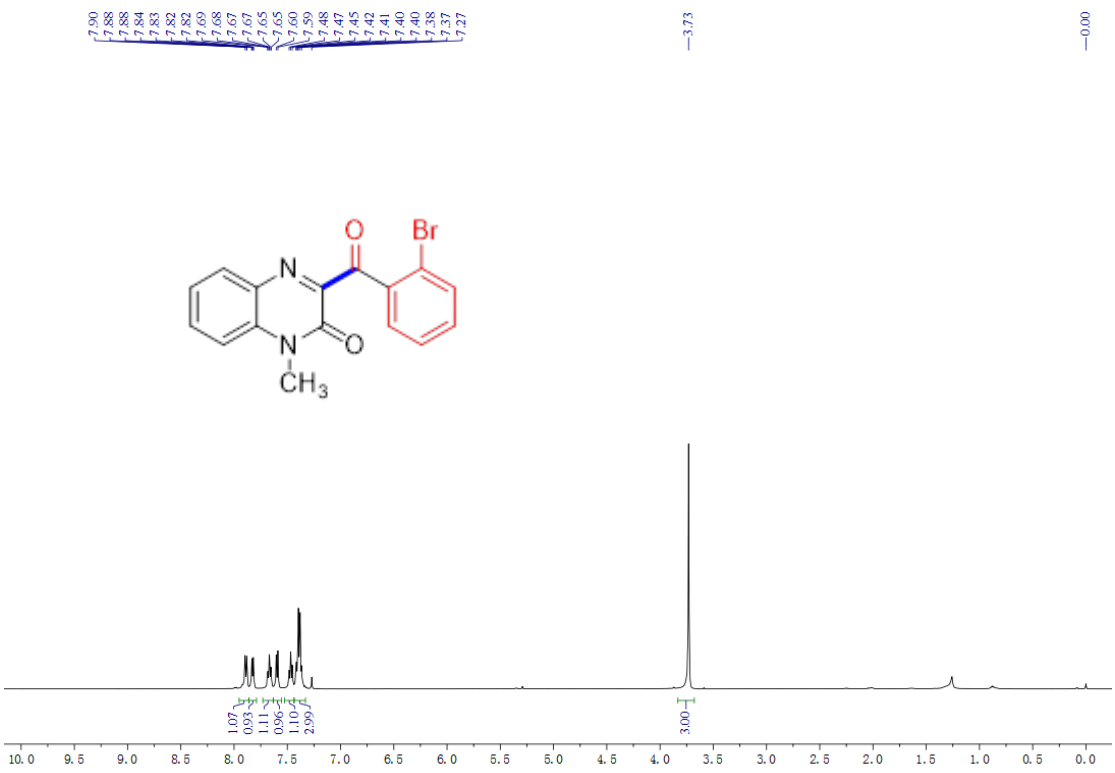
^{13}C NMR spectrum of compound 3b



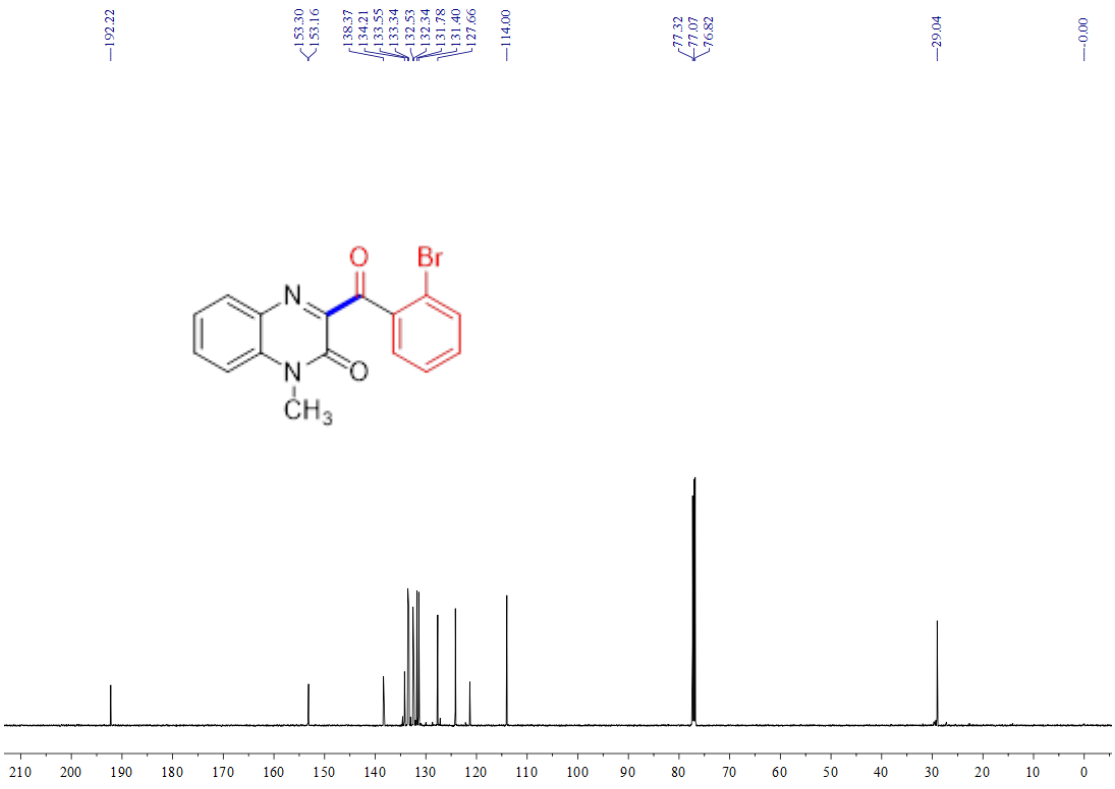
^{1}H NMR spectrum of compound 3c



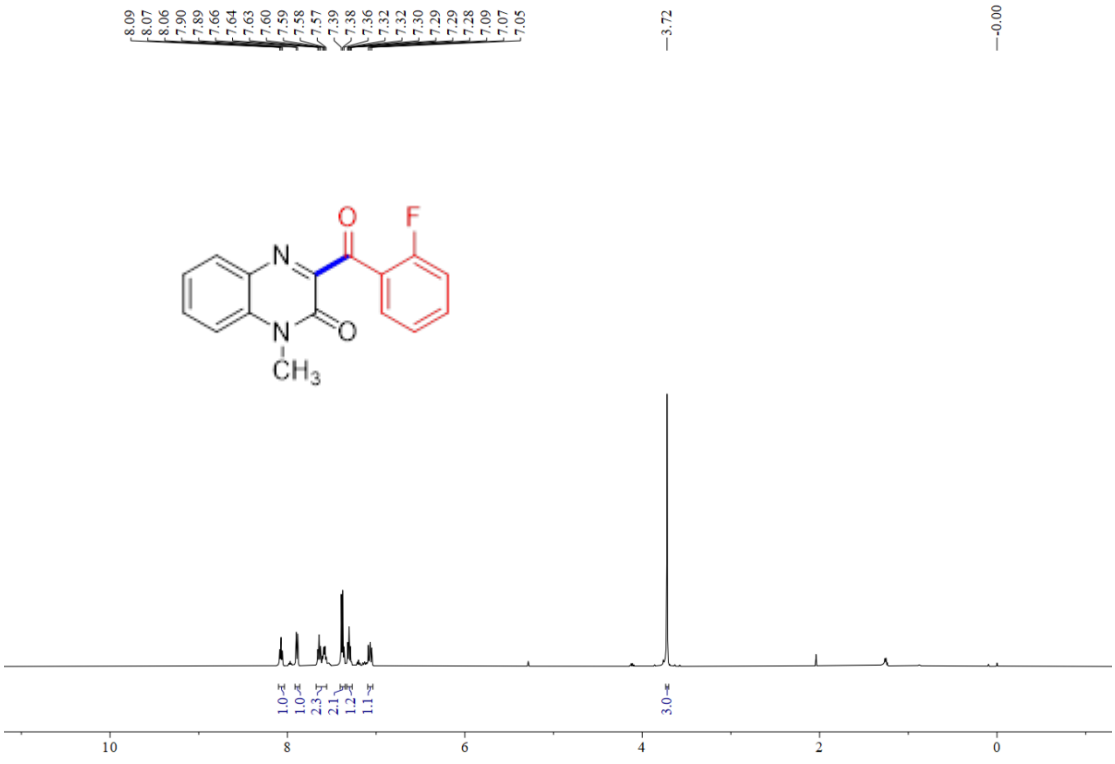
^{13}C NMR spectrum of compound 3c



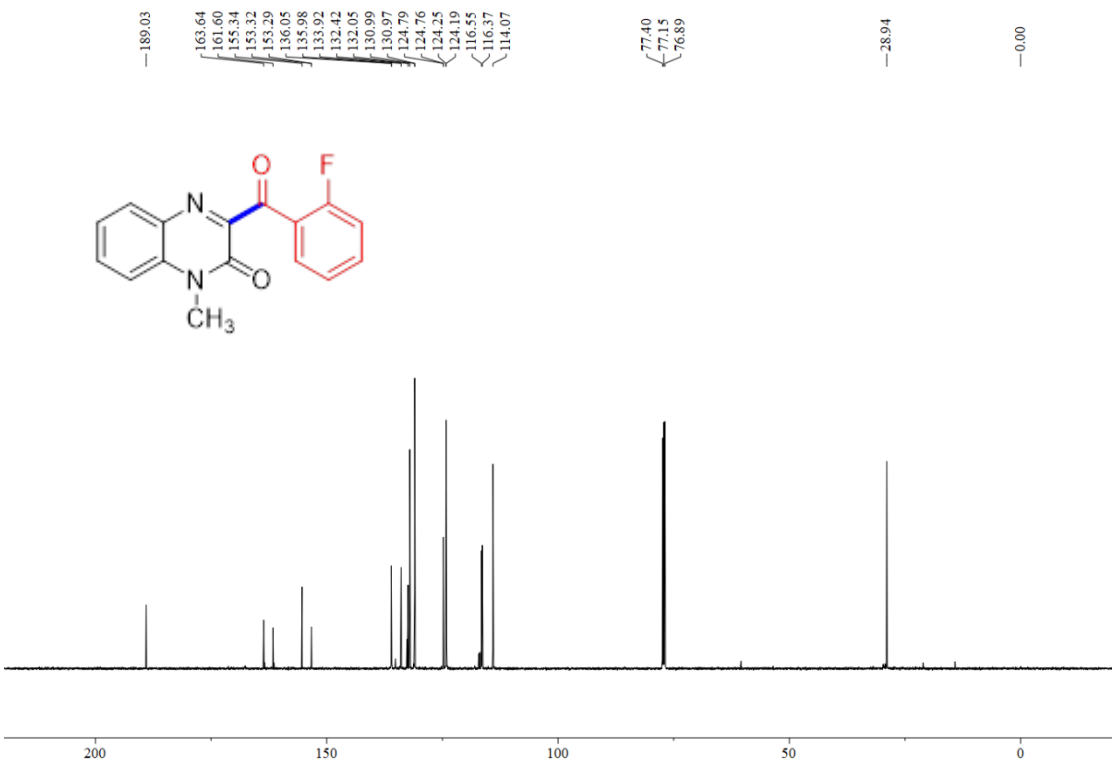
^{1}H NMR spectrum of compound 3d



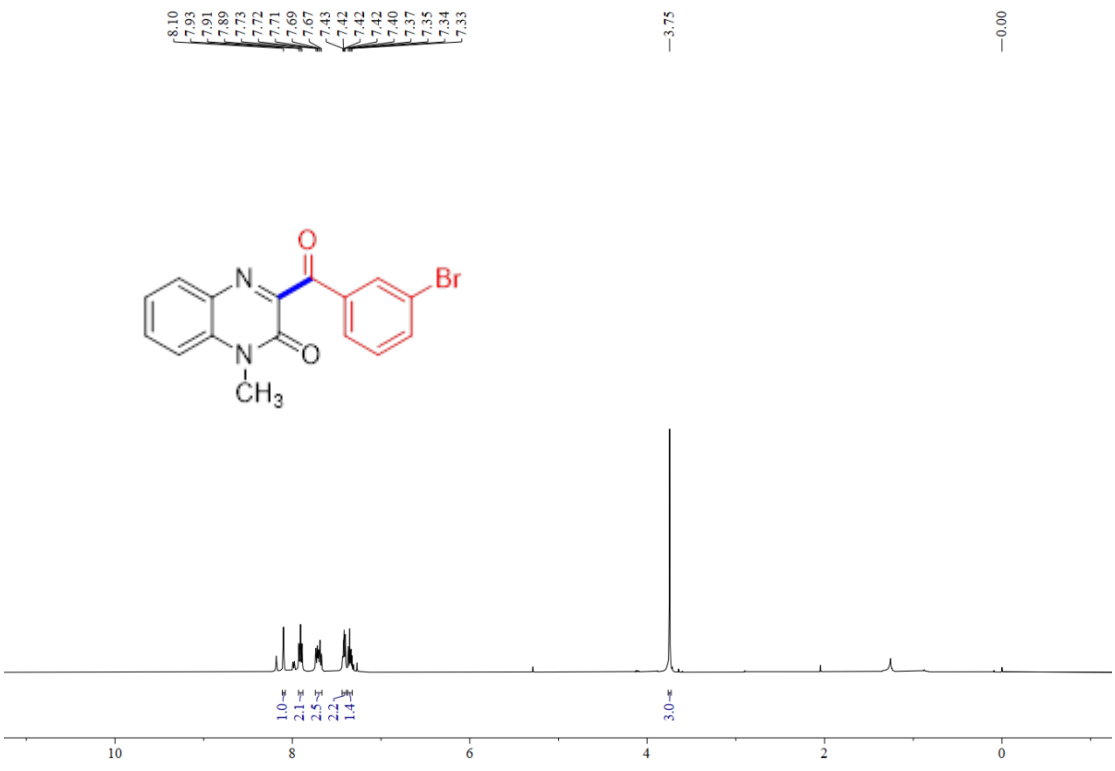
^{13}C NMR spectrum of compound 3d



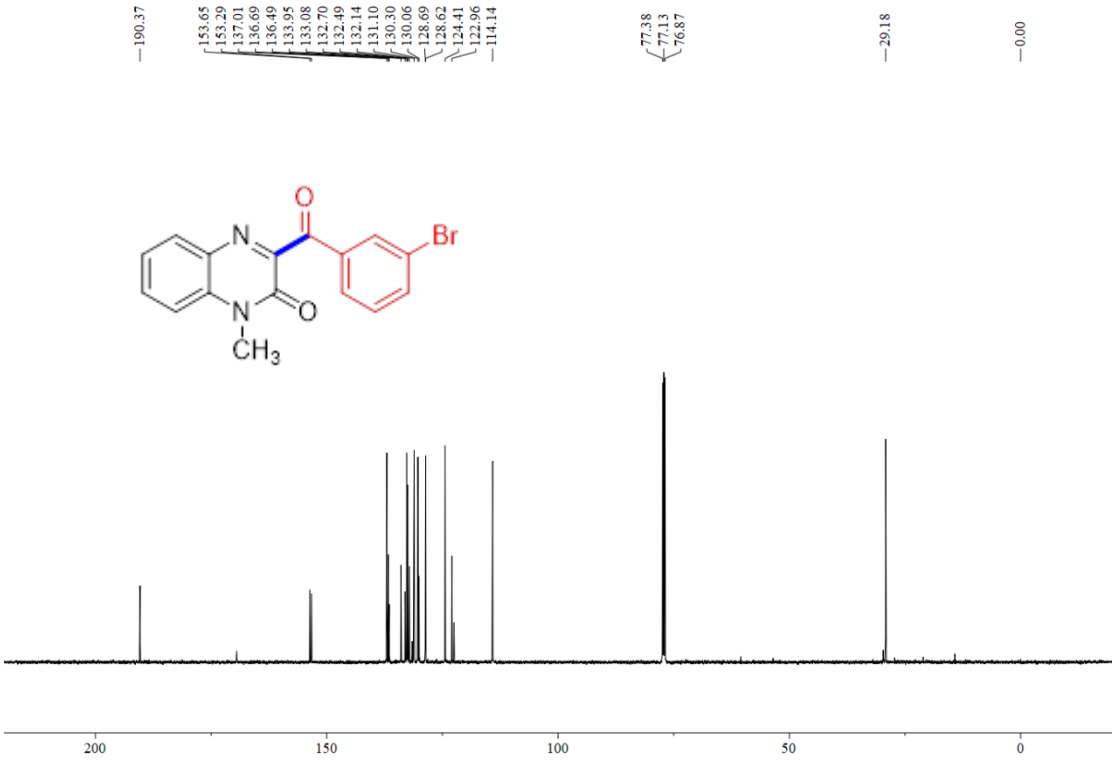
^{1}H NMR spectrum of compound 3e



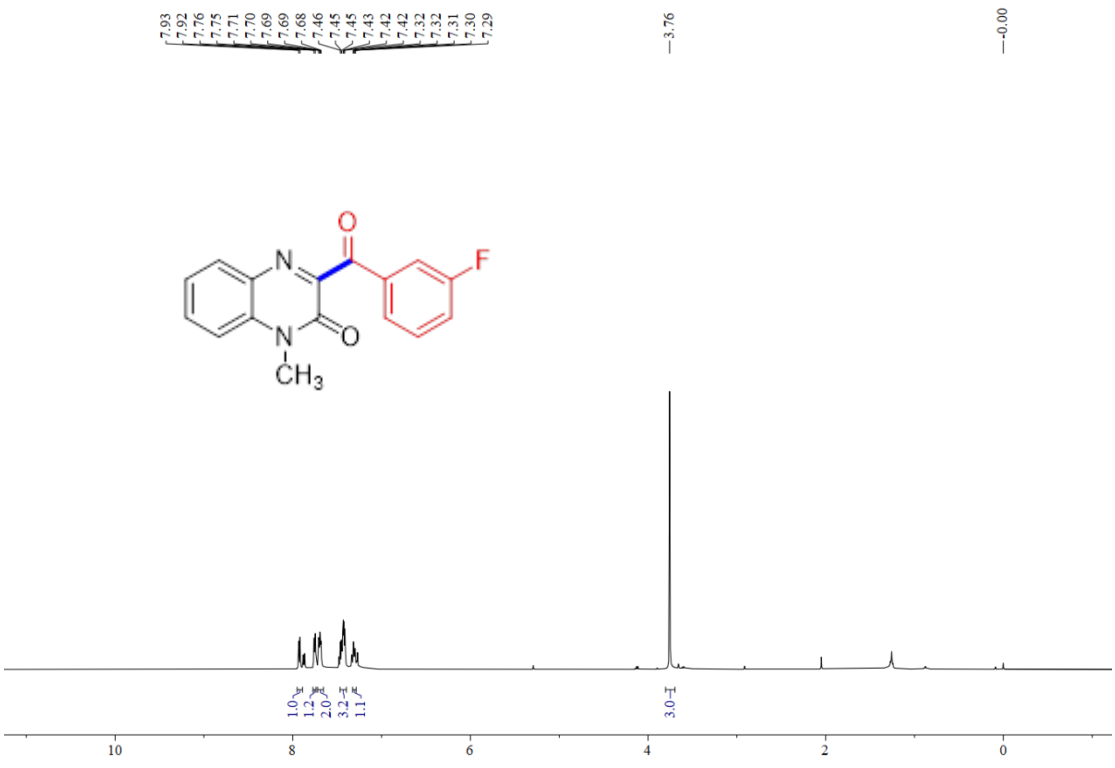
^{13}C NMR spectrum of compound 3e



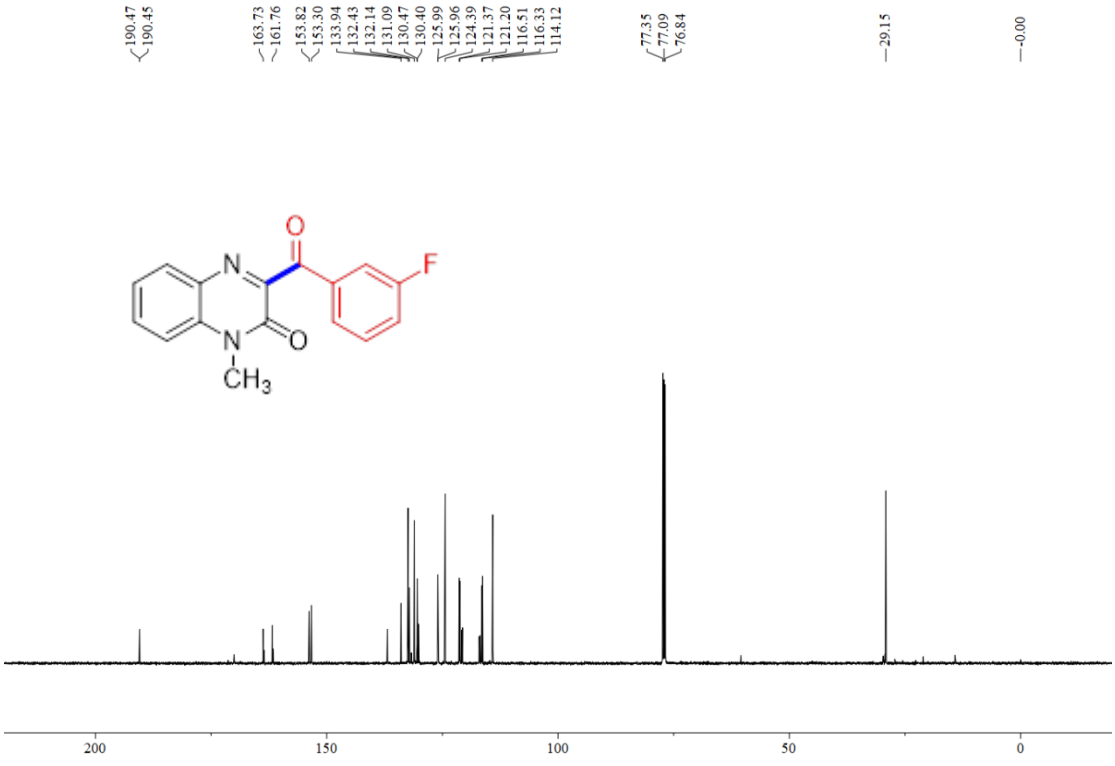
^{1}H NMR spectrum of compound 3f



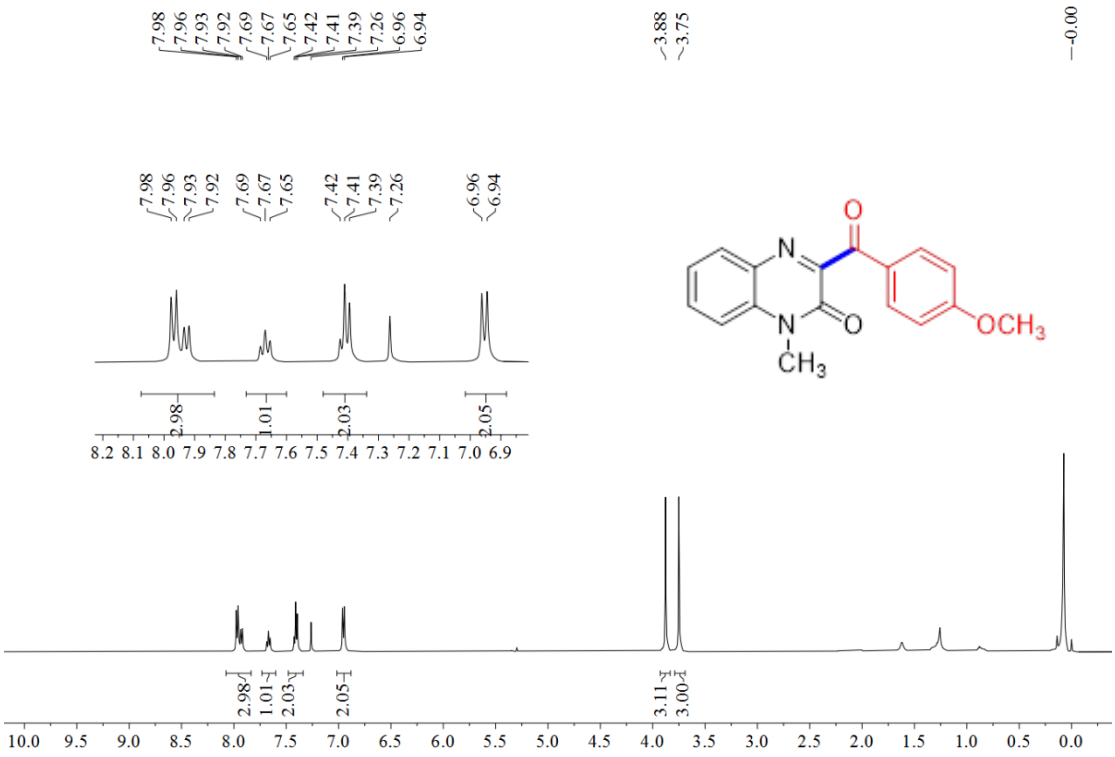
^{13}C NMR spectrum of compound 3f



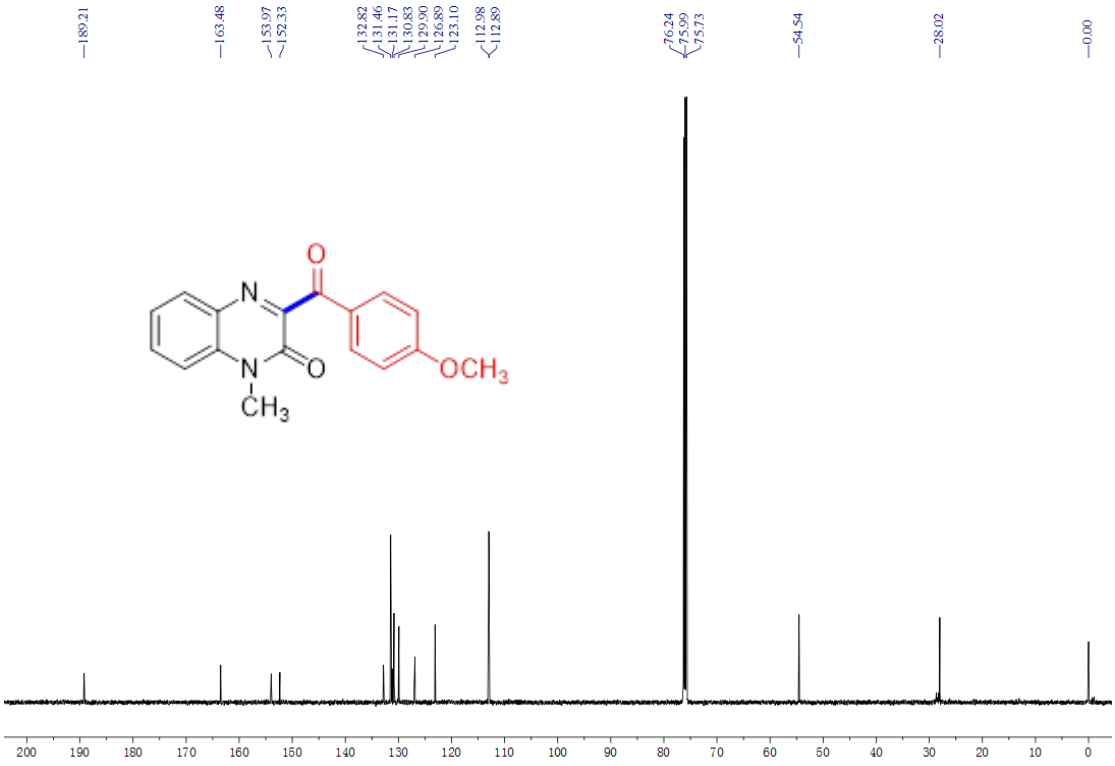
[1]H NMR spectrum of compound 3g



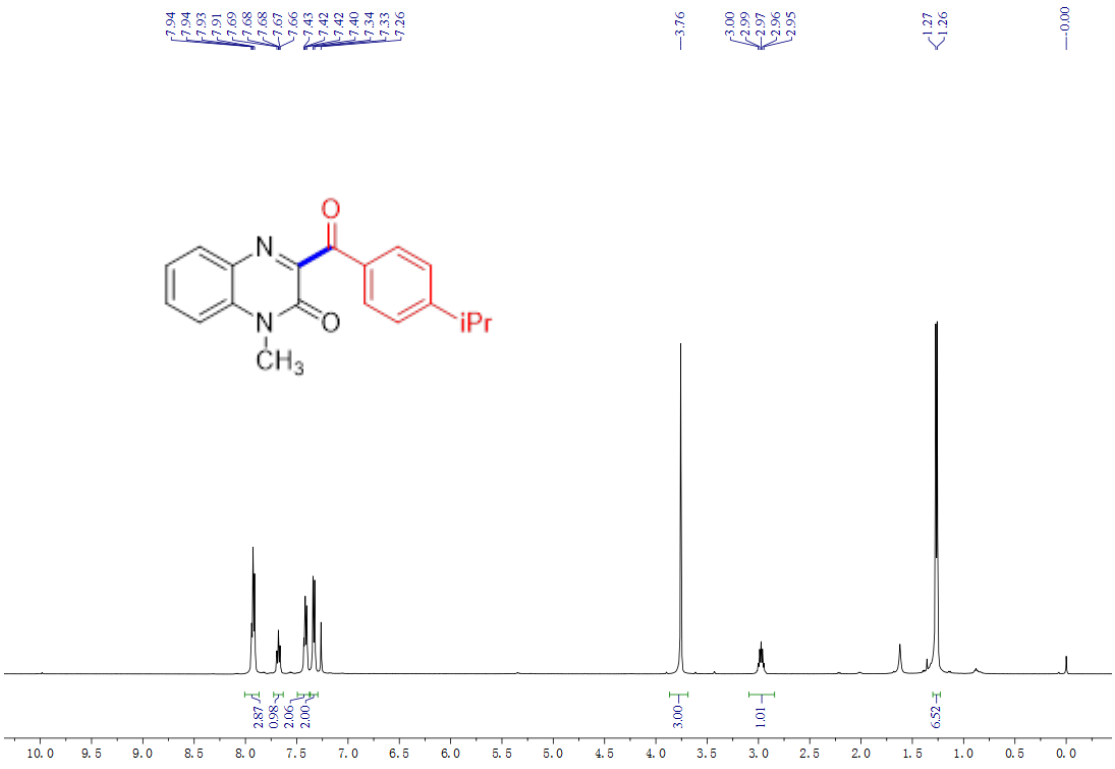
[13]C NMR spectrum of compound 3g



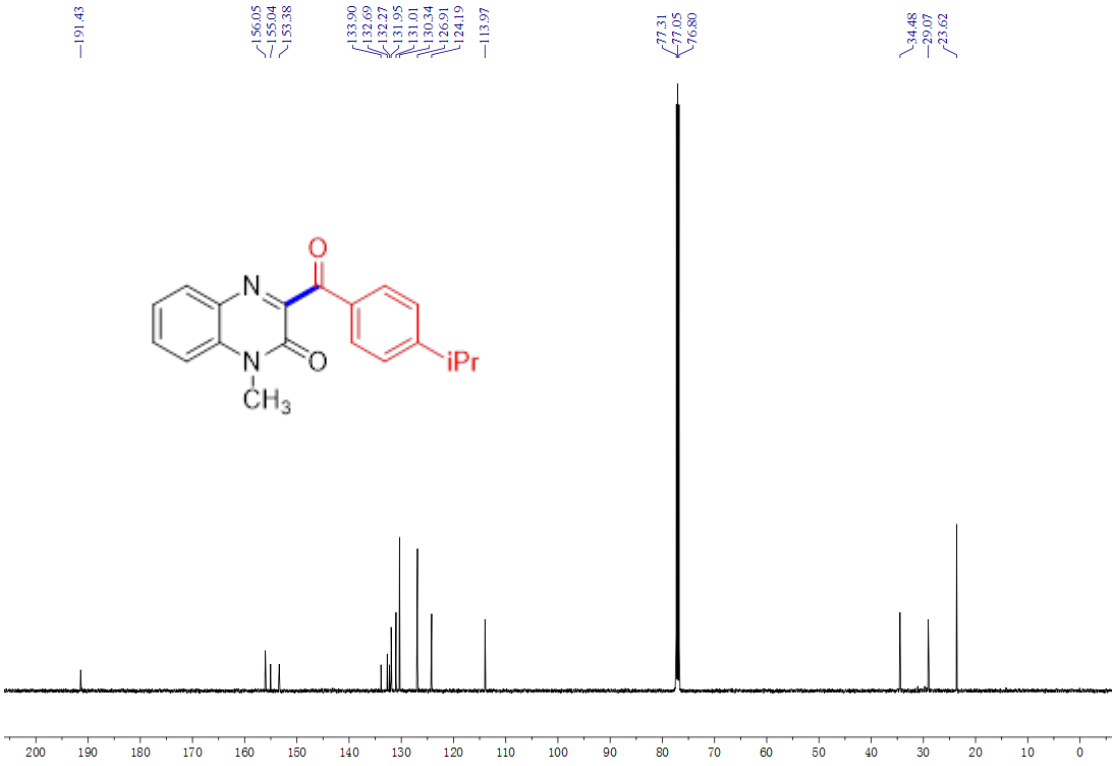
^{1}H NMR spectrum of compound 3h



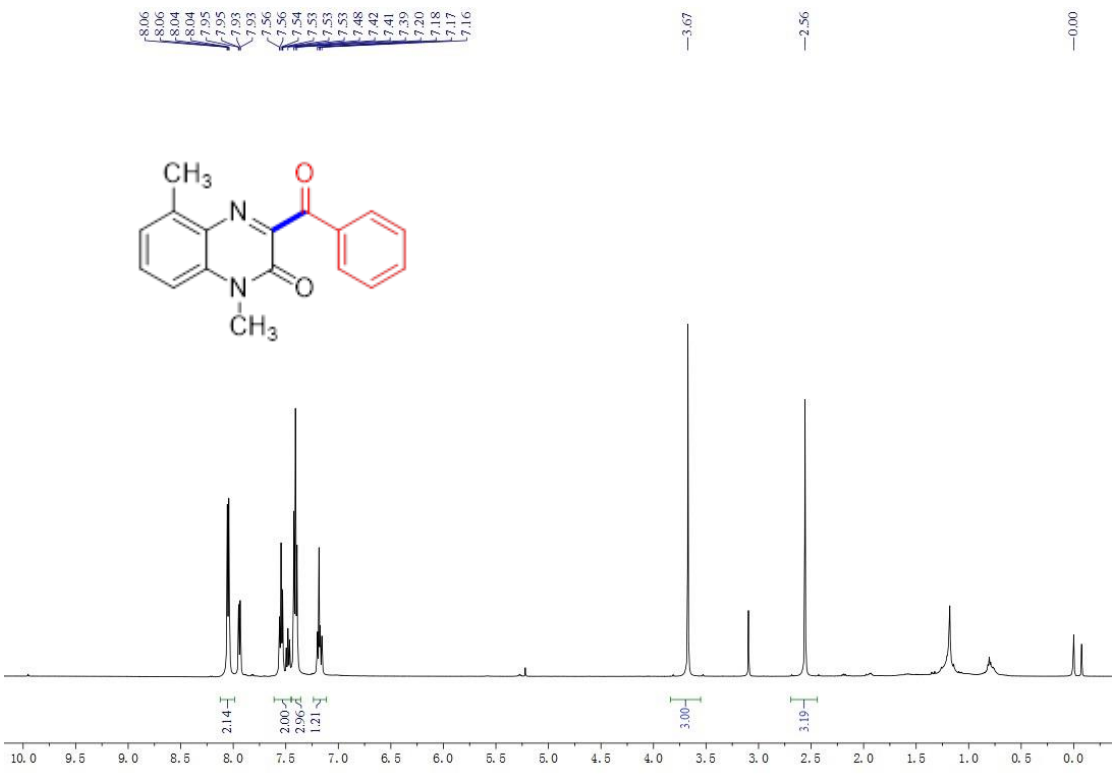
^{13}C NMR spectrum of compound 3h



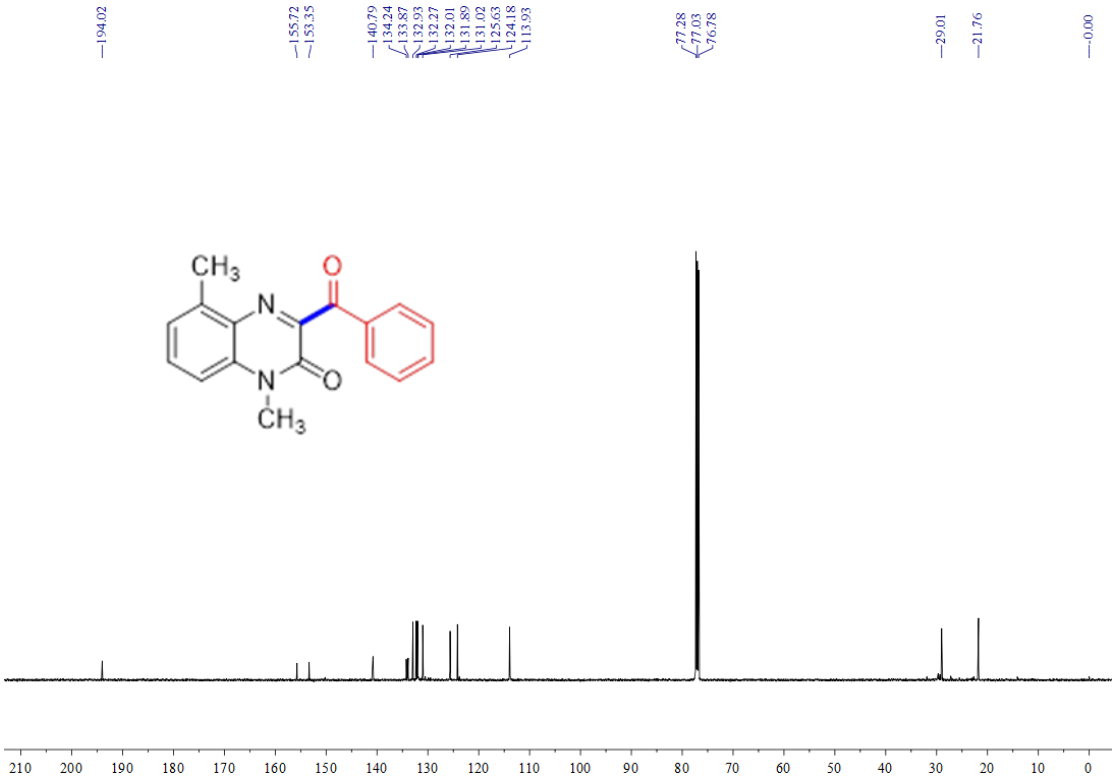
^{1}H NMR spectrum of compound 3i



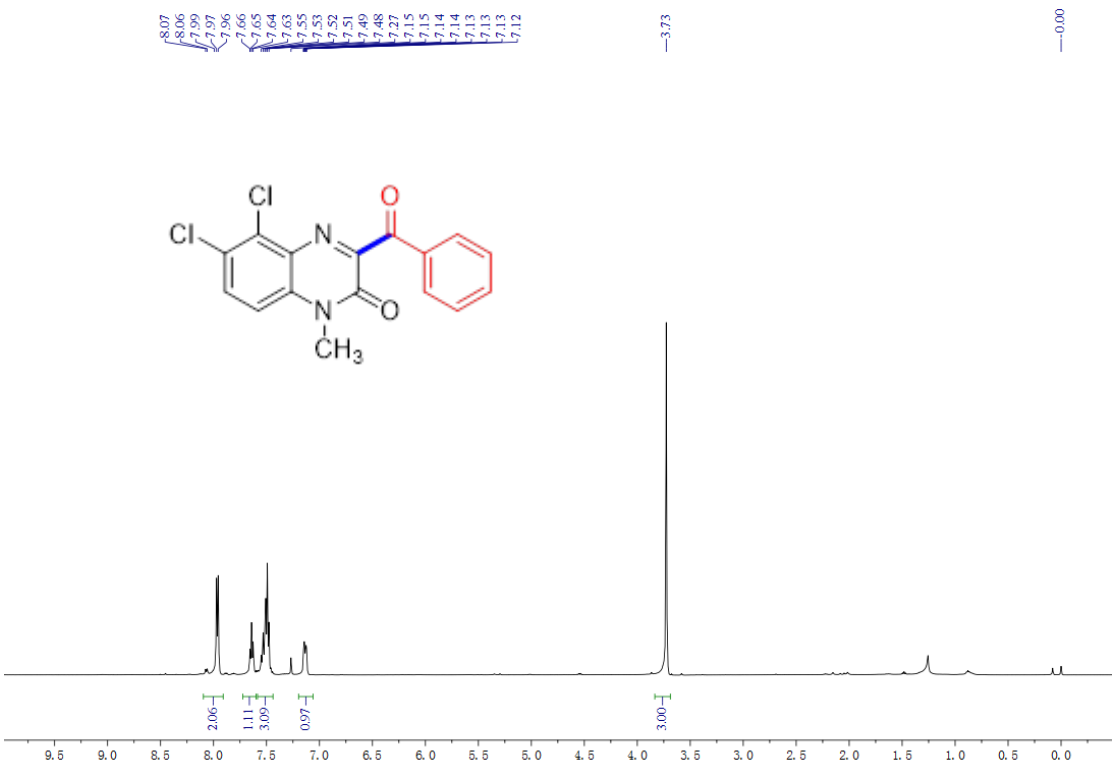
^{13}C NMR spectrum of compound 3i



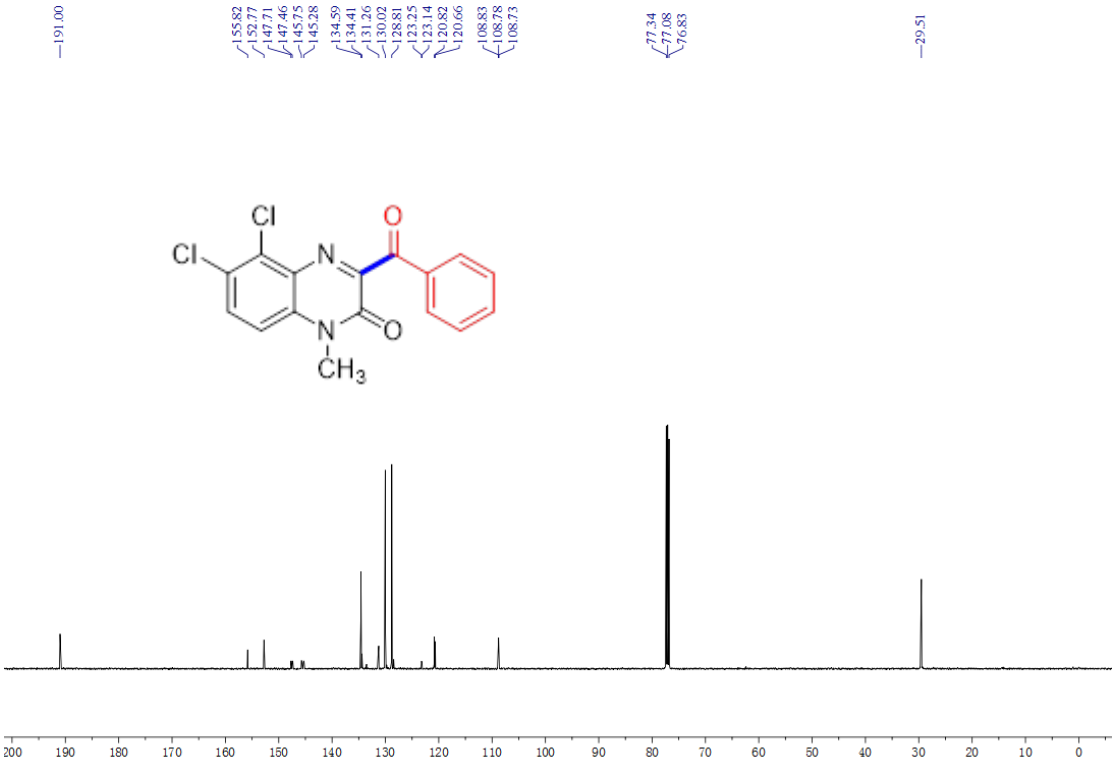
^{1}H NMR spectrum of compound 3j



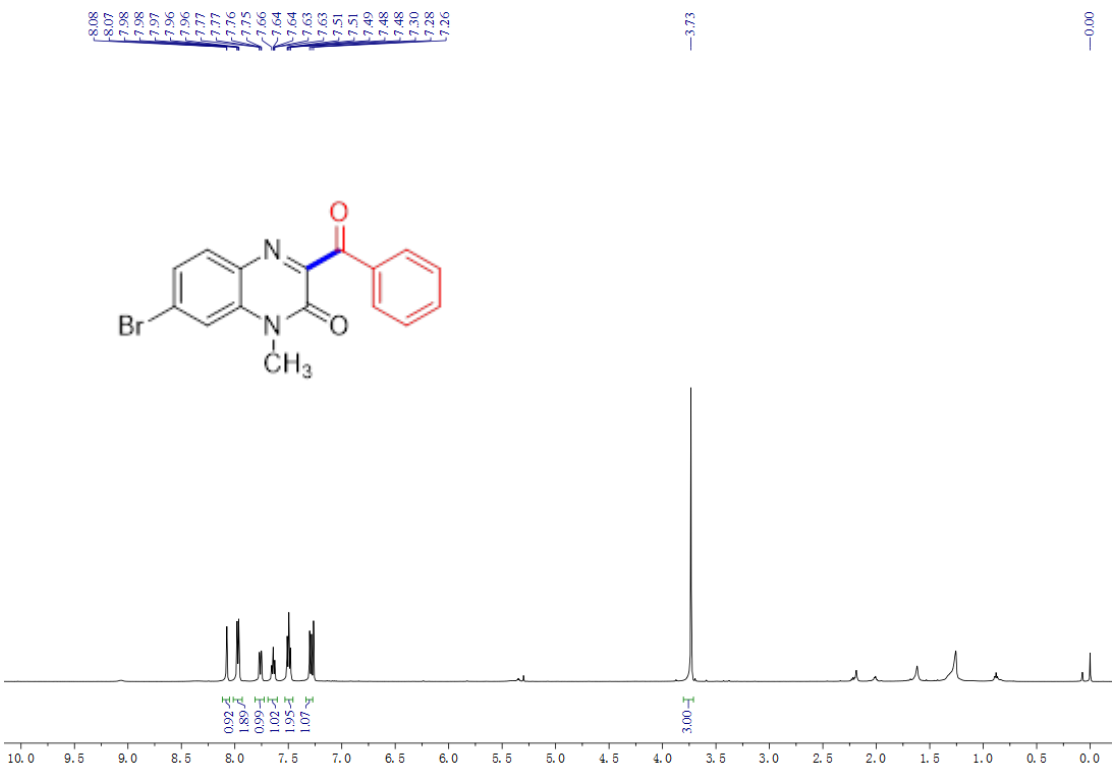
^{13}C NMR spectrum of compound 3j



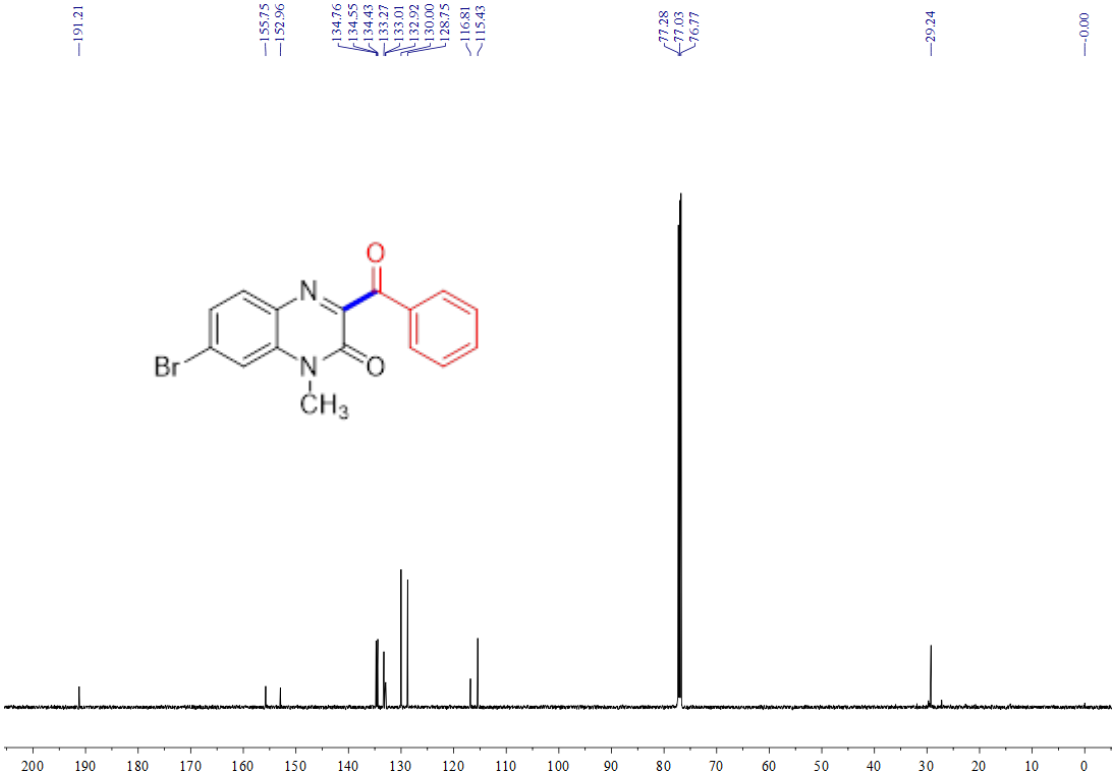
^{1}H NMR spectrum of compound 3k



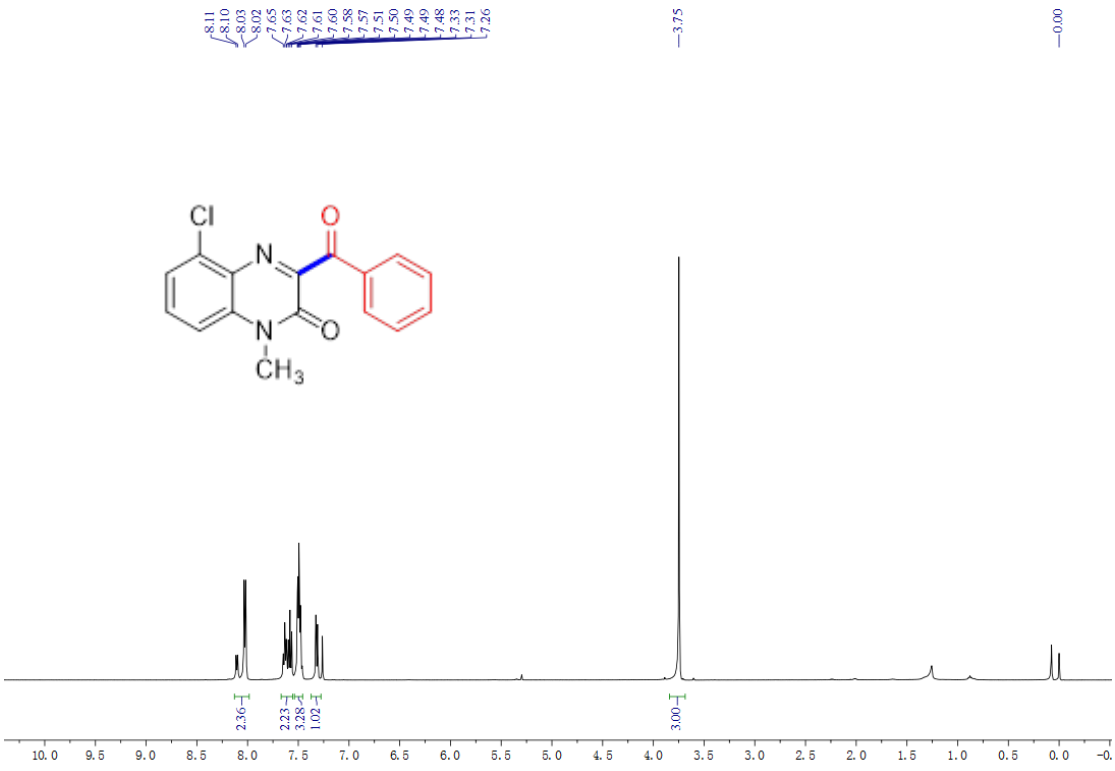
^{13}C NMR spectrum of compound 3k



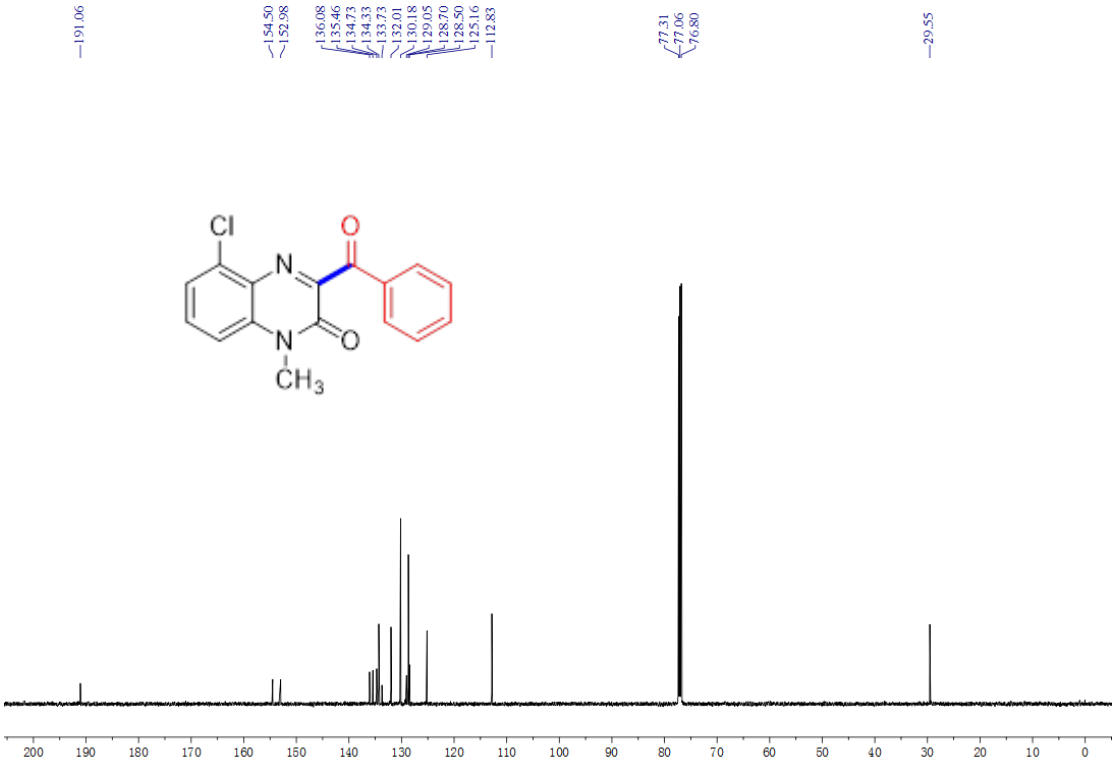
^{1}H NMR spectrum of compound 3l



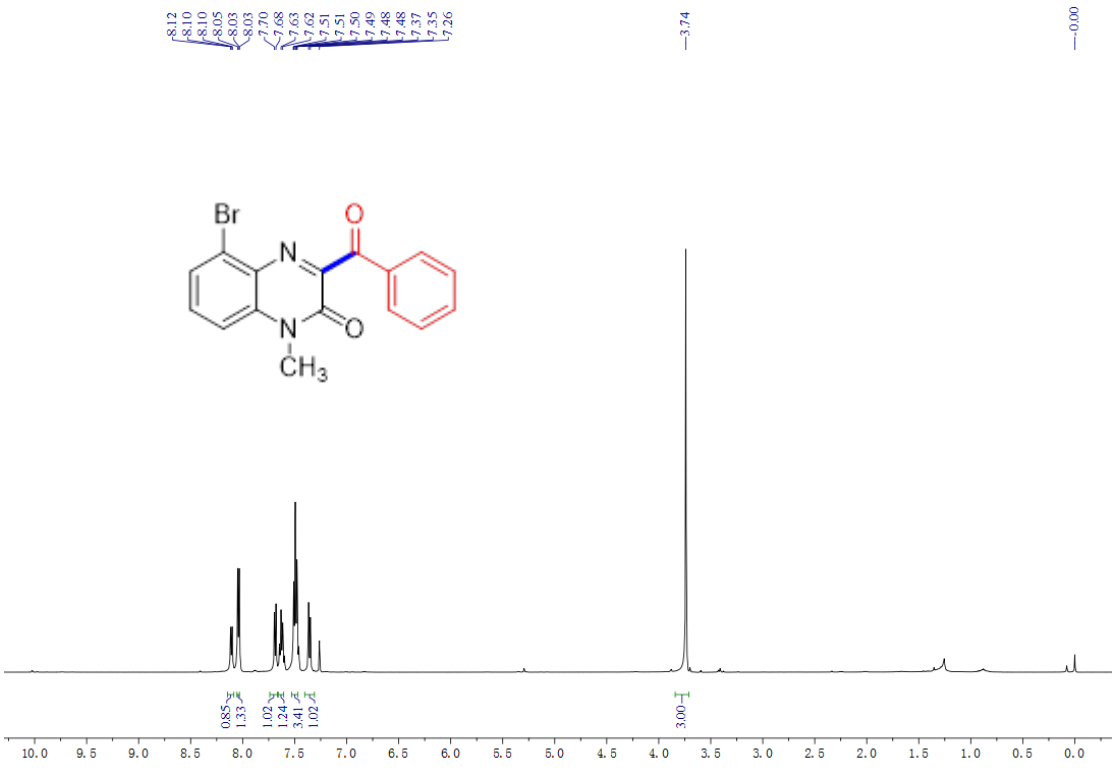
^{13}C NMR spectrum of compound 3l



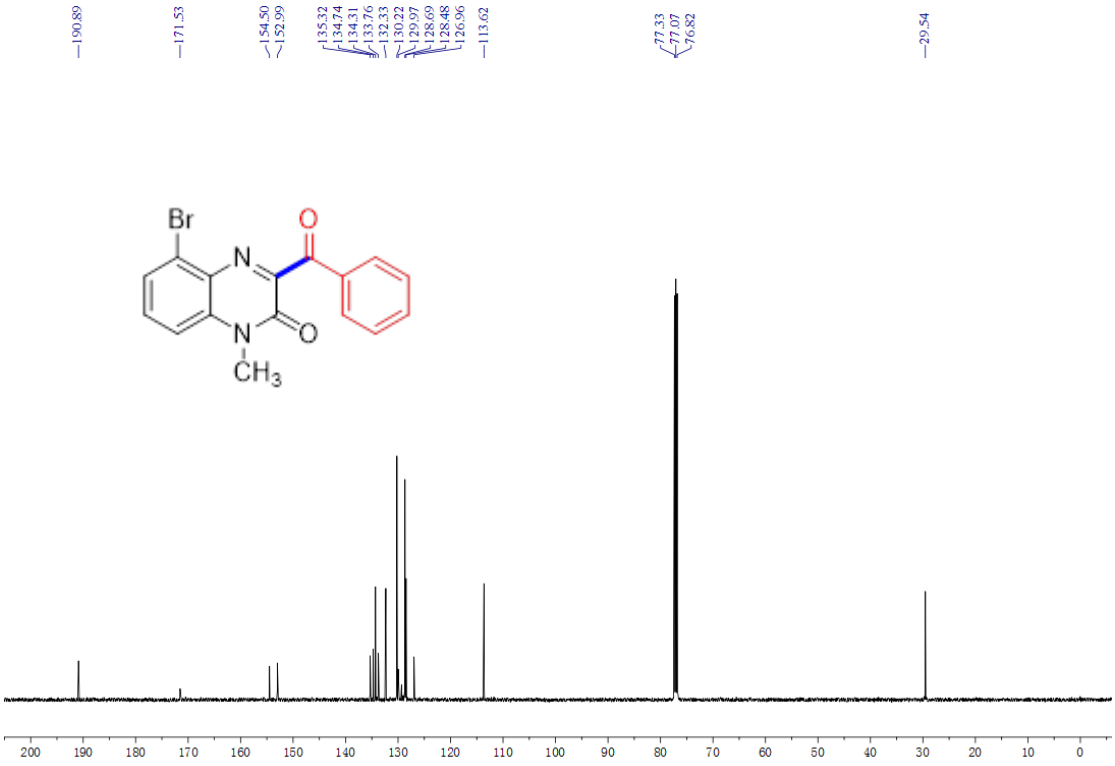
^{1}H NMR spectrum of compound 3m



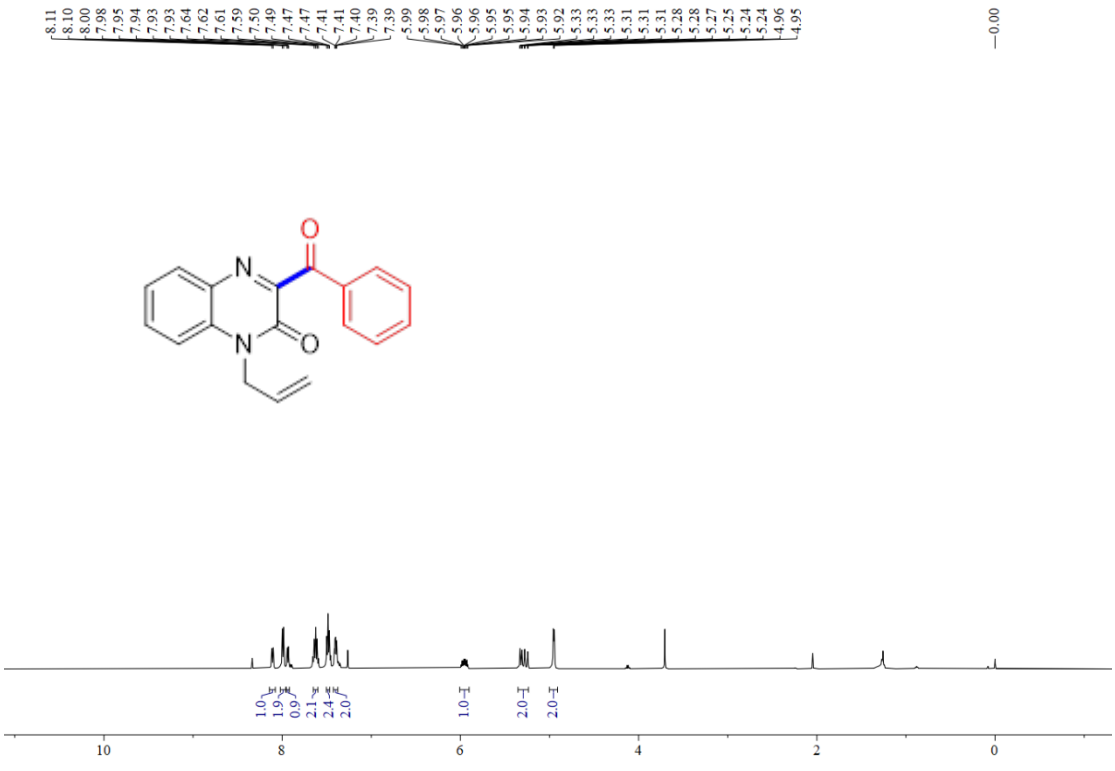
^{13}C NMR spectrum of compound 3m



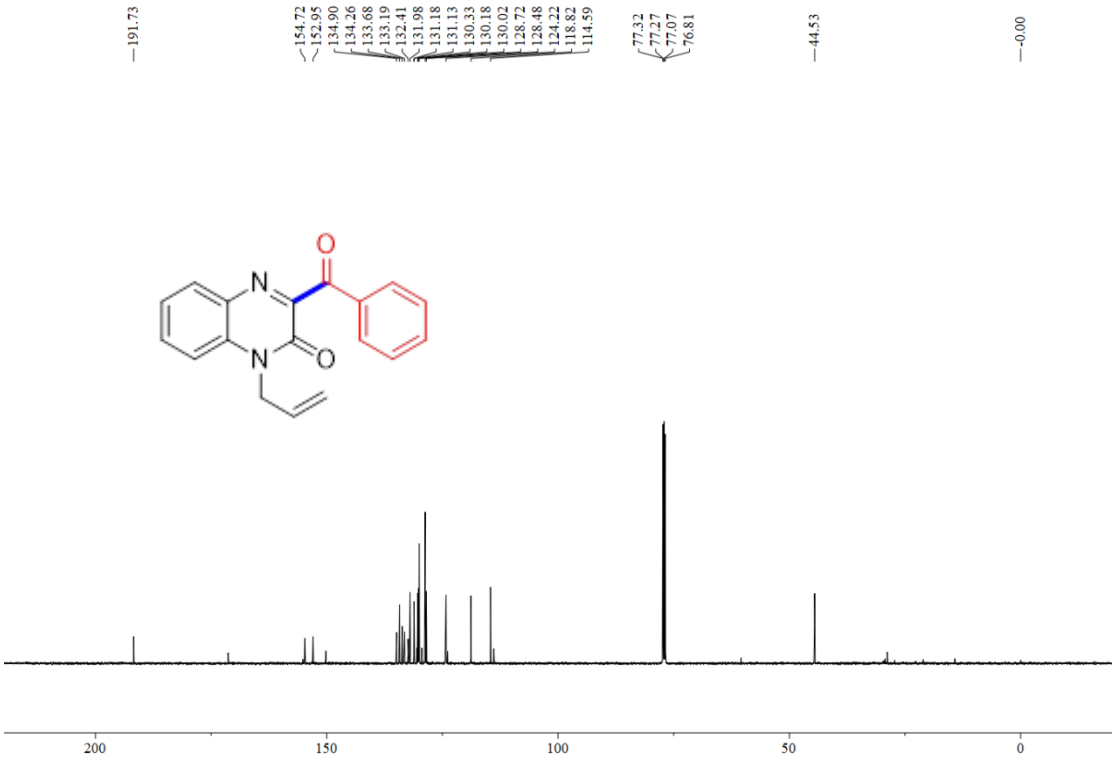
^{1}H NMR spectrum of compound 3n



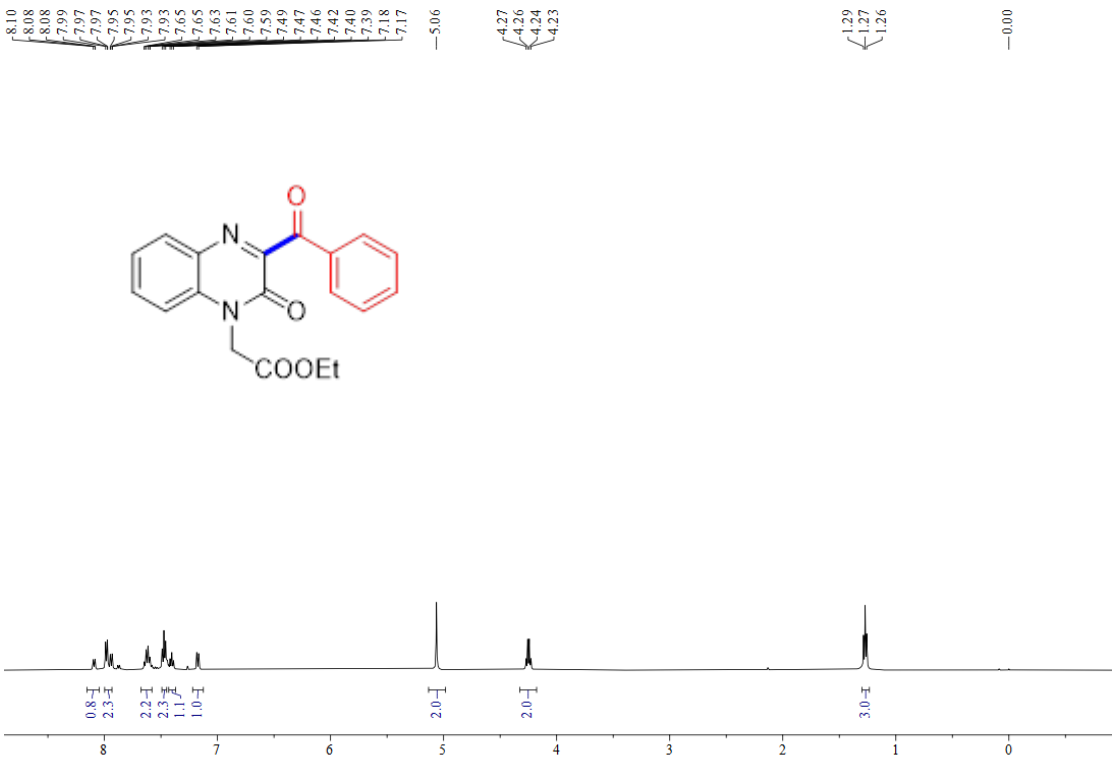
^{13}C NMR spectrum of compound 3n



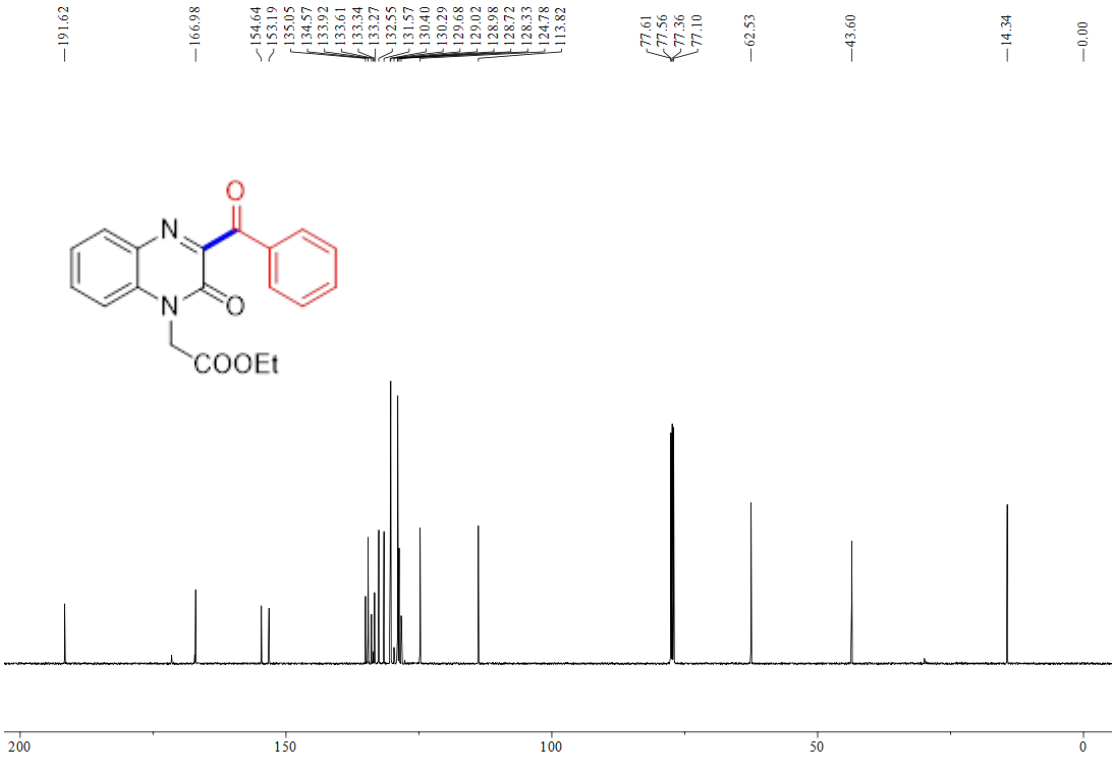
^{1}H NMR spectrum of compound 3o



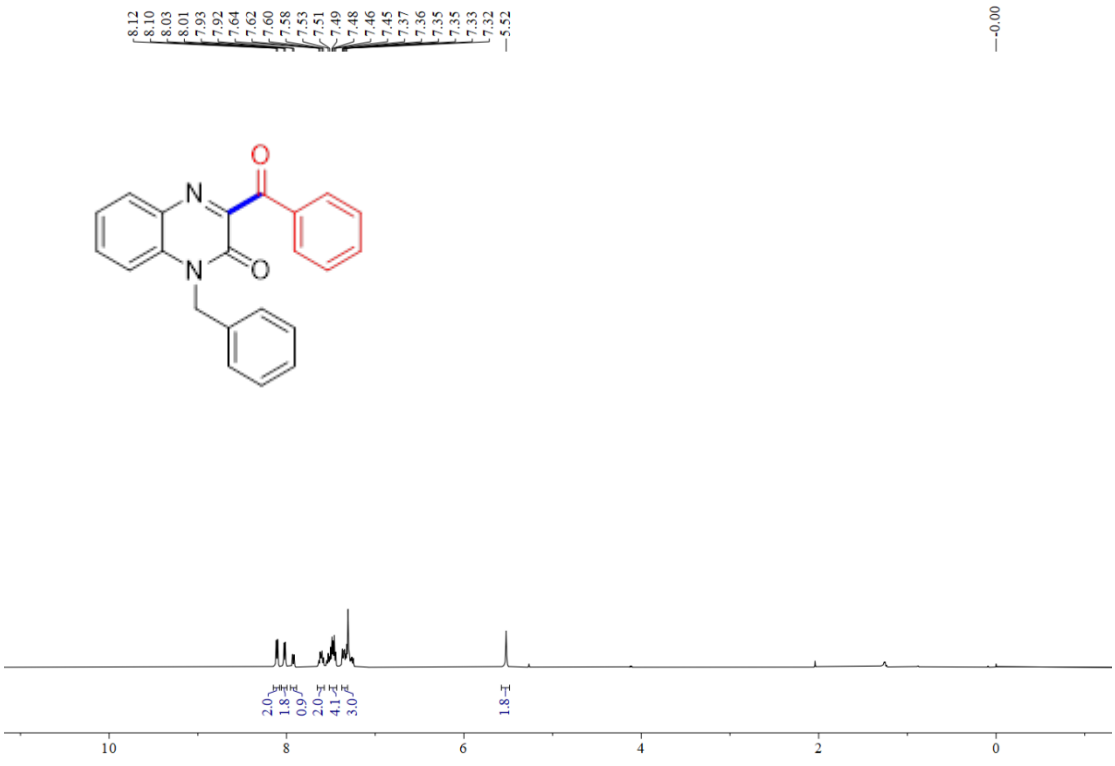
^{13}C NMR spectrum of compound 3o



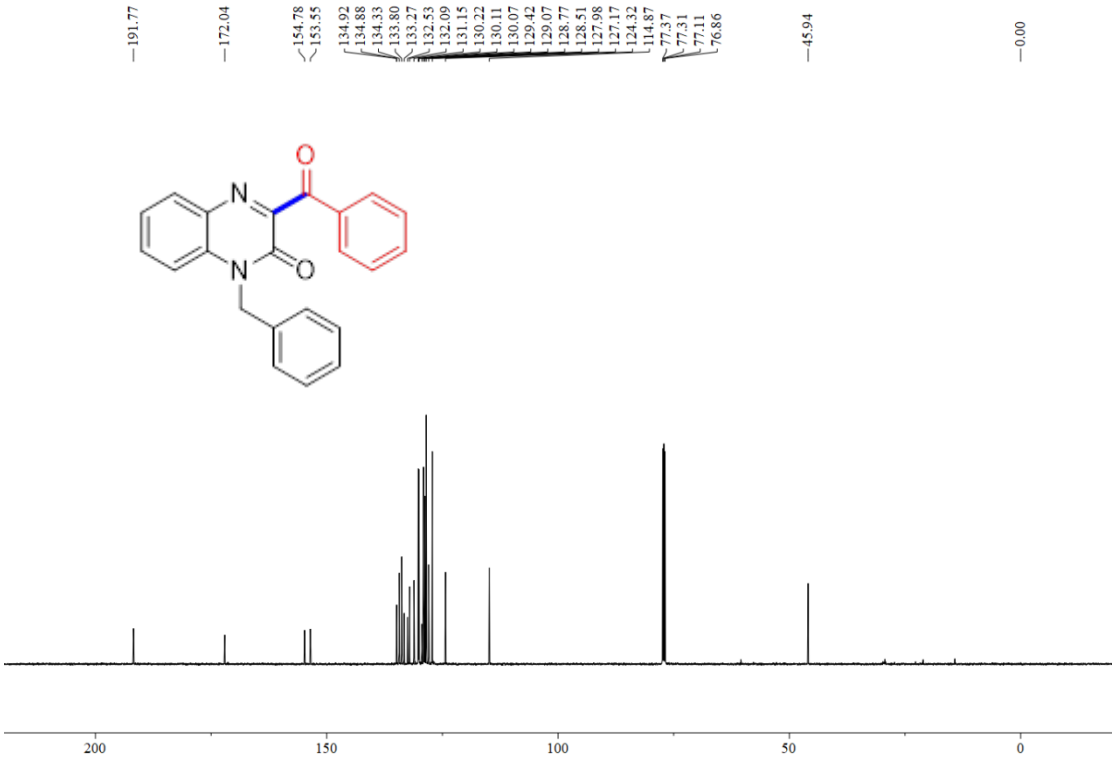
^{1}H NMR spectrum of compound 3p



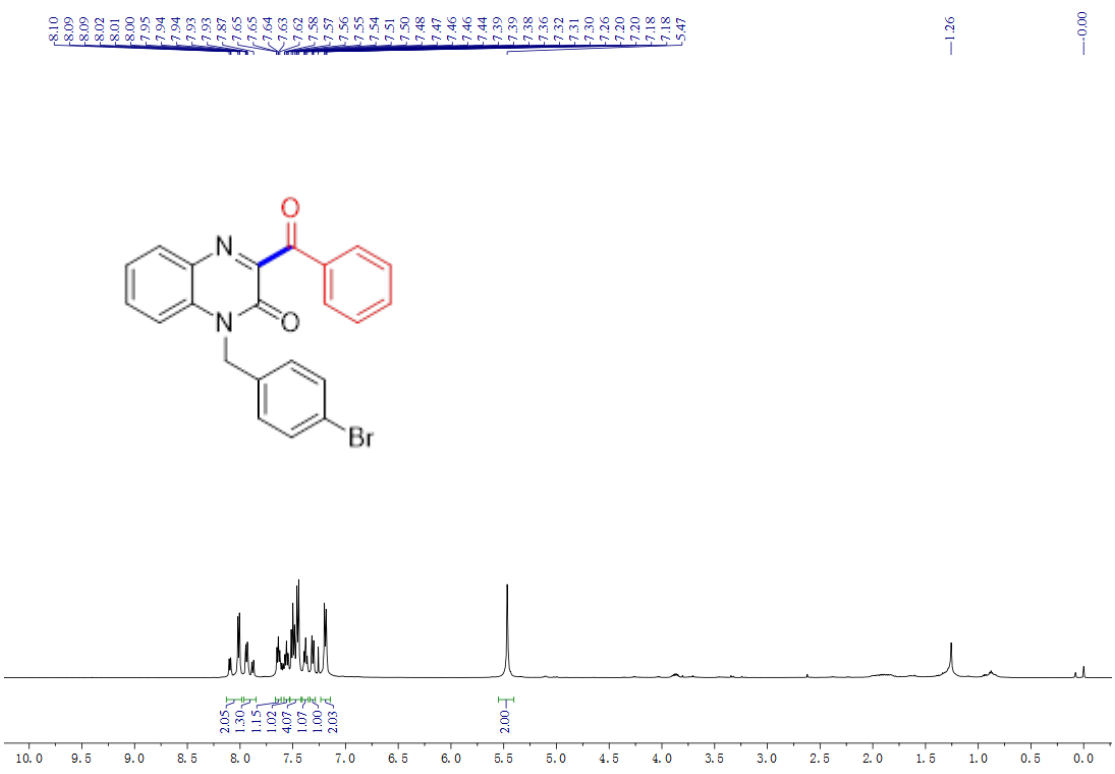
^{13}C NMR spectrum of compound 3p



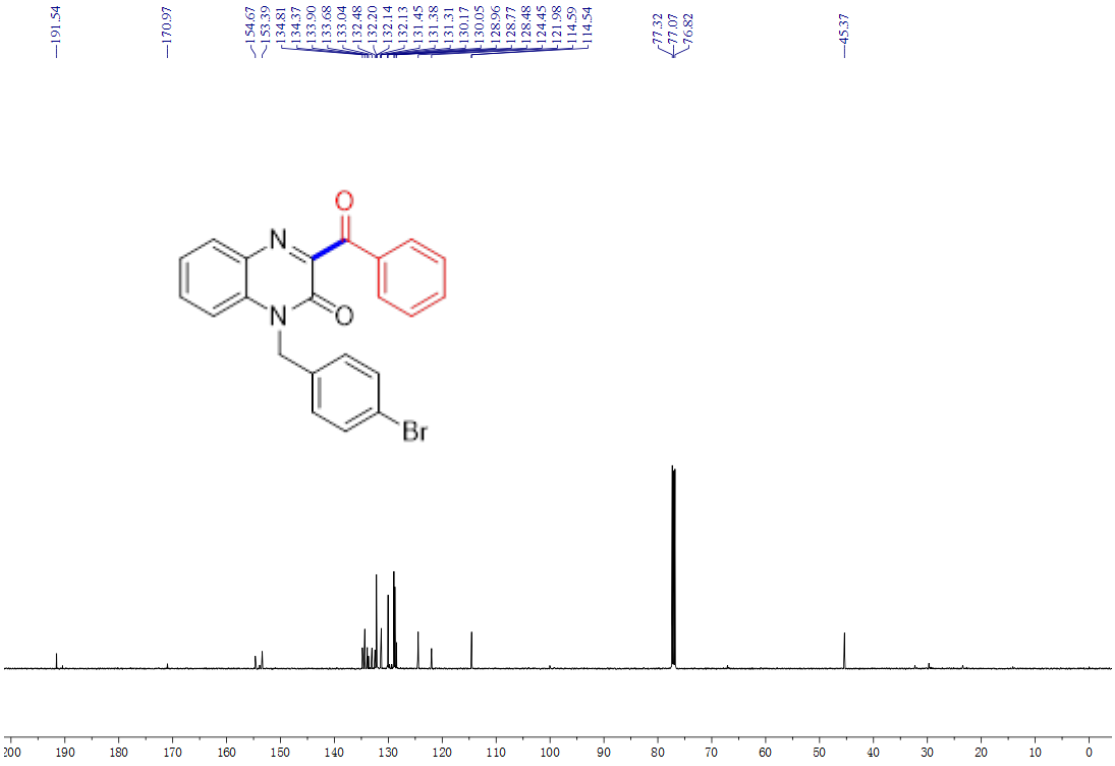
^{1}H NMR spectrum of compound 3q



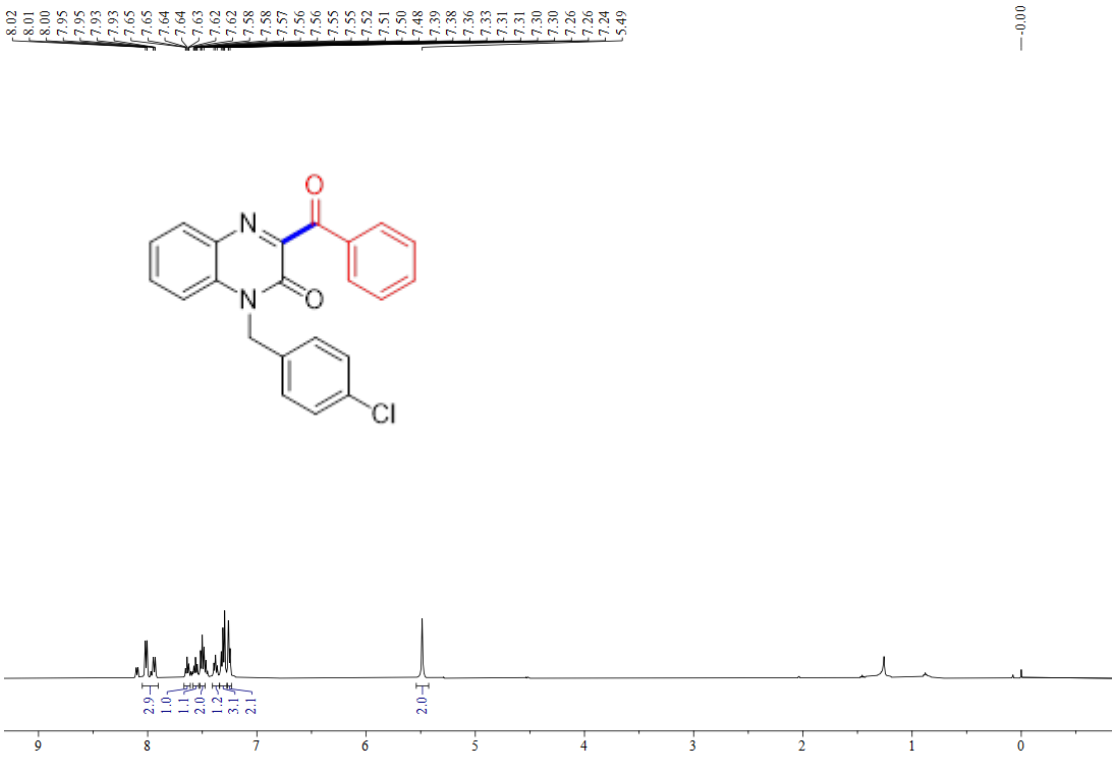
^{13}C NMR spectrum of compound 3q



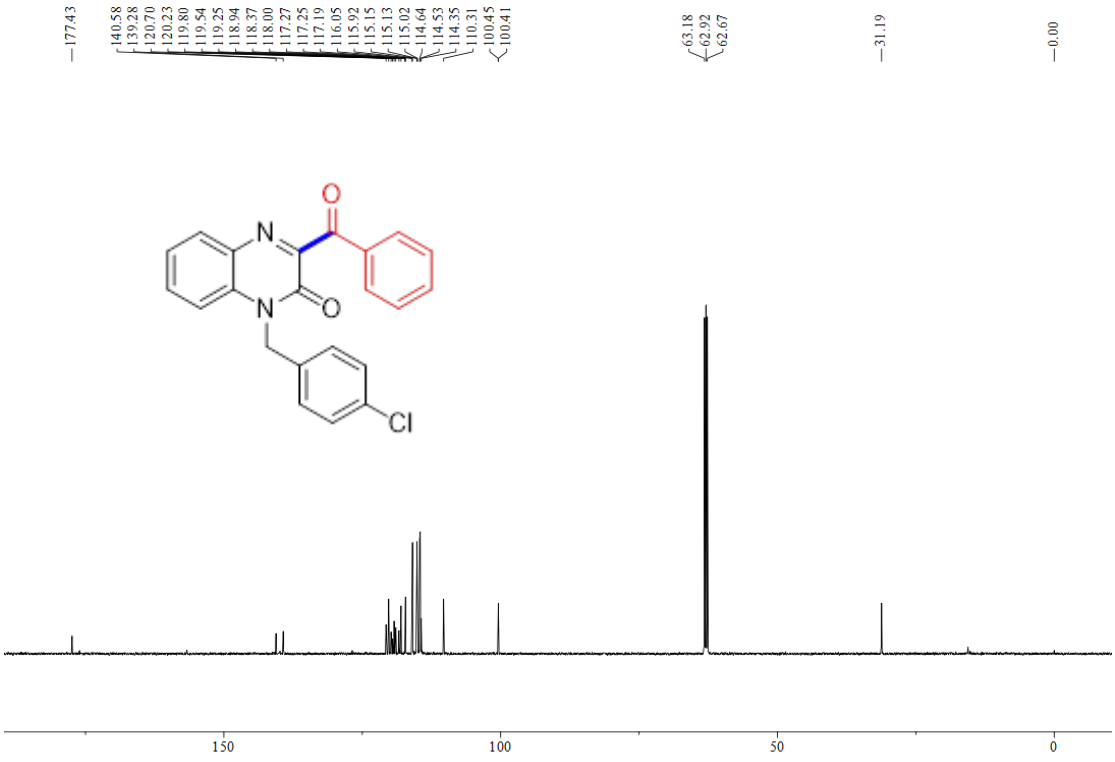
^{1}H NMR spectrum of compound 3r



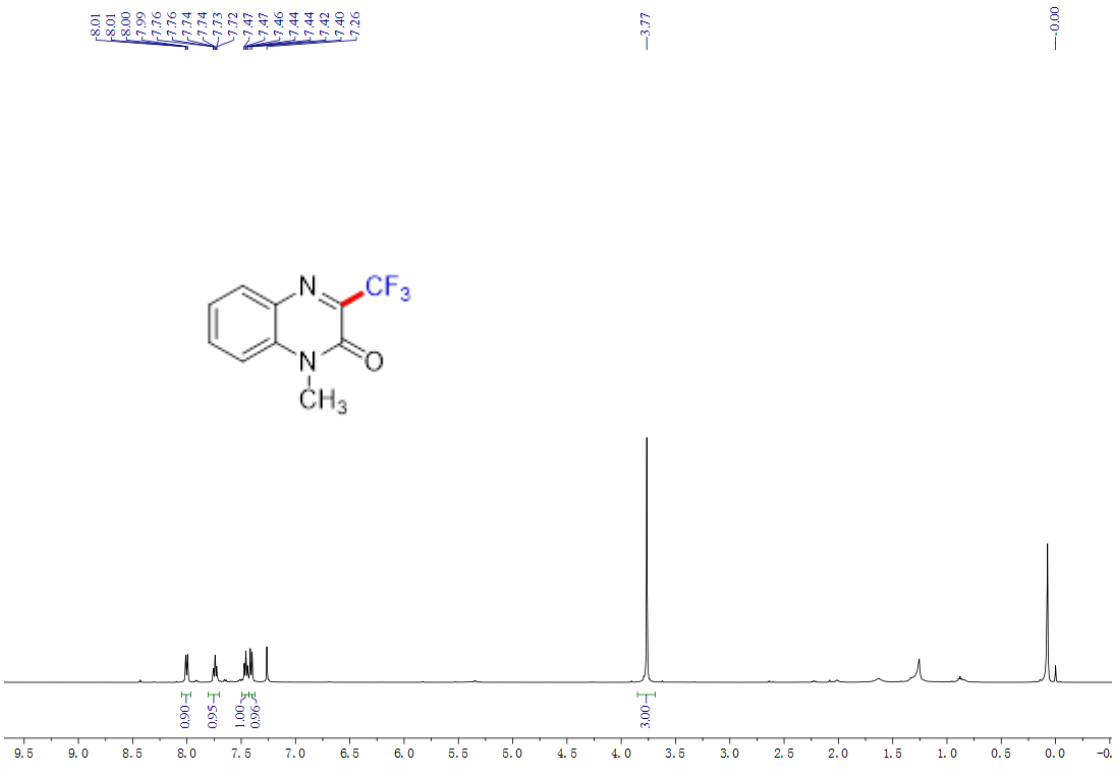
^{13}C NMR spectrum of compound 3r



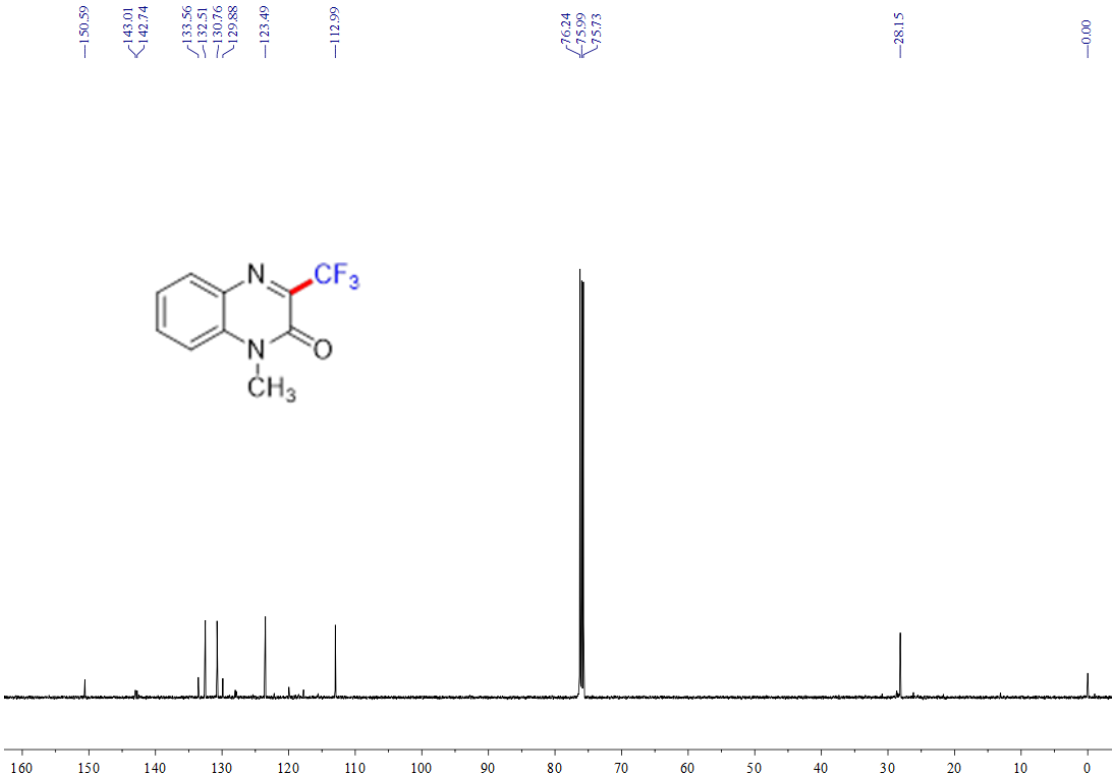
^{1}H NMR spectrum of compound 3s



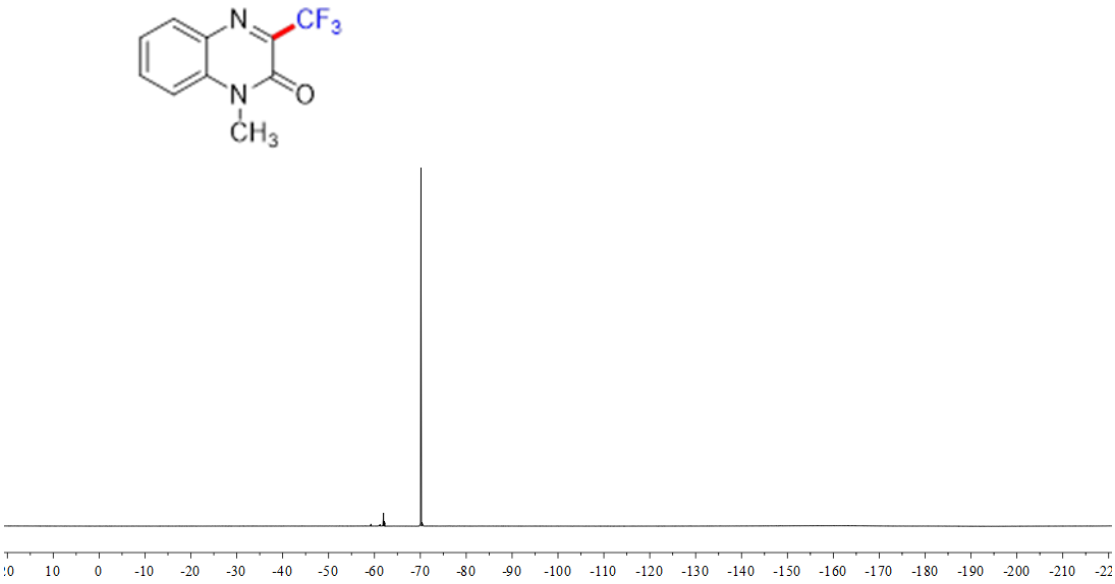
^{13}C NMR spectrum of compound 3s



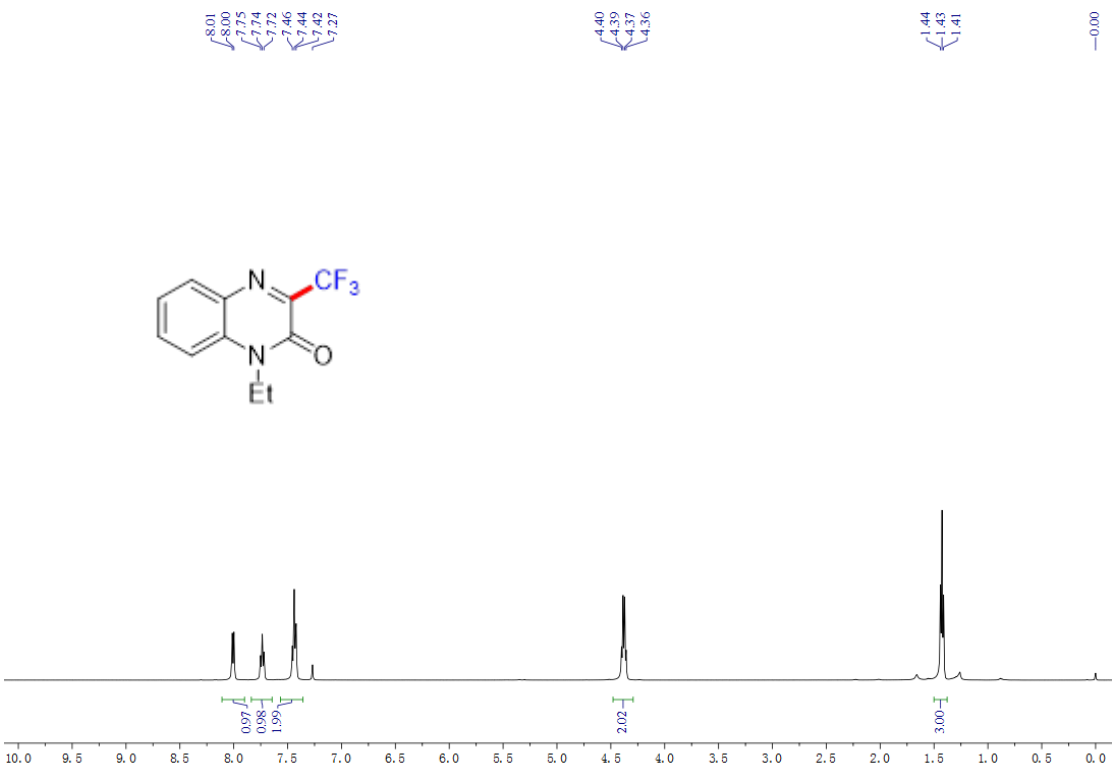
^{1}H NMR spectrum of compound 5a



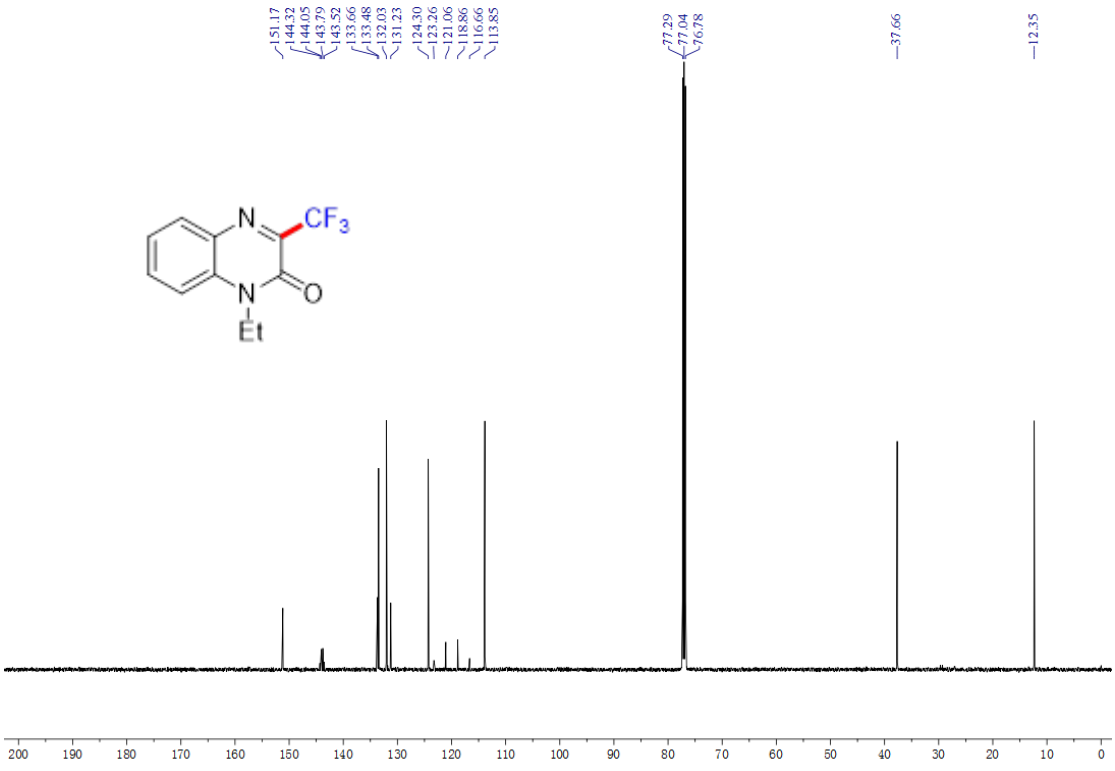
^{13}C NMR spectrum of compound 5a



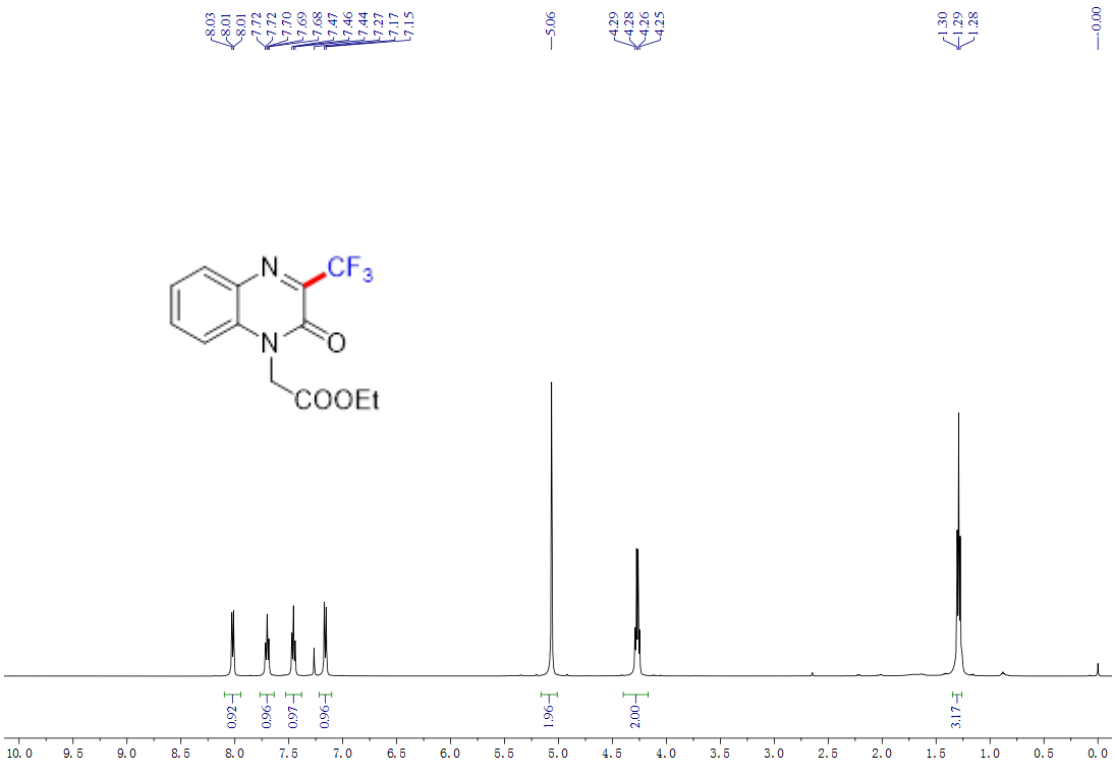
^{19}F NMR spectrum of compound 5a



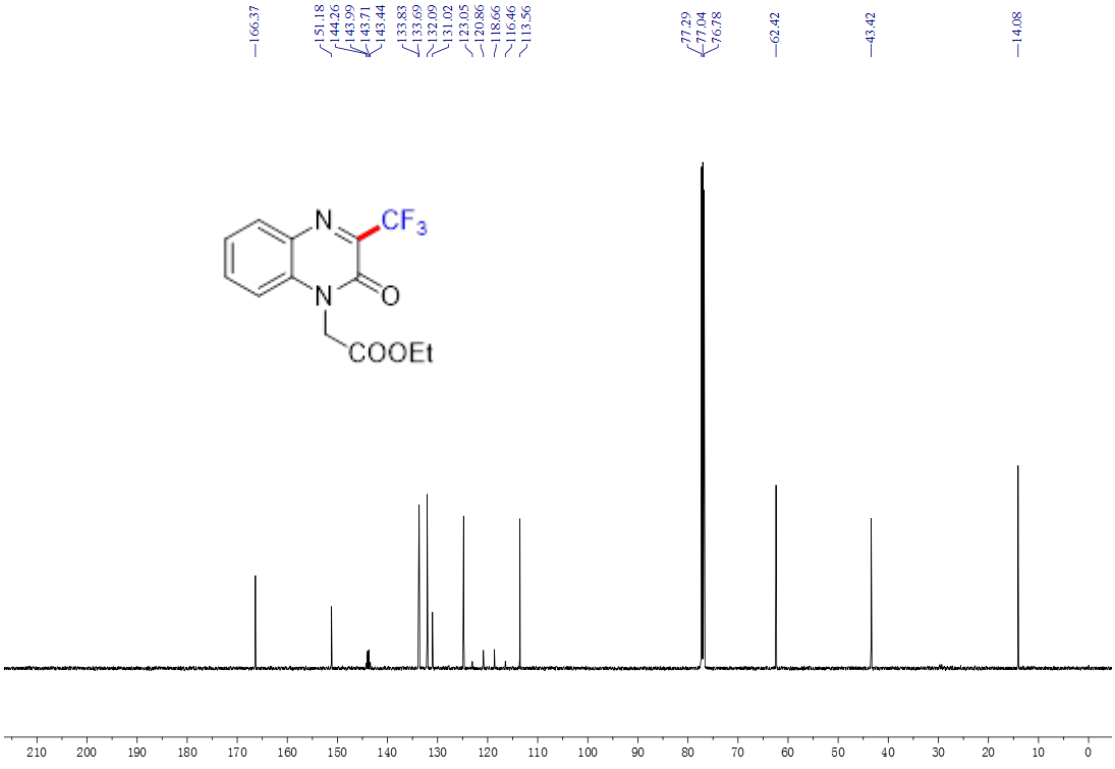
^{1}H NMR spectrum of compound 5b



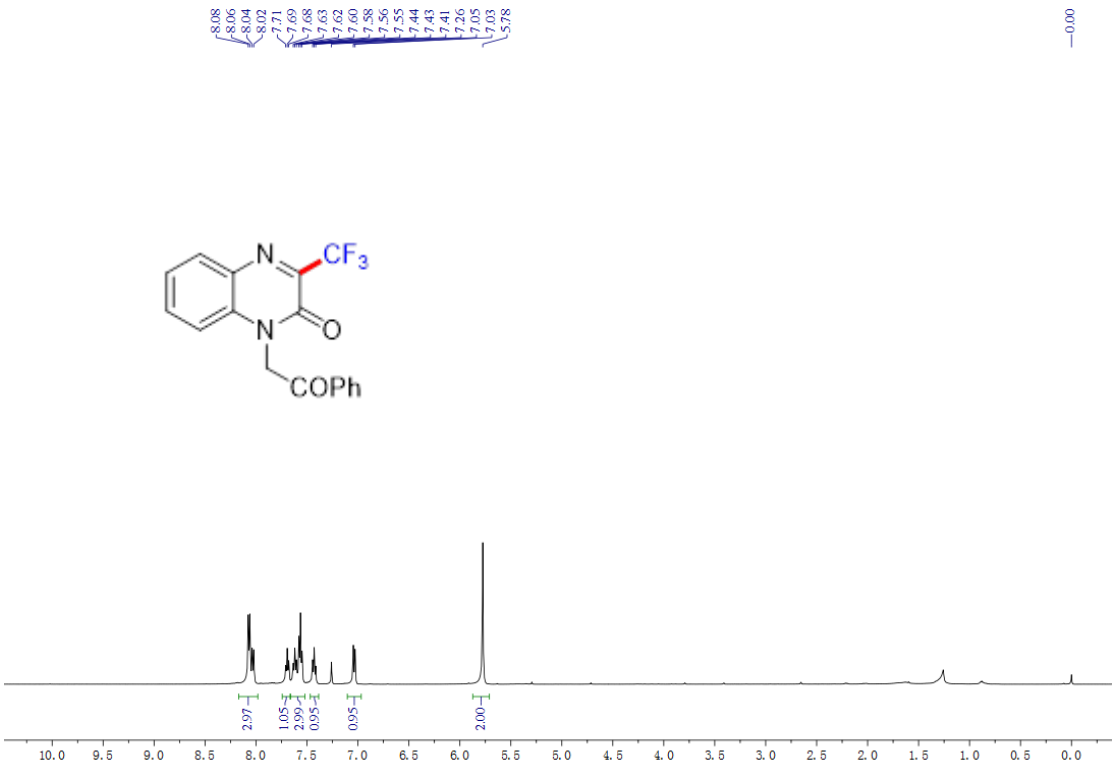
^{13}C NMR spectrum of compound 5b



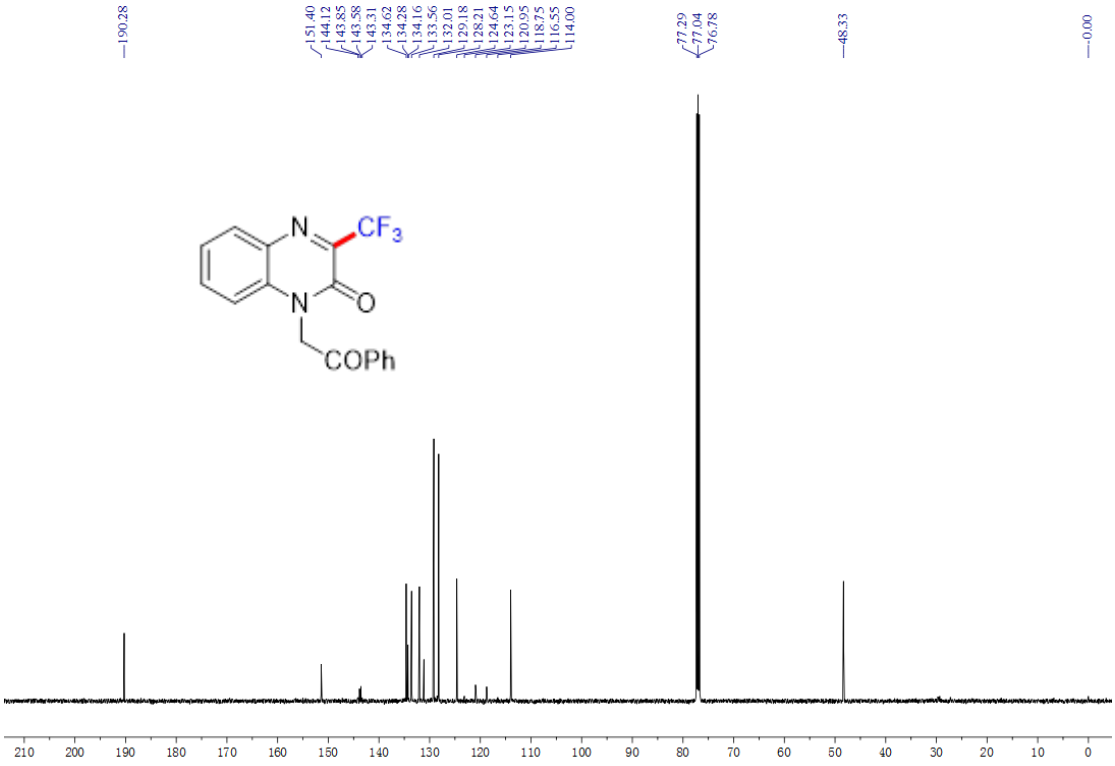
^{1}H NMR spectrum of compound 5c



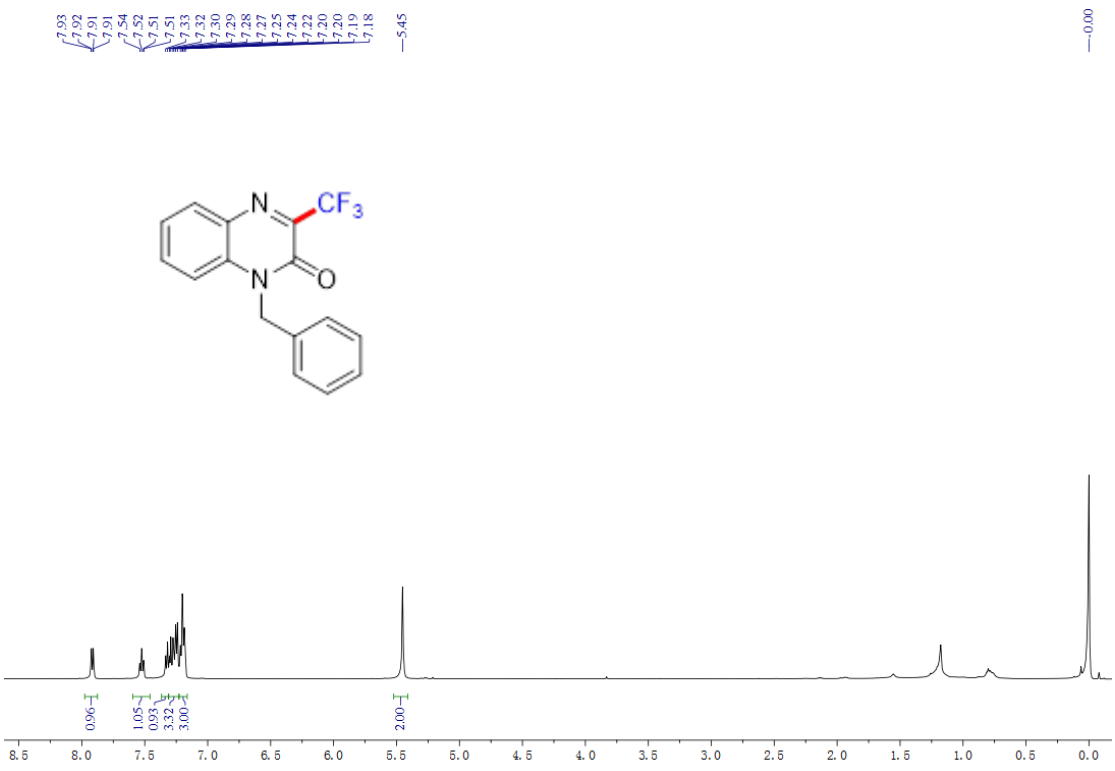
^{13}C NMR spectrum of compound 5c



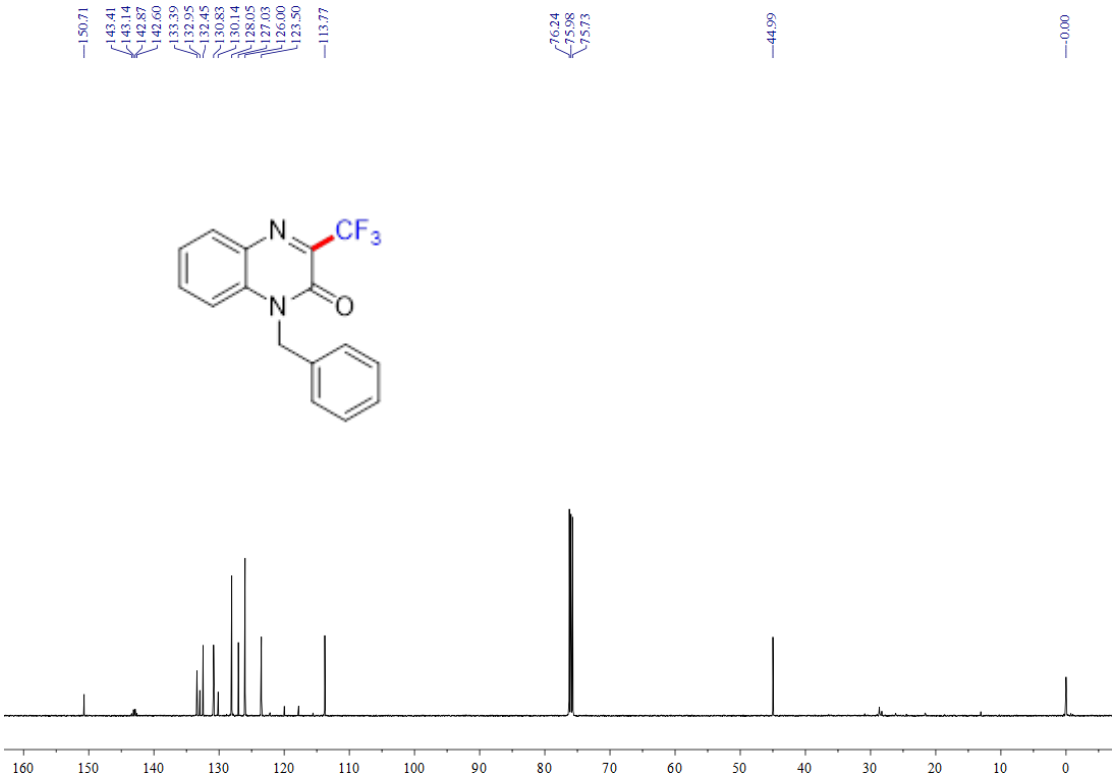
^{1}H NMR spectrum of compound 5d



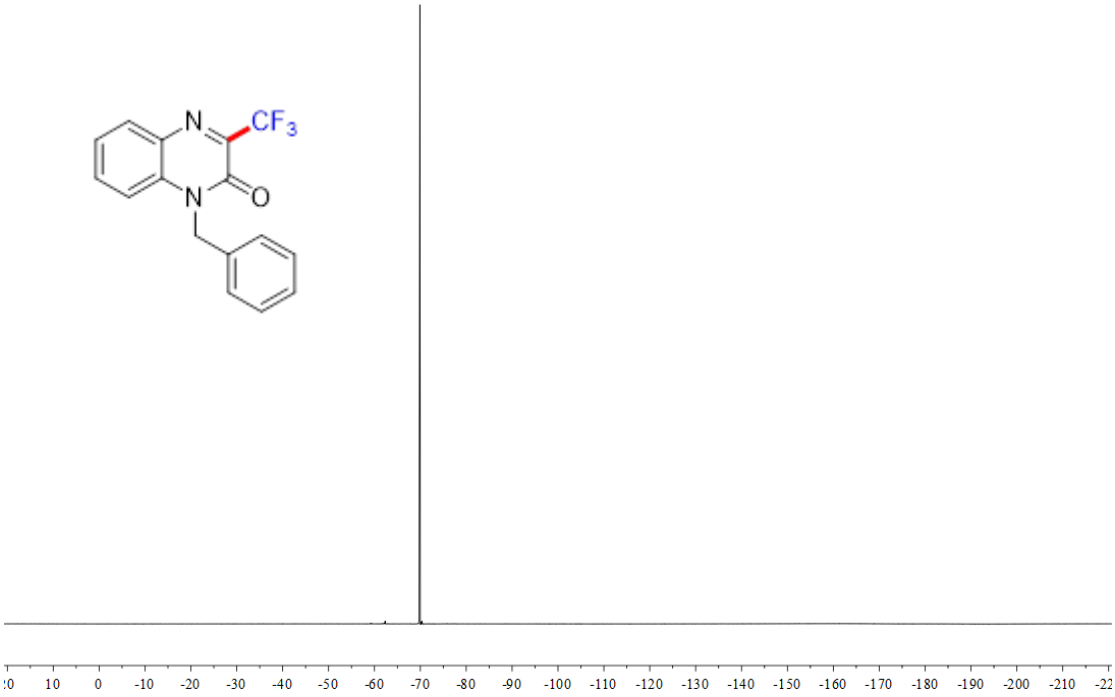
^{13}C NMR spectrum of compound 5d



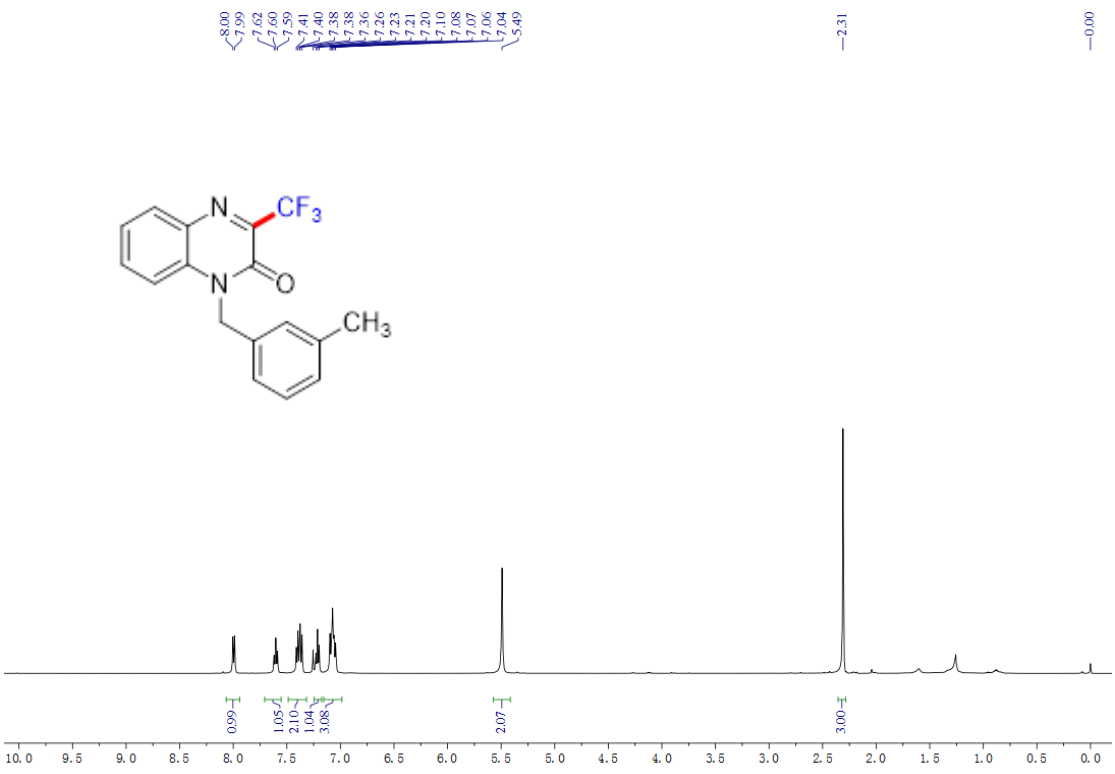
^{1}H NMR spectrum of compound 5e



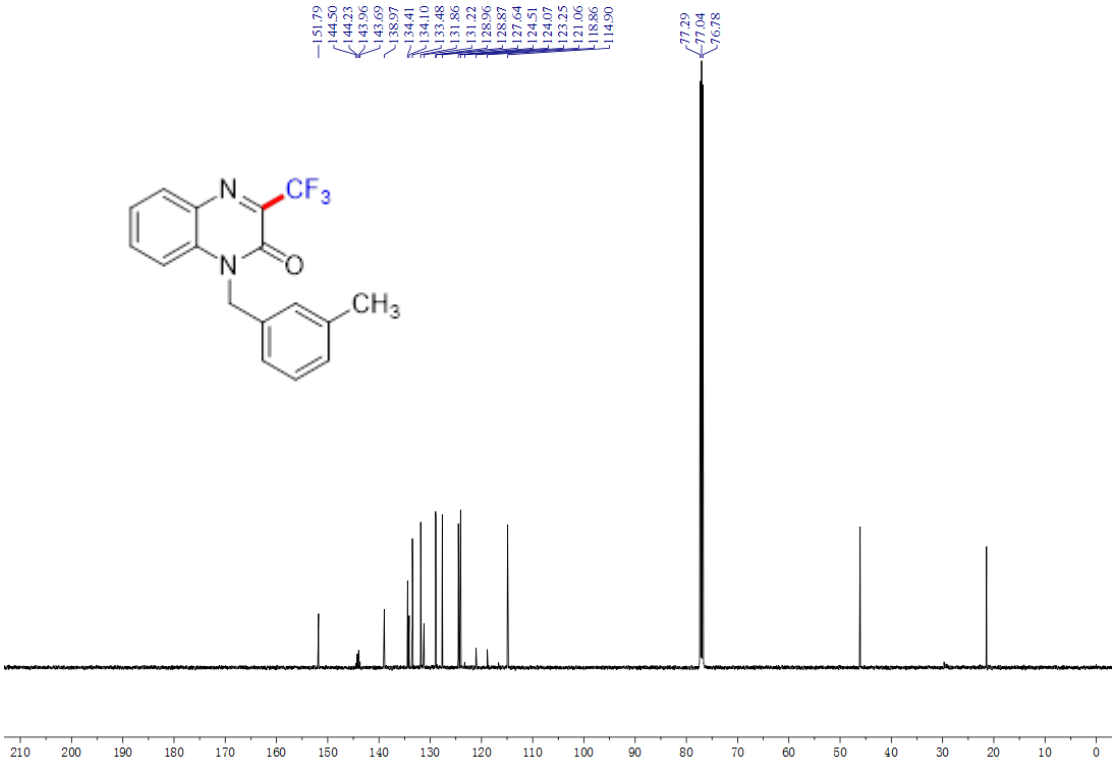
^{13}C NMR spectrum of compound 5e



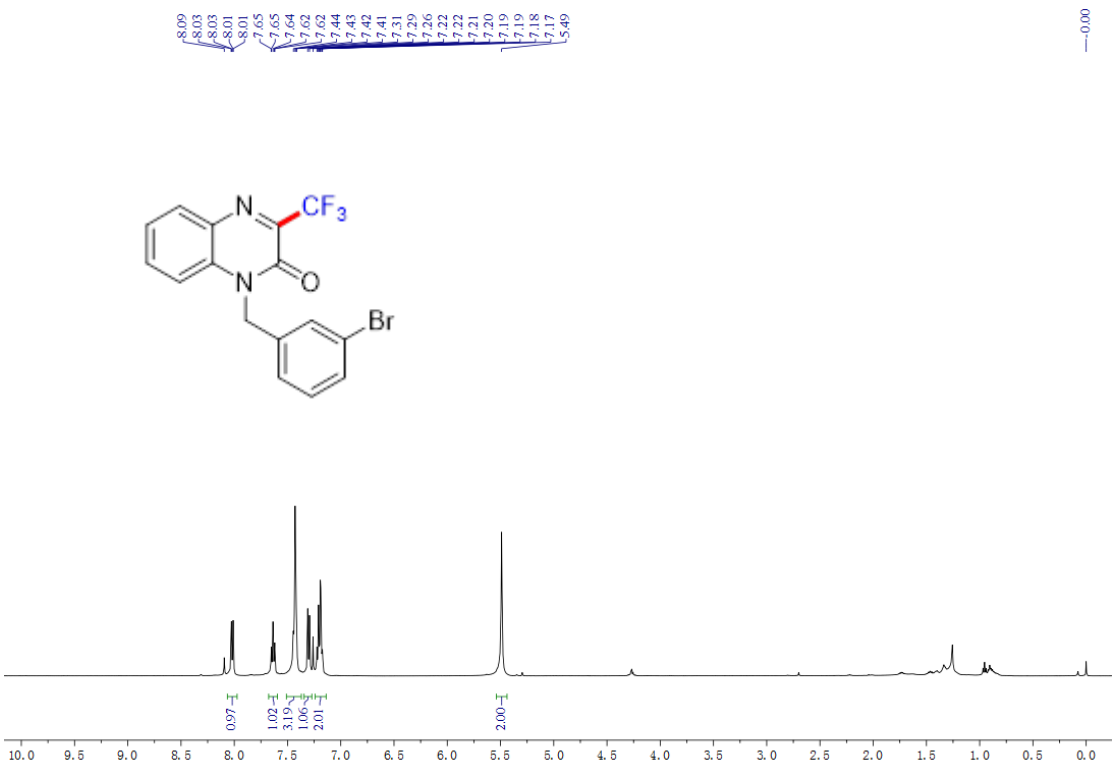
^{19}F NMR spectrum of compound 5e



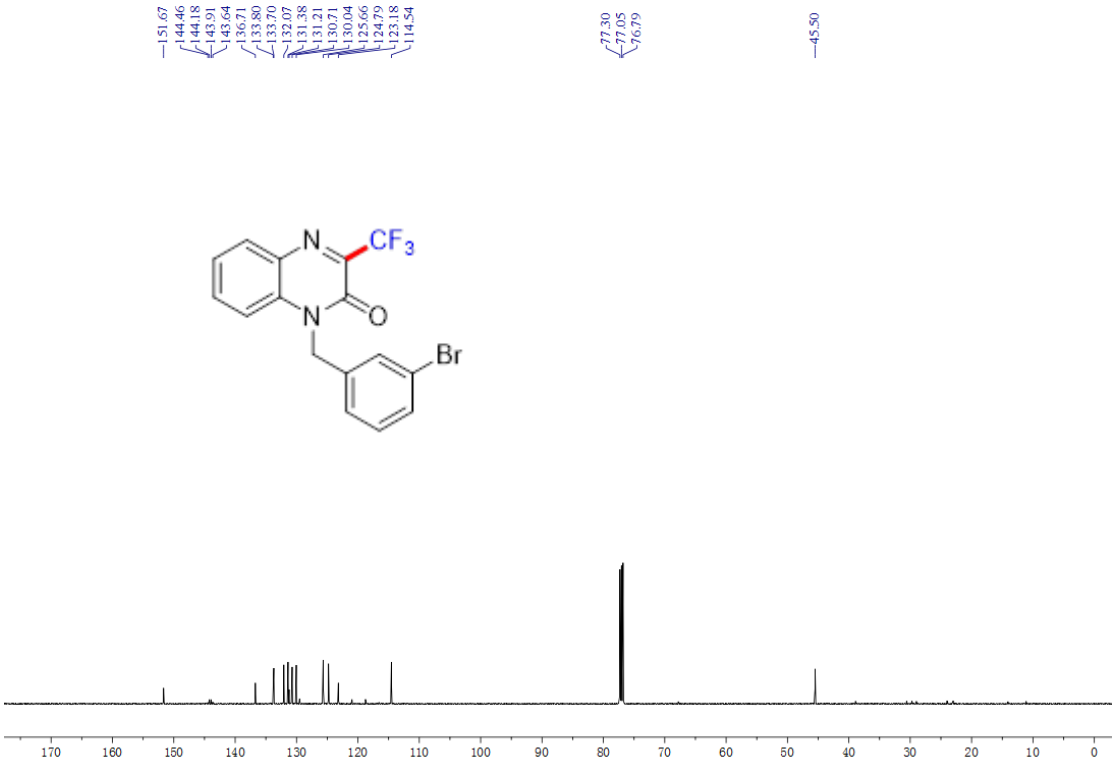
^{1}H NMR spectrum of compound 5f



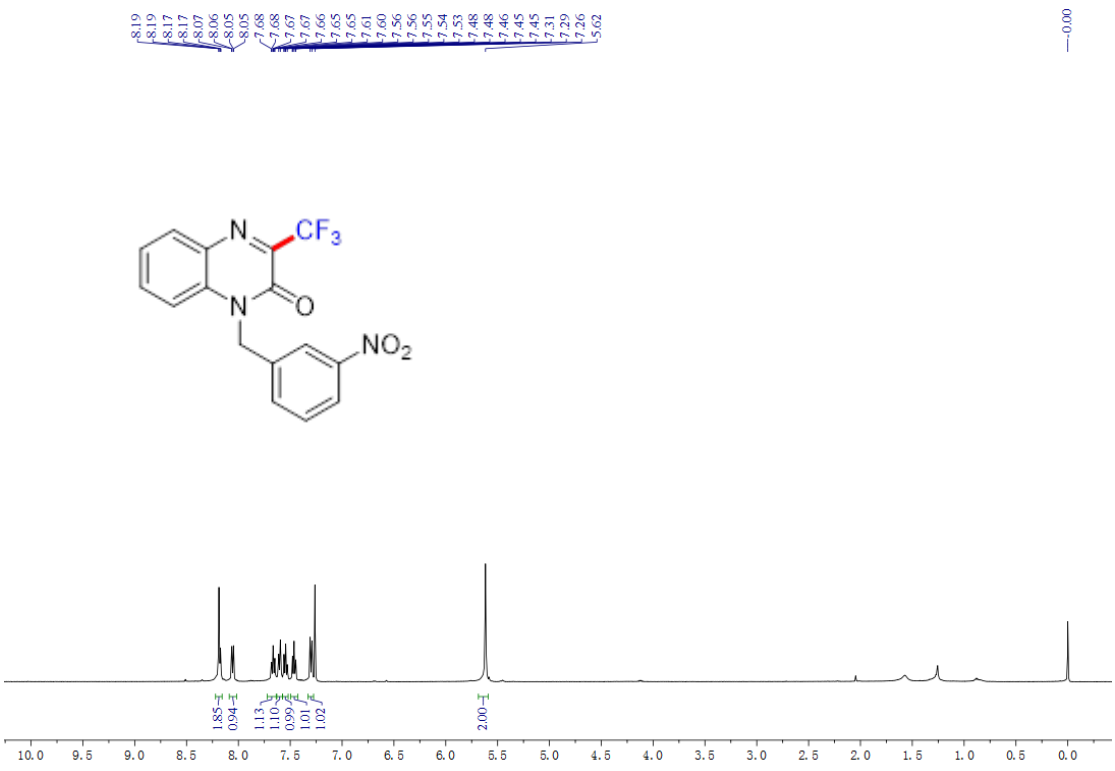
^{13}C NMR spectrum of compound 5f



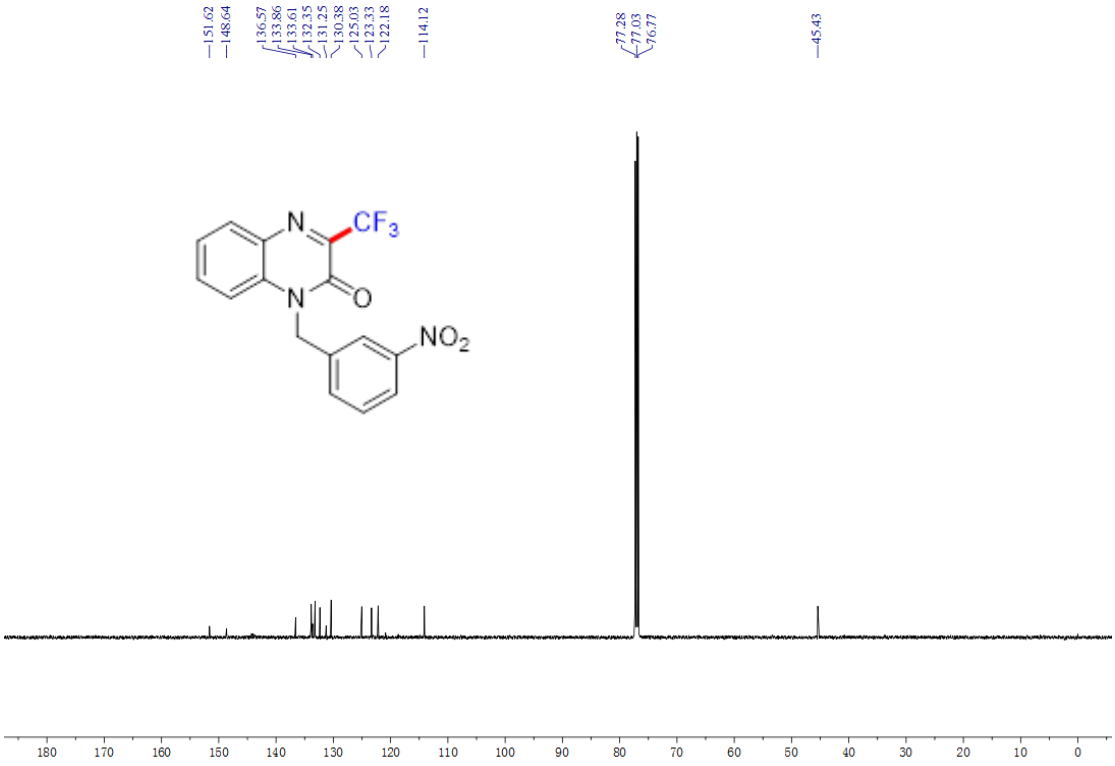
^{1}H NMR spectrum of compound 5g



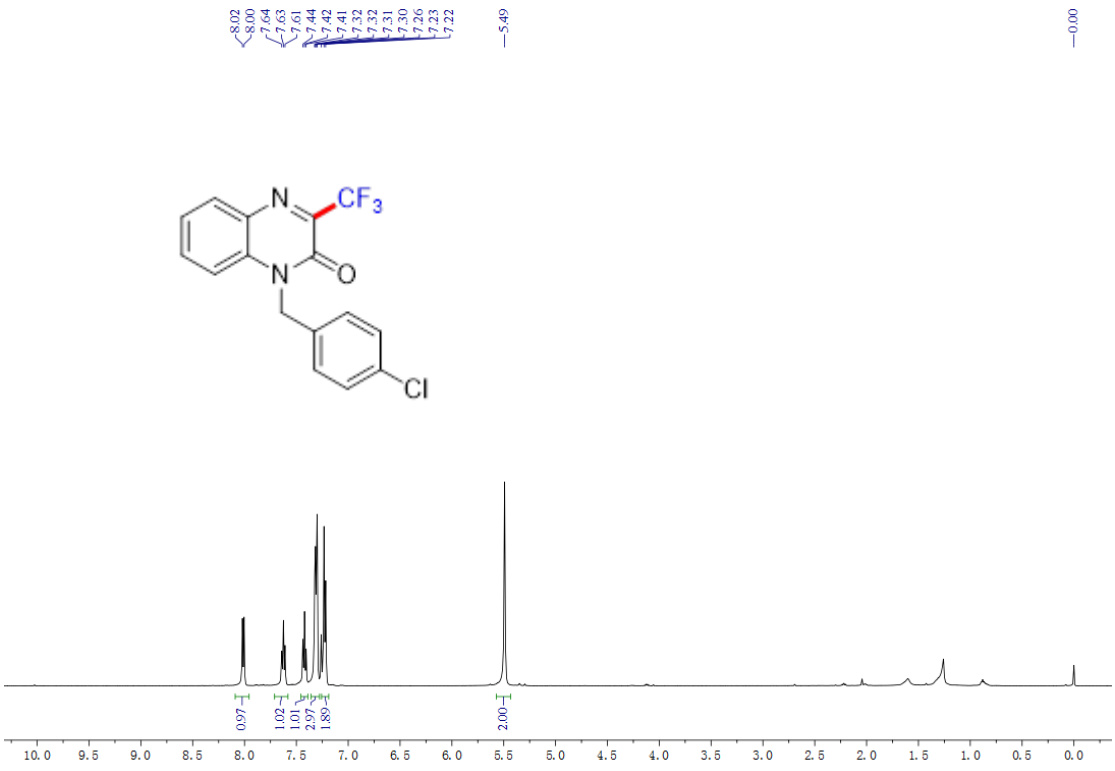
^{13}C NMR spectrum of compound 5g



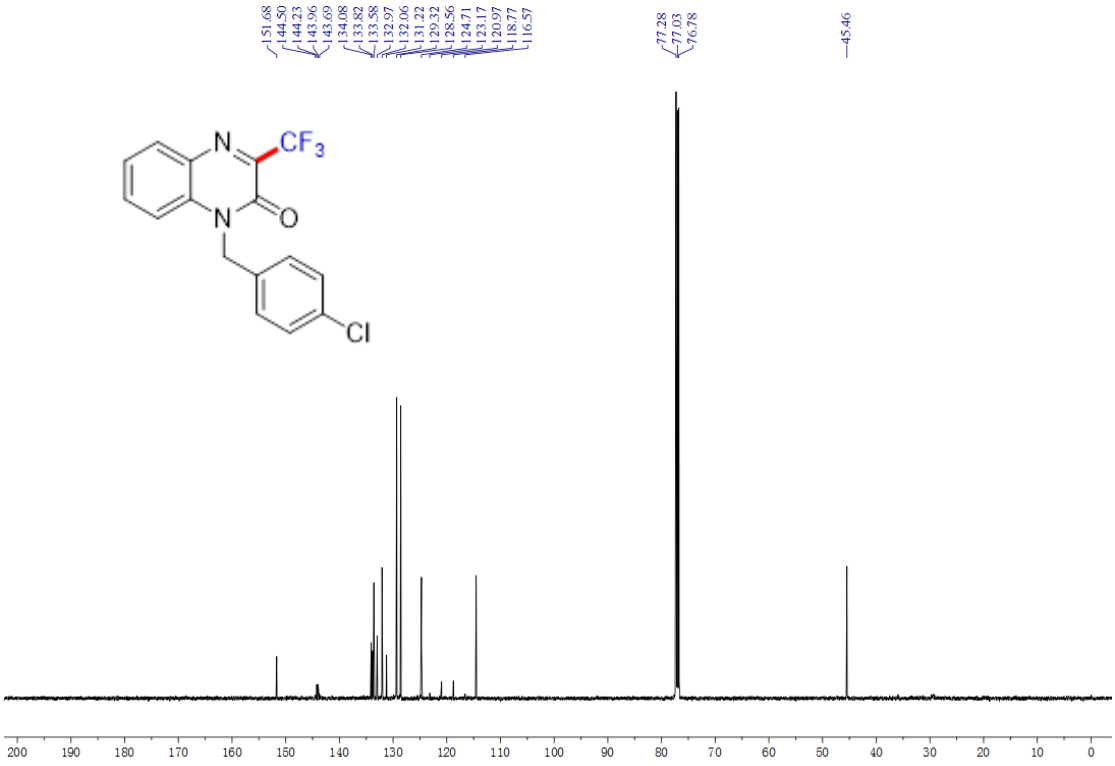
^{1}H NMR spectrum of compound 5h



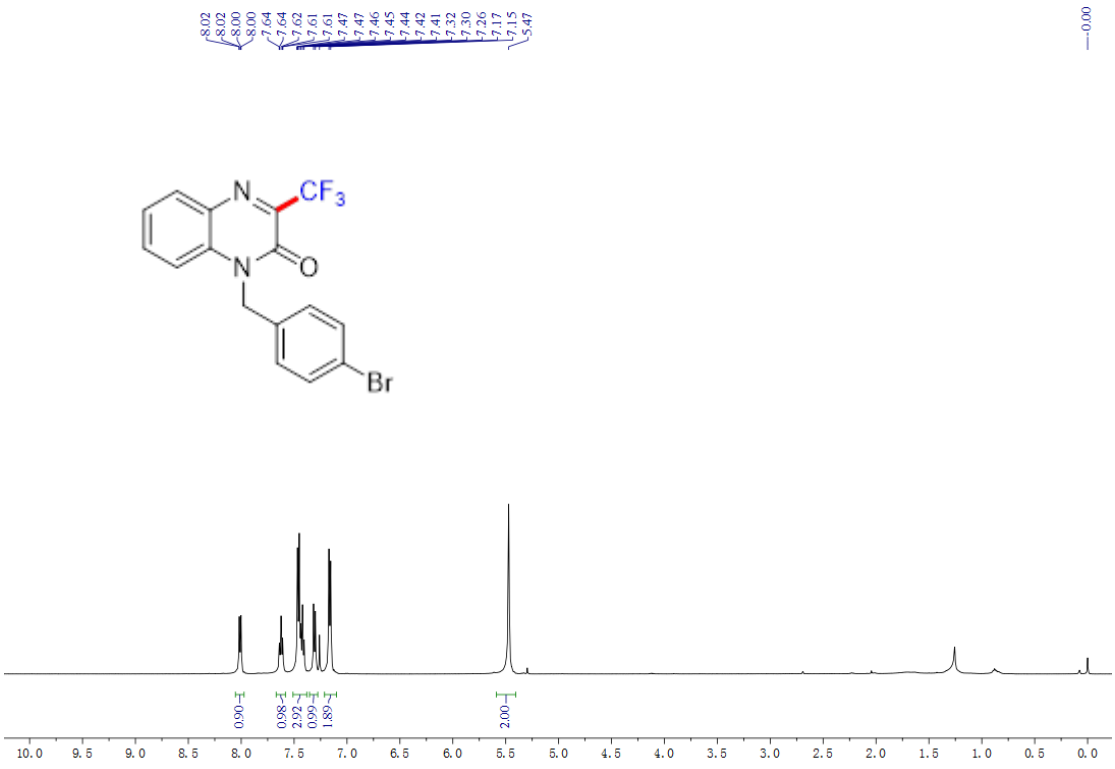
^{13}C NMR spectrum of compound 5h



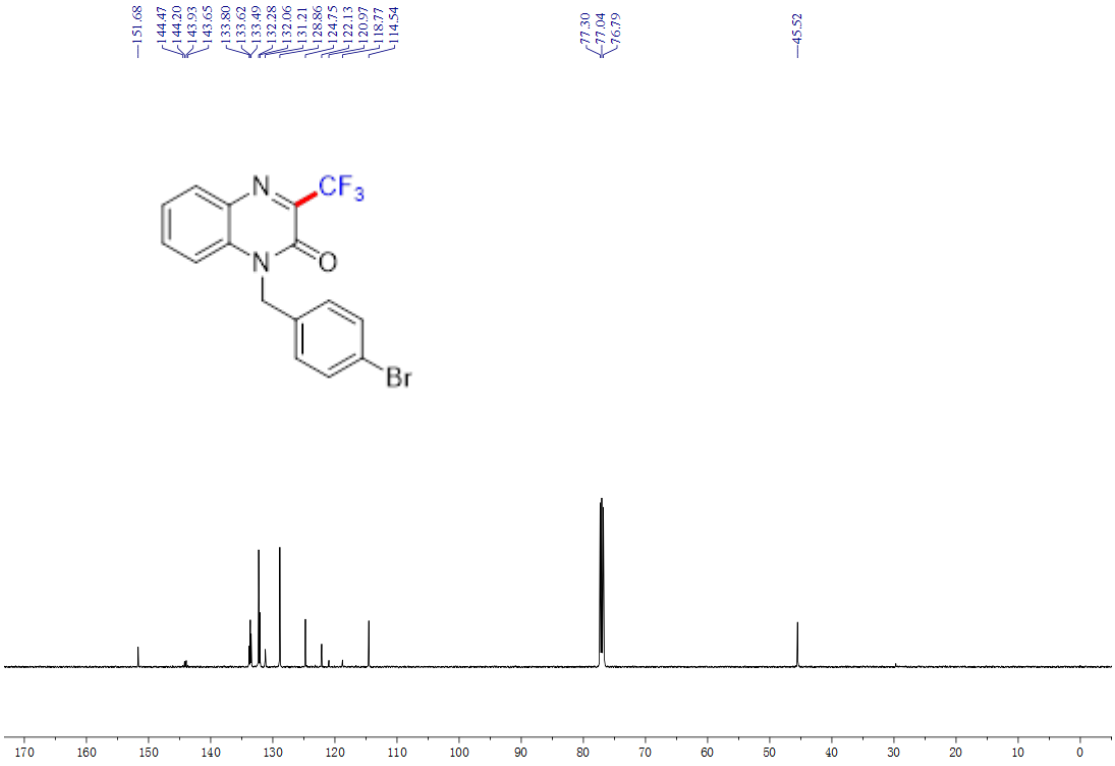
^{1}H NMR spectrum of compound 5i



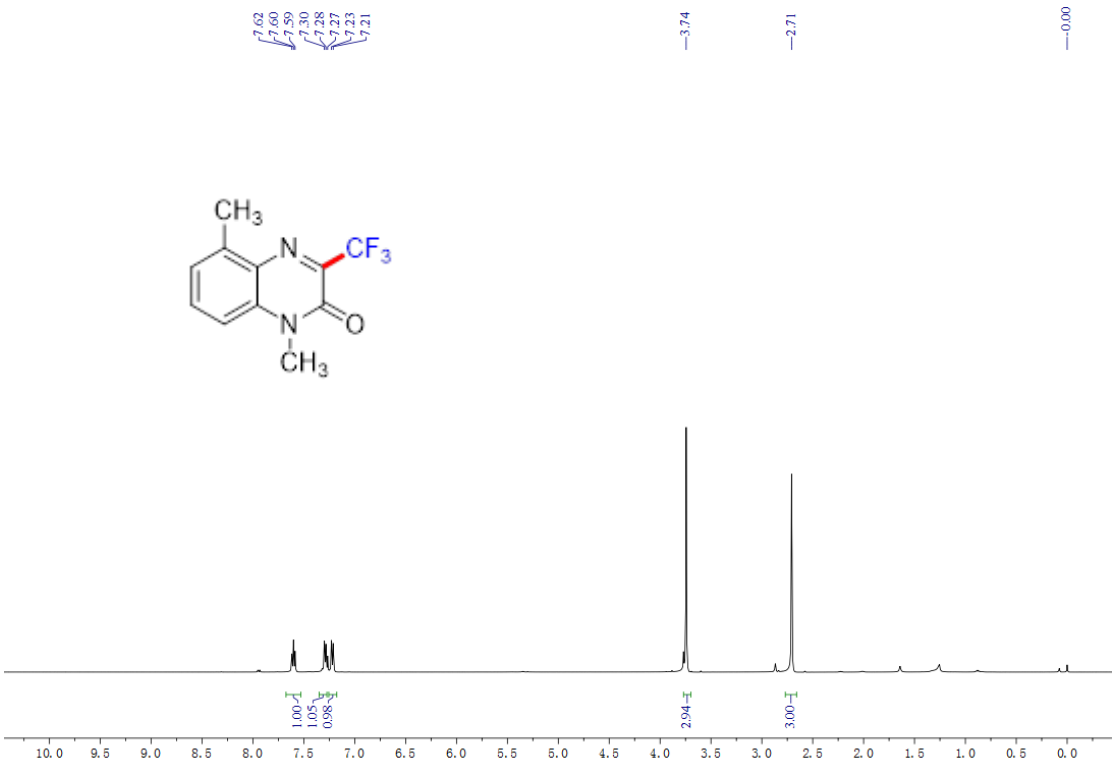
^{13}C NMR spectrum of compound 5i



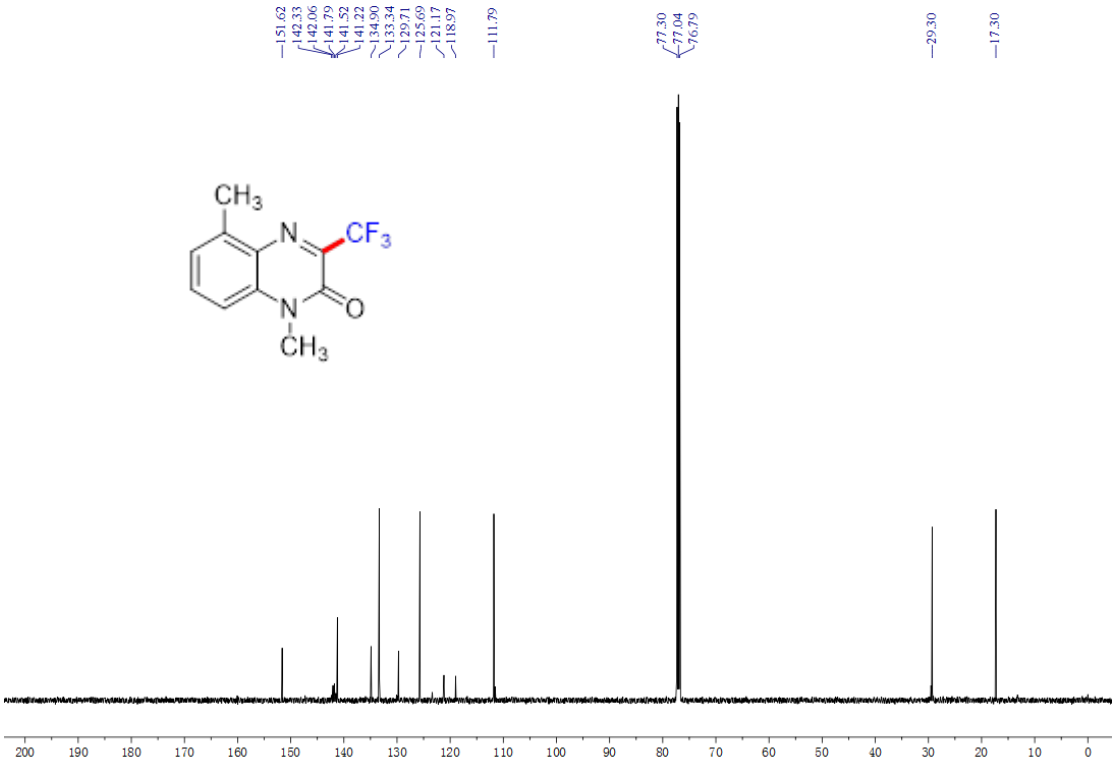
^{1}H NMR spectrum of compound 5j



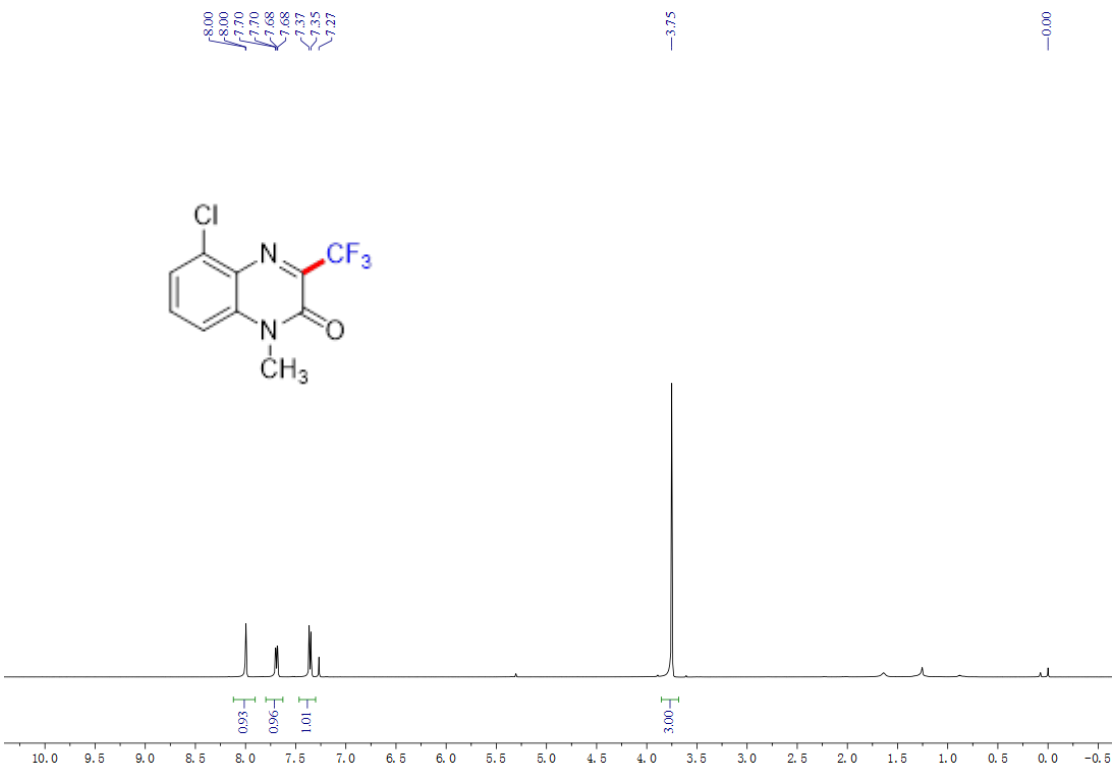
^{13}C NMR spectrum of compound 5j



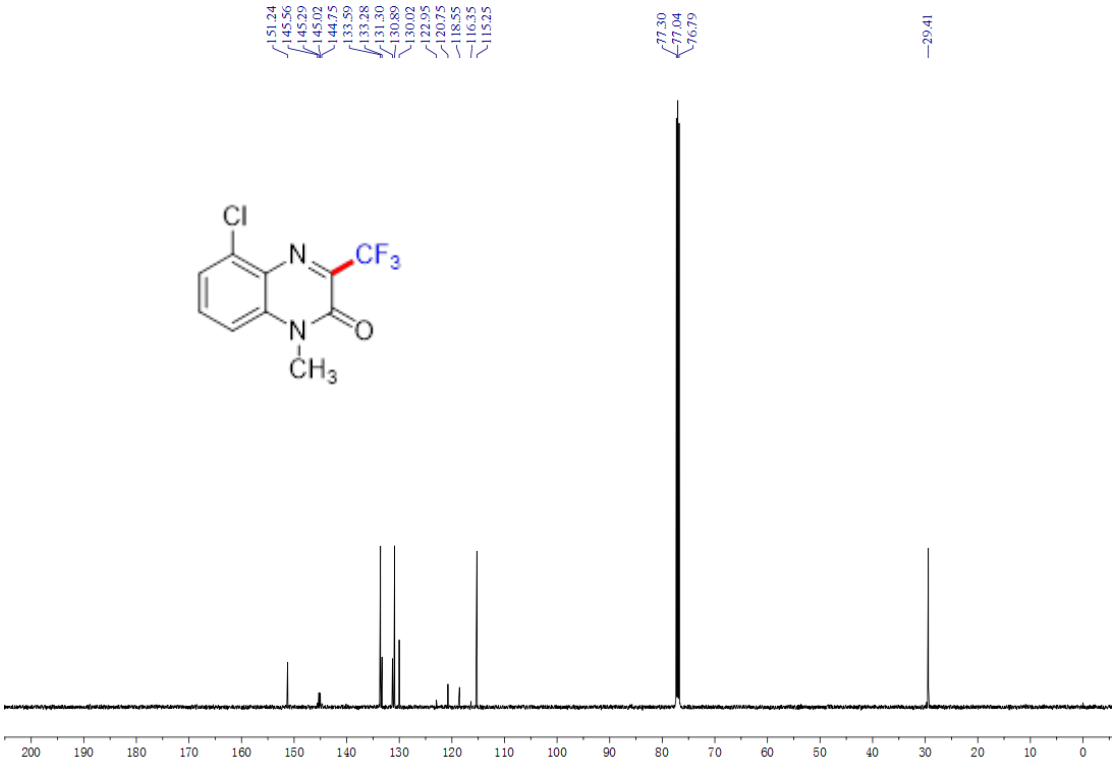
^{1}H NMR spectrum of compound 5k



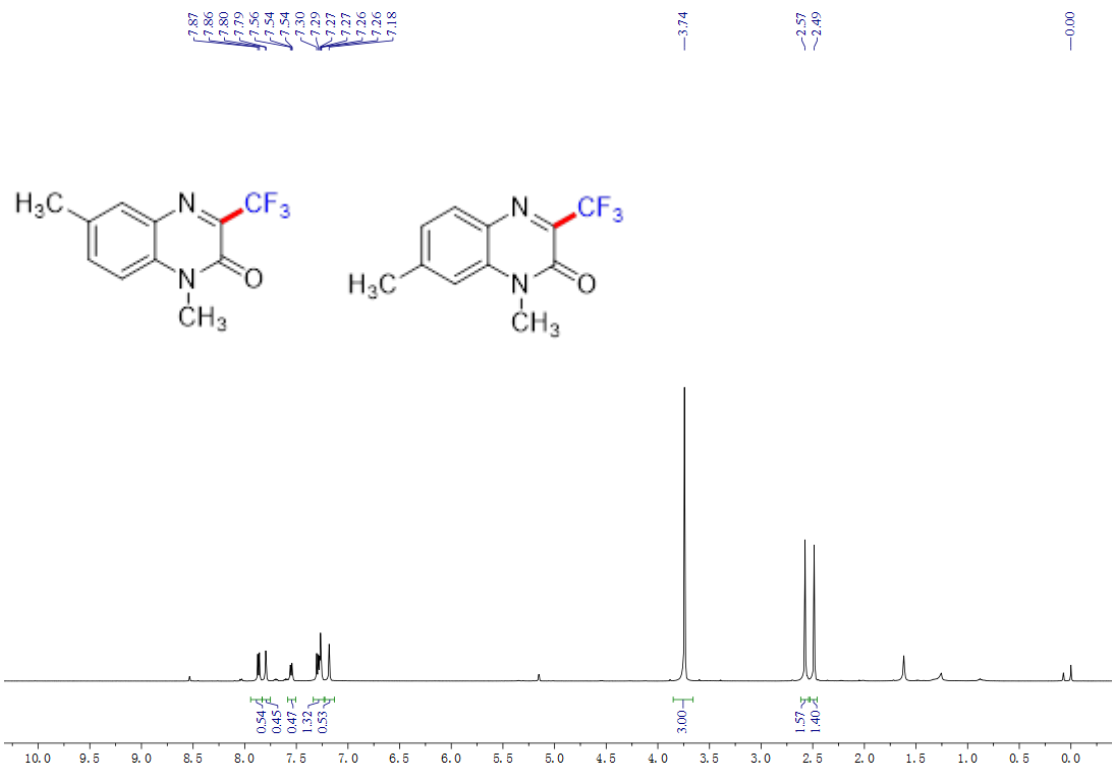
^{13}C NMR spectrum of compound 5k



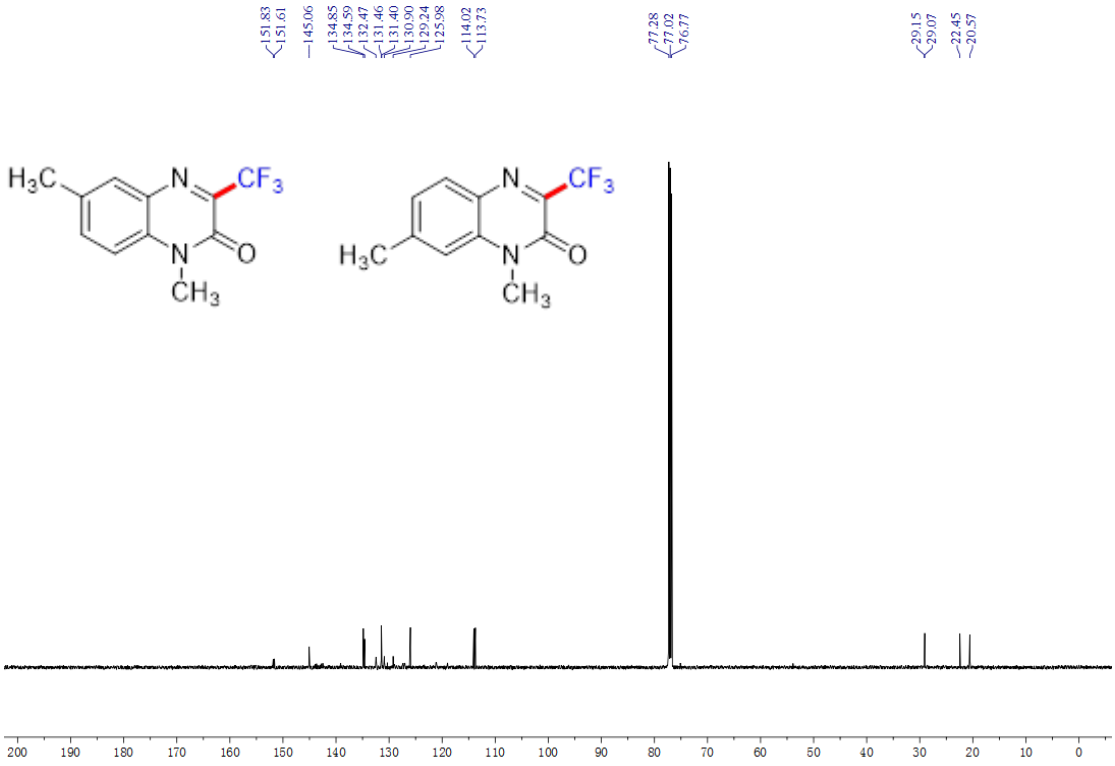
^{1}H NMR spectrum of compound 5l



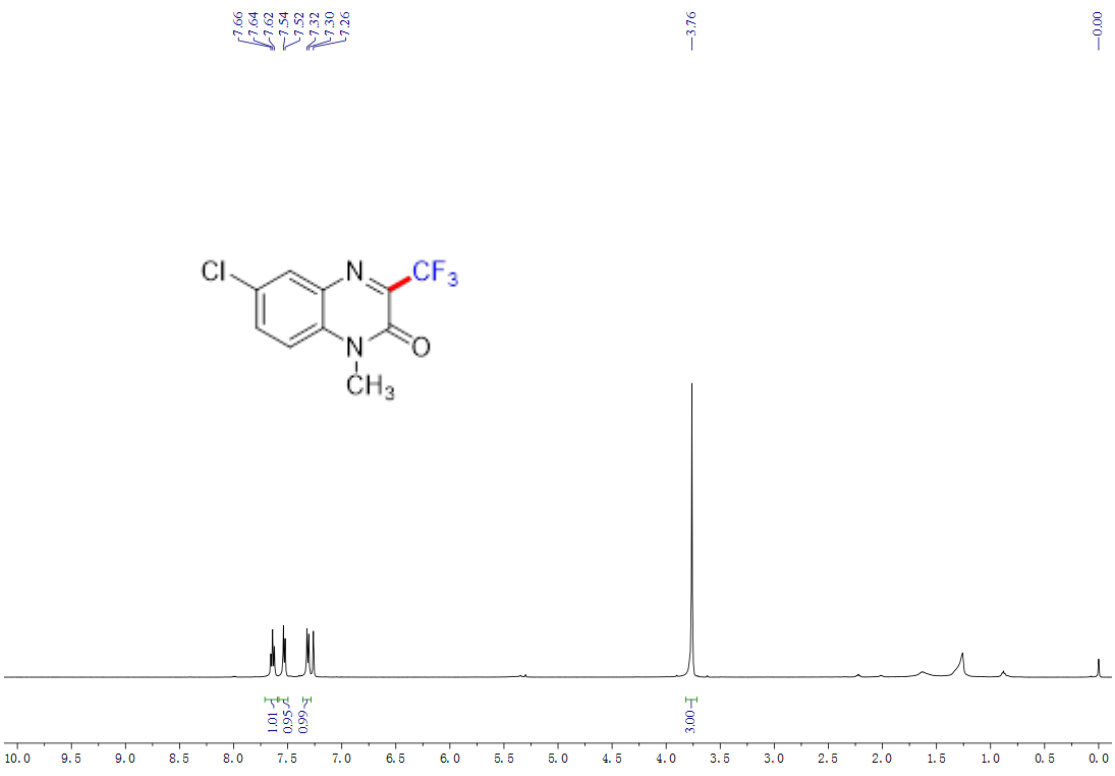
^{13}C NMR spectrum of compound 5l



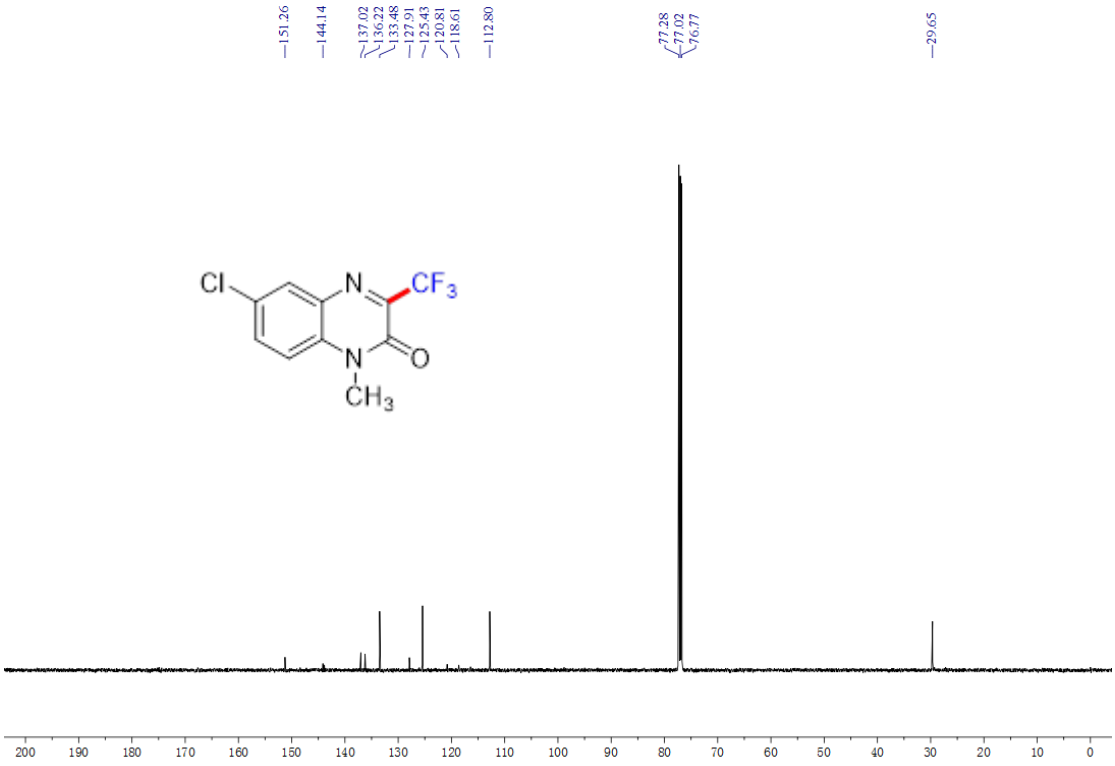
^{1}H NMR spectrum of compound 5m and 5m'



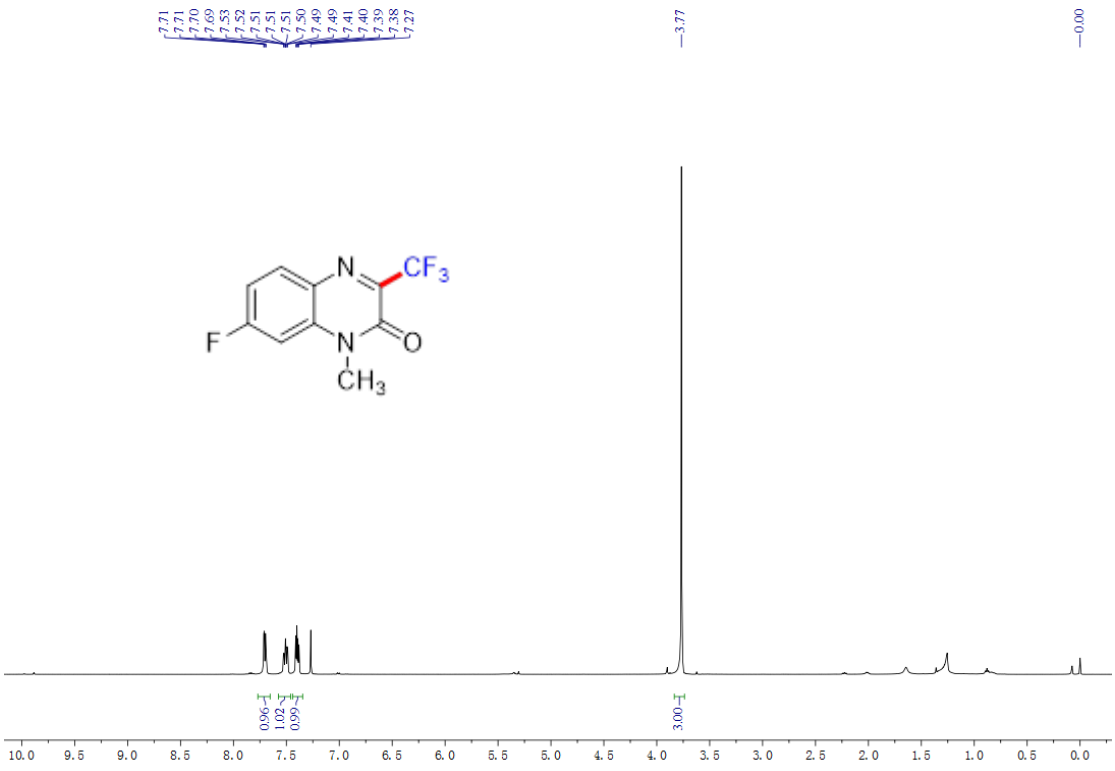
^{13}C NMR spectrum of compound 5m and 5m'



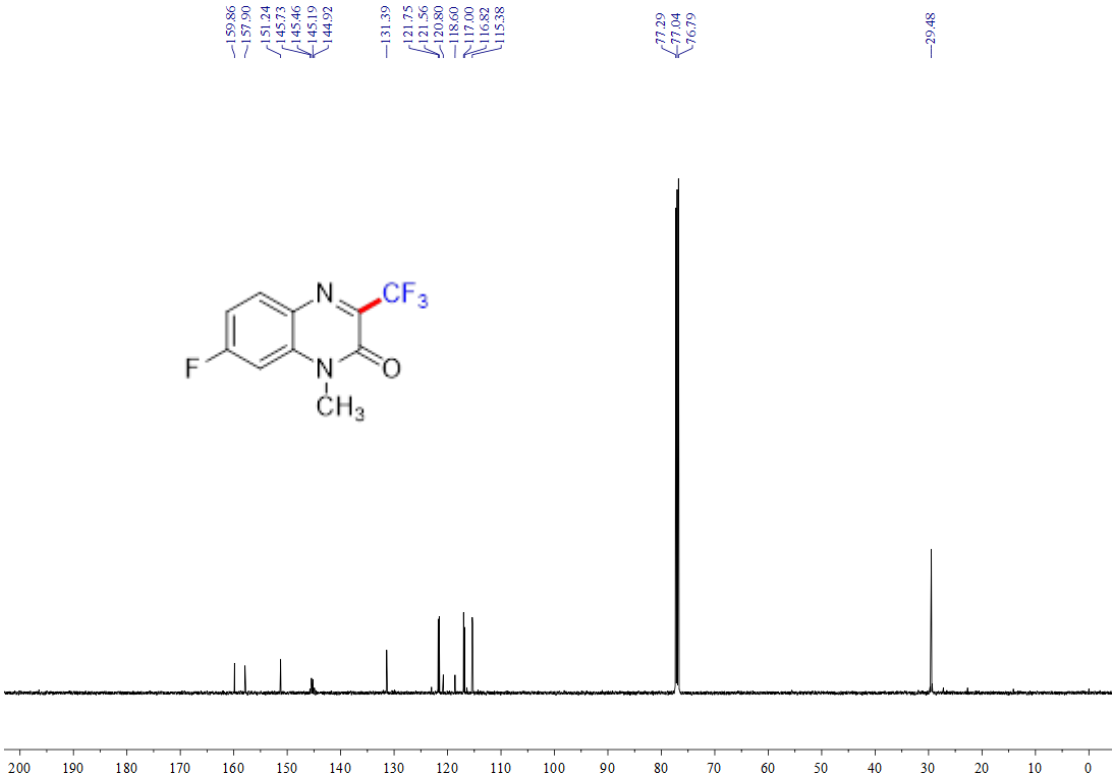
^{1}H NMR spectrum of compound 5n



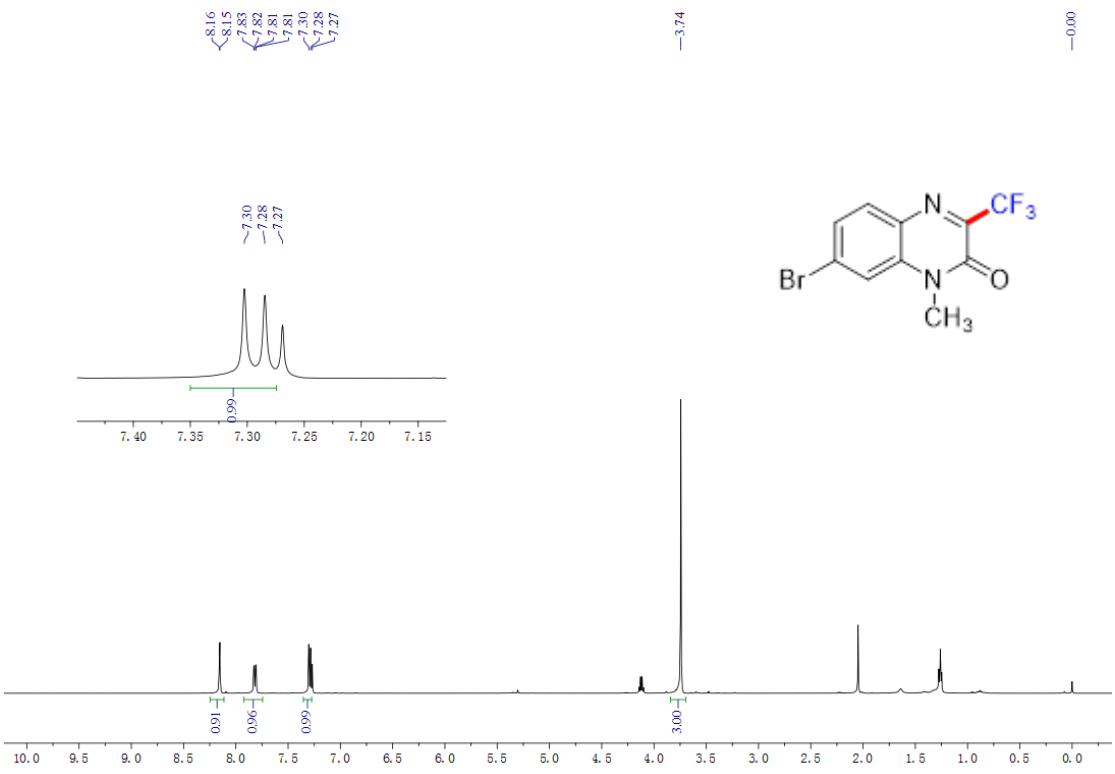
^{13}C NMR spectrum of compound 5n



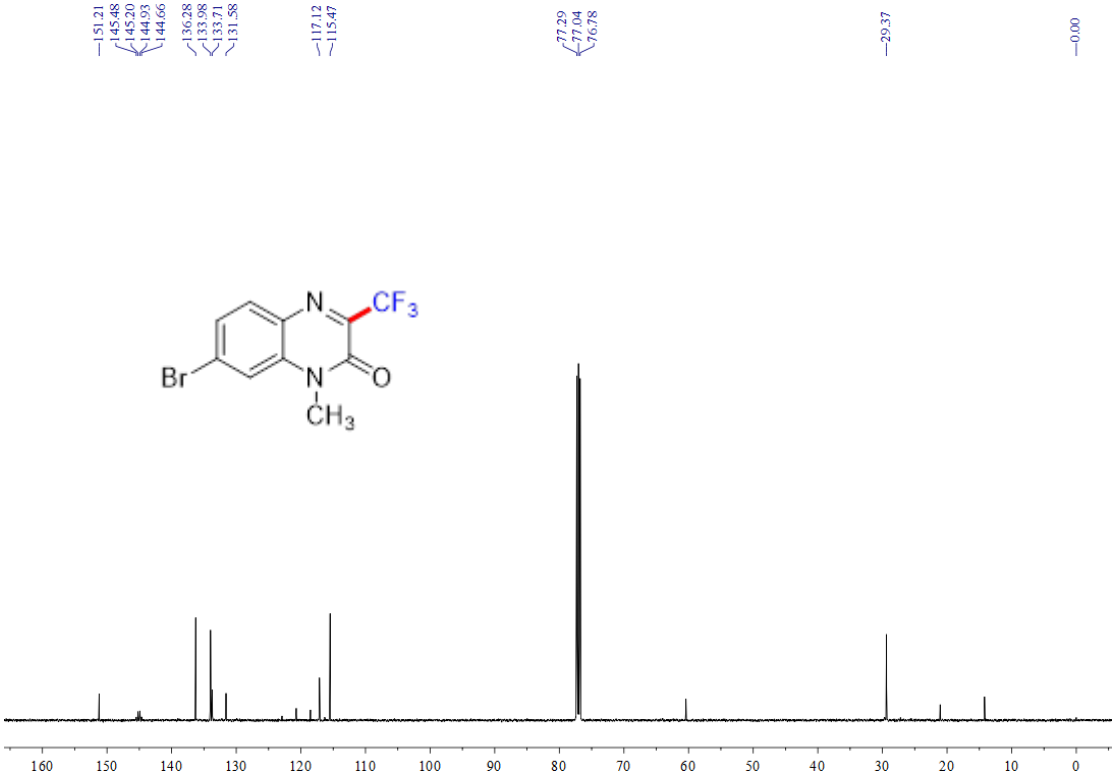
^{1}H NMR spectrum of compound 5o



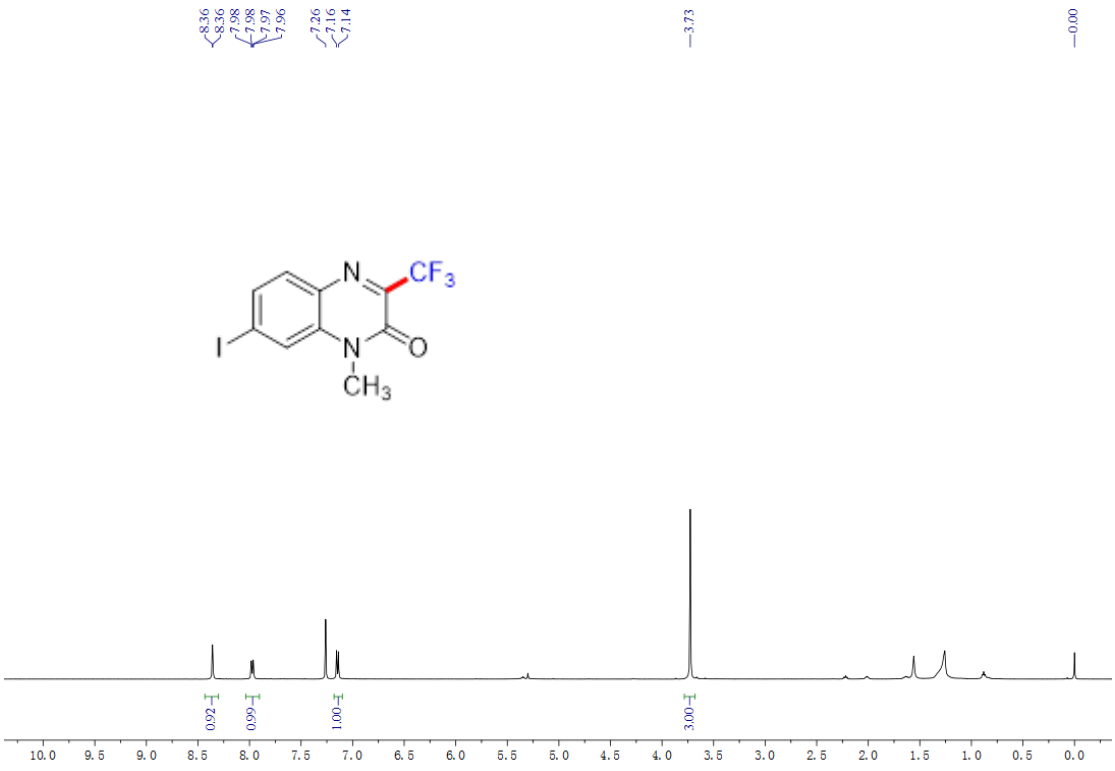
^{13}C NMR spectrum of compound 5o



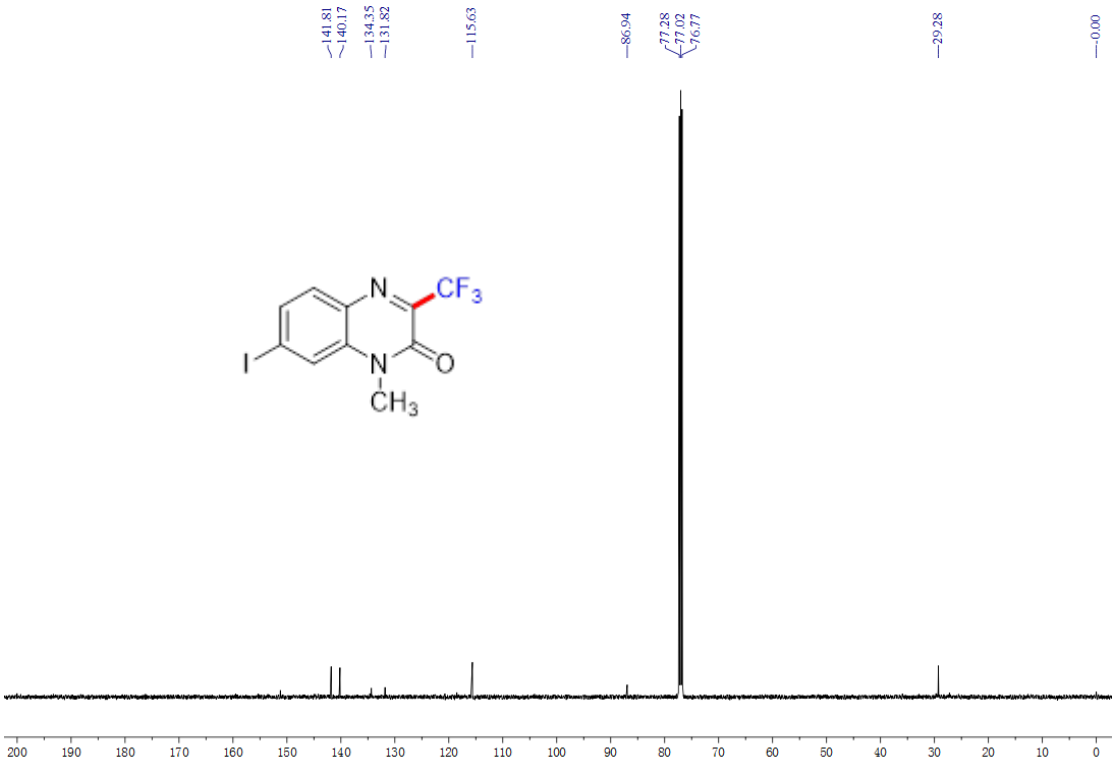
^{1}H NMR spectrum of compound 5p



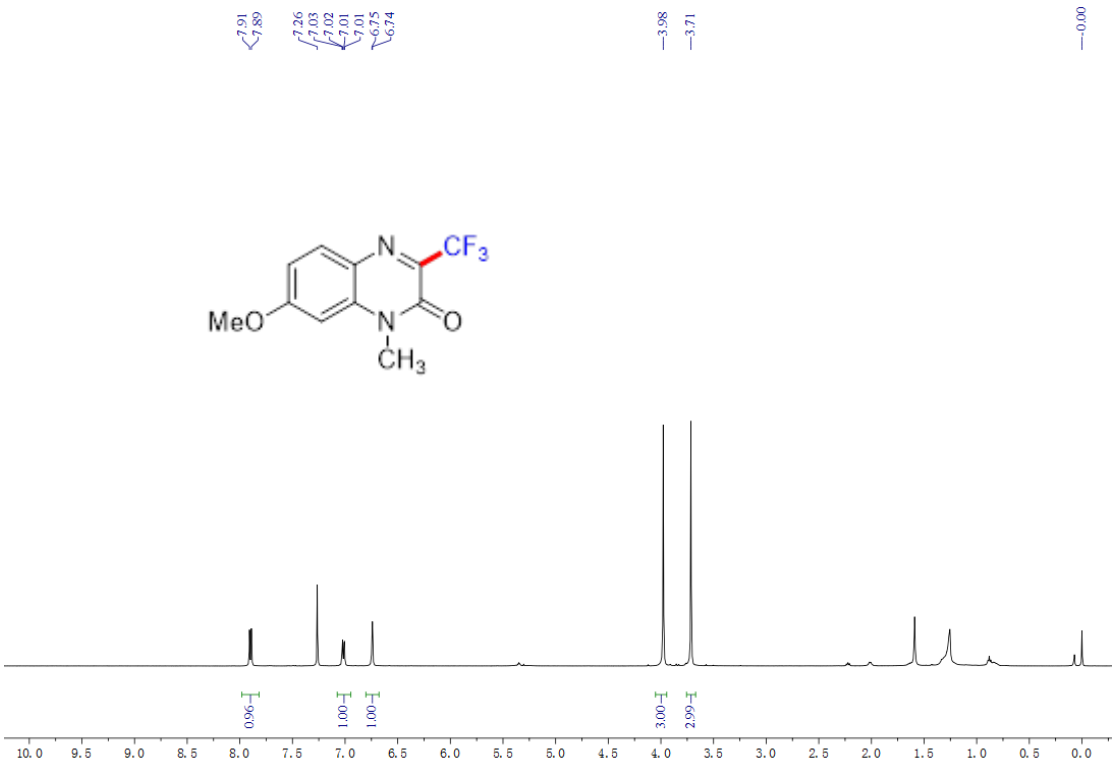
^{13}C NMR spectrum of compound 5p



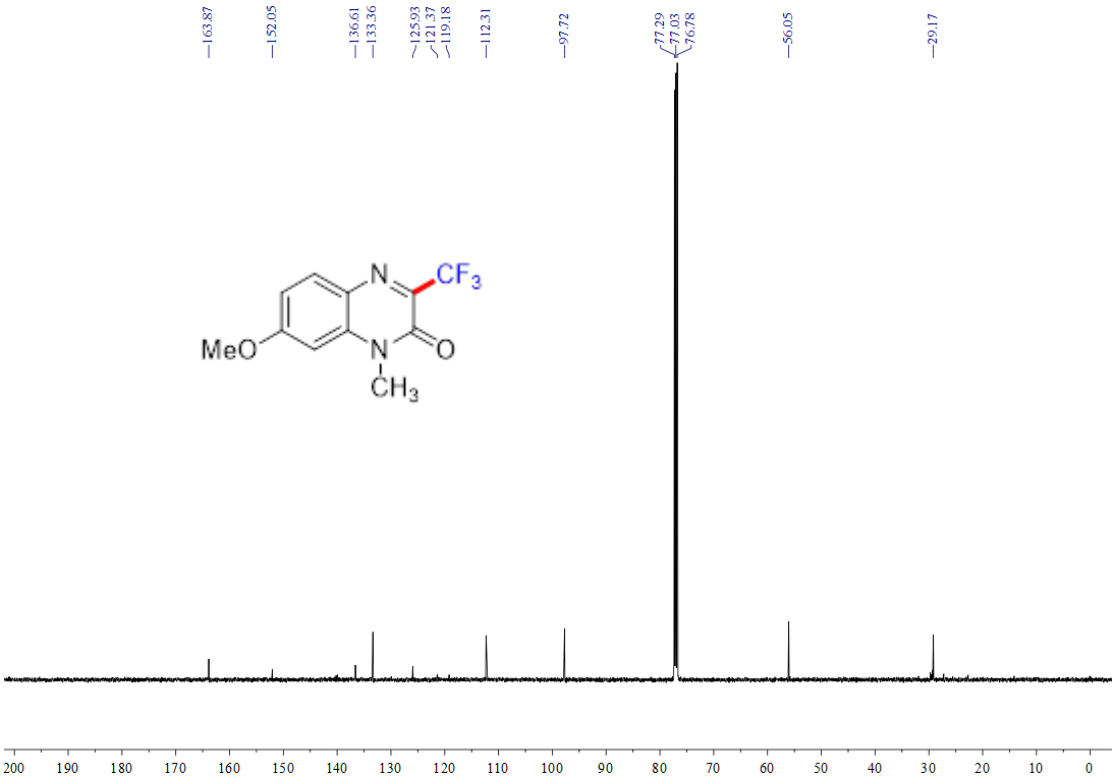
^{1}H NMR spectrum of compound 5q



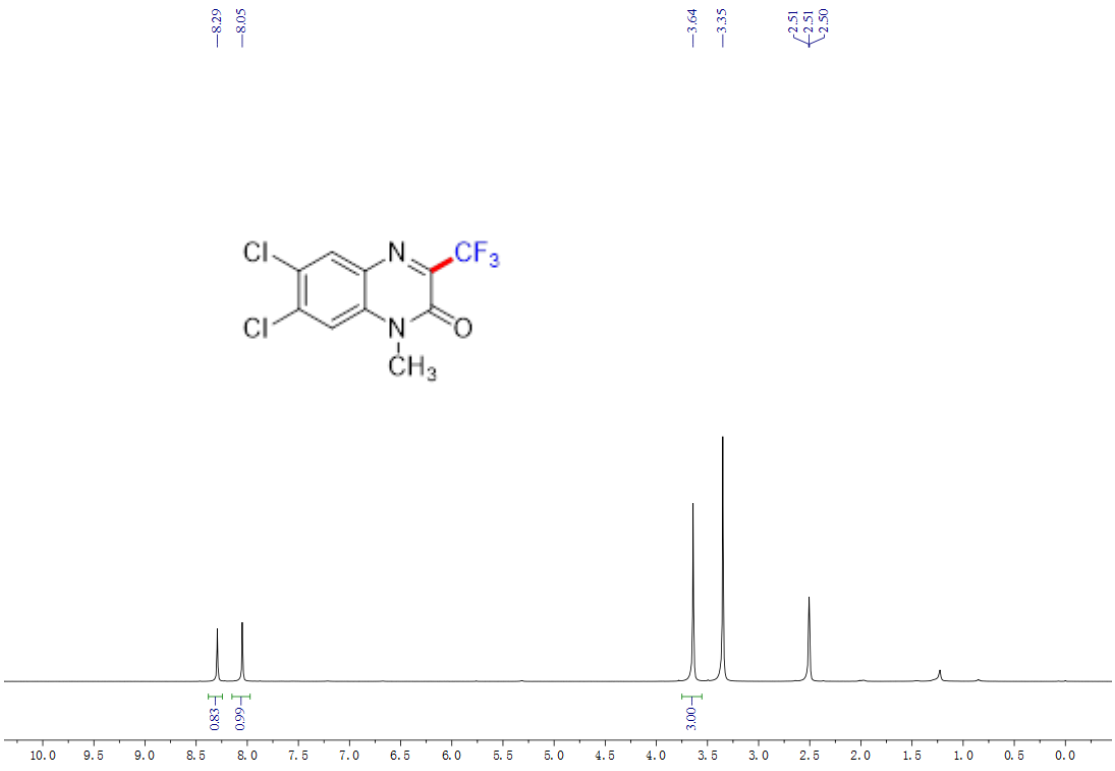
^{13}C NMR spectrum of compound 5q



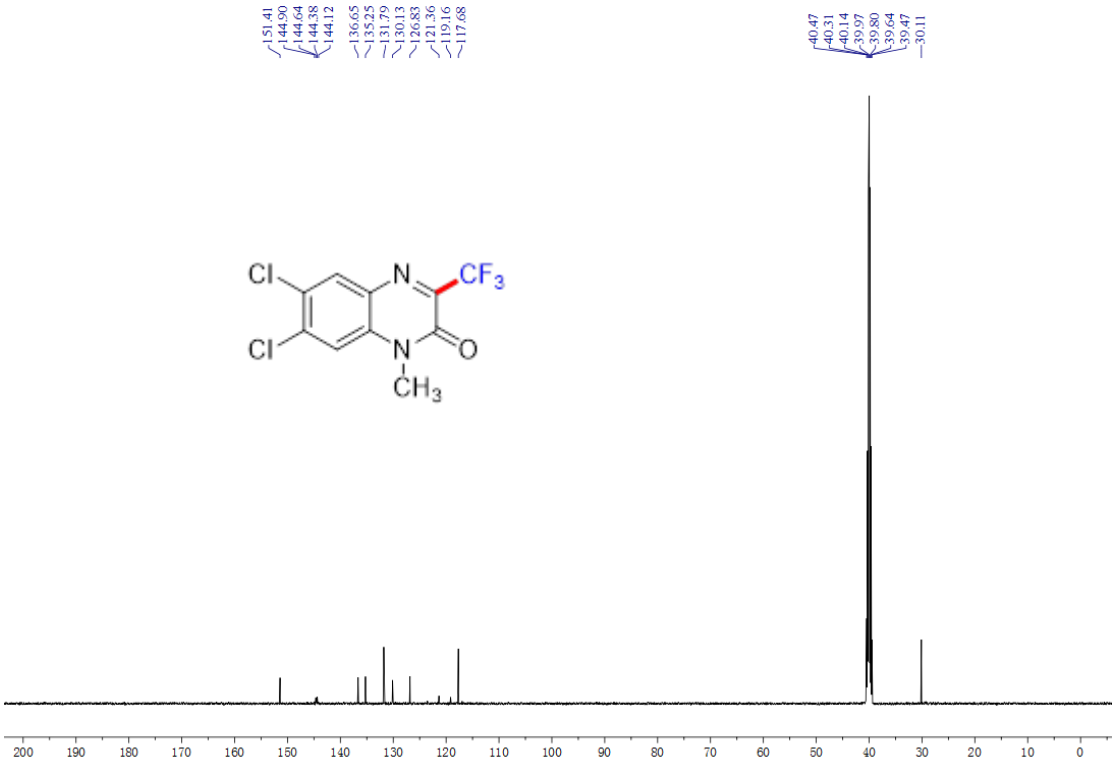
^{1}H NMR spectrum of compound 5r



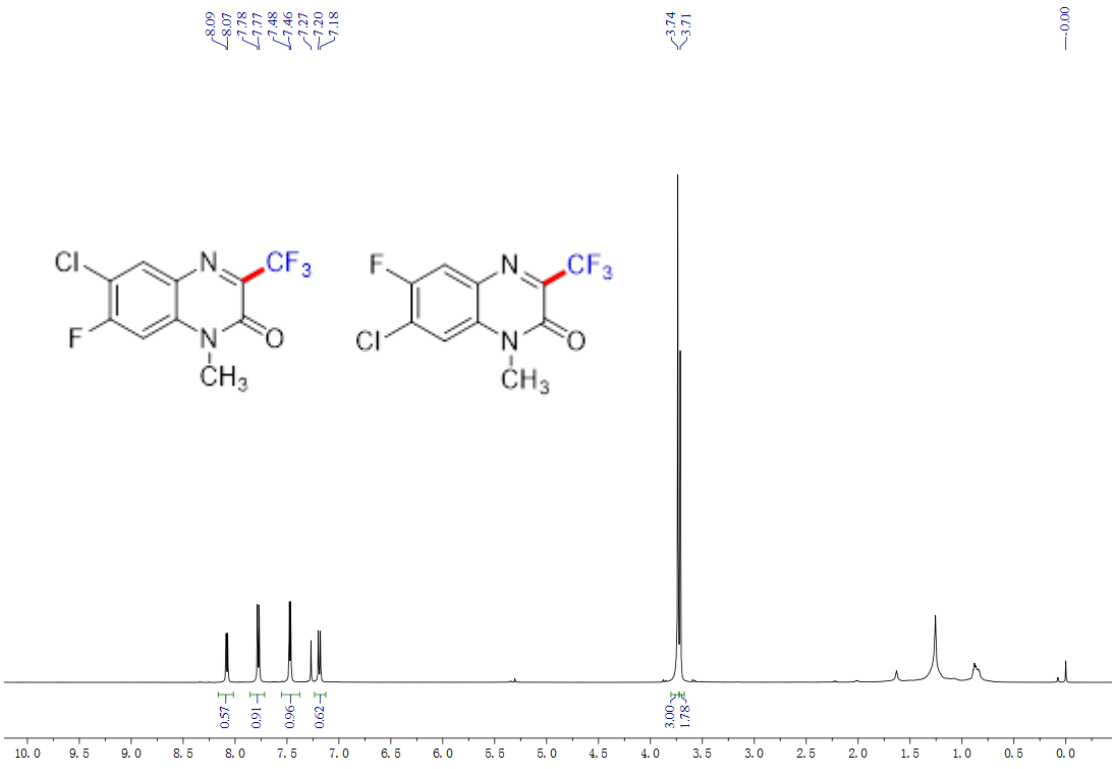
^{13}C NMR spectrum of compound 5r



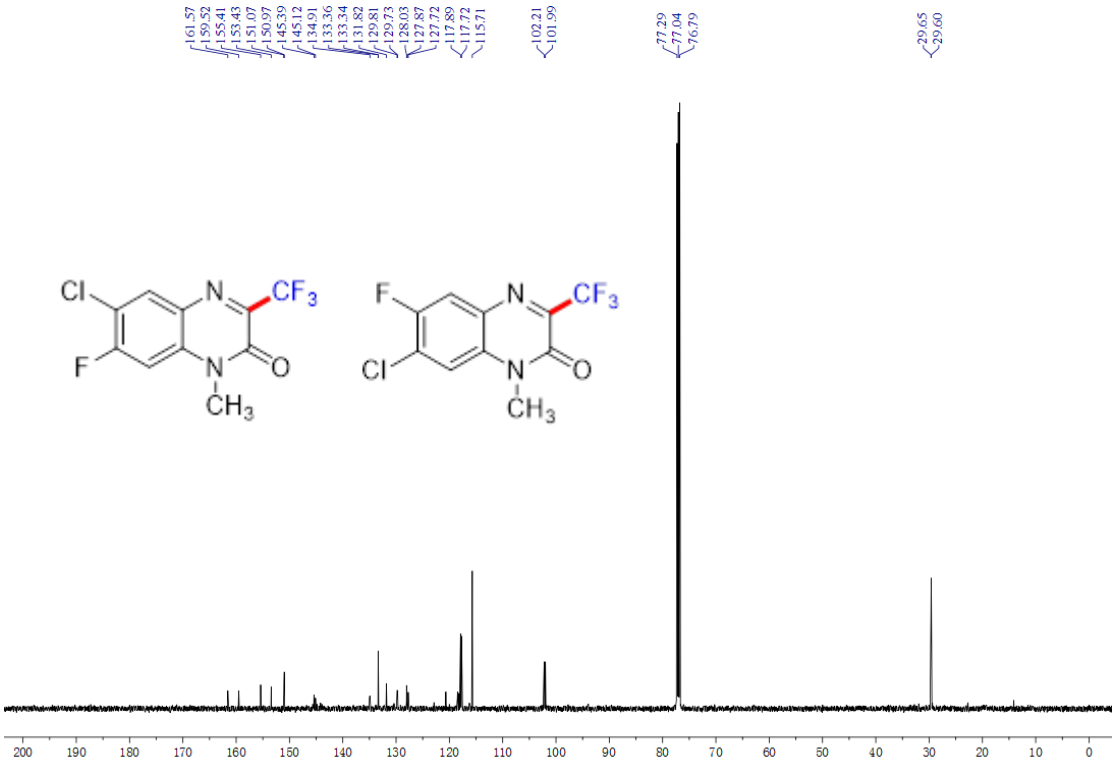
^{1}H NMR spectrum of compound 5s



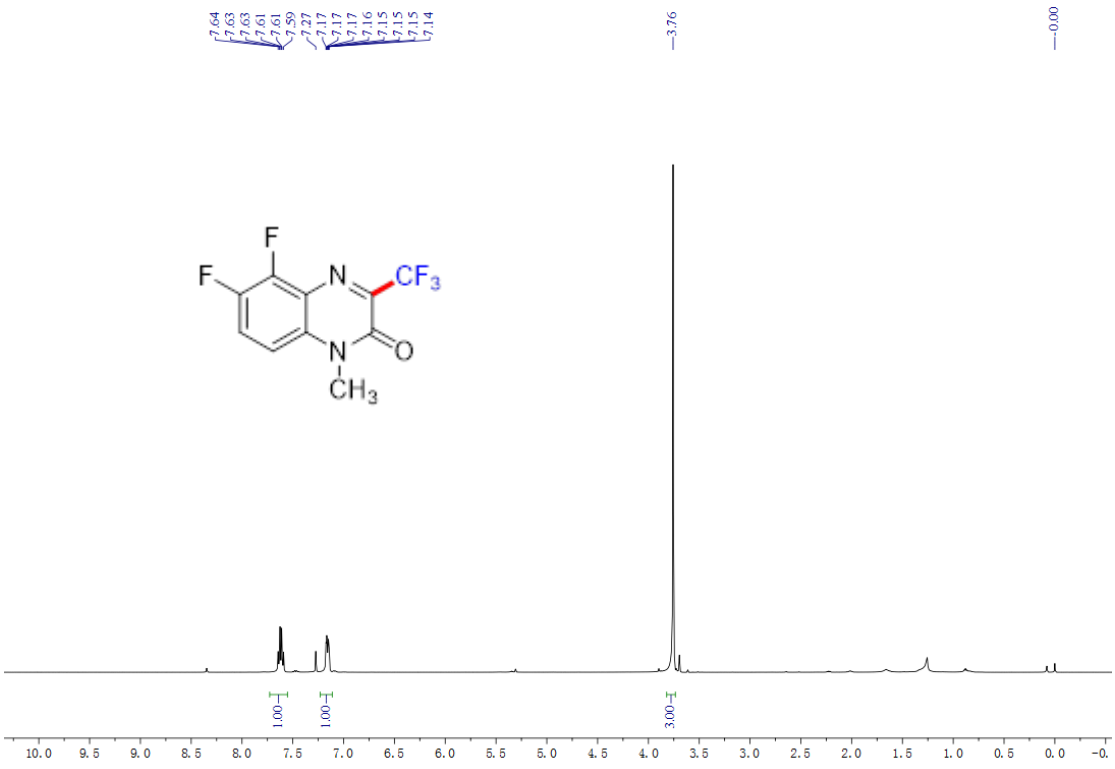
^{13}C NMR spectrum of compound 5s



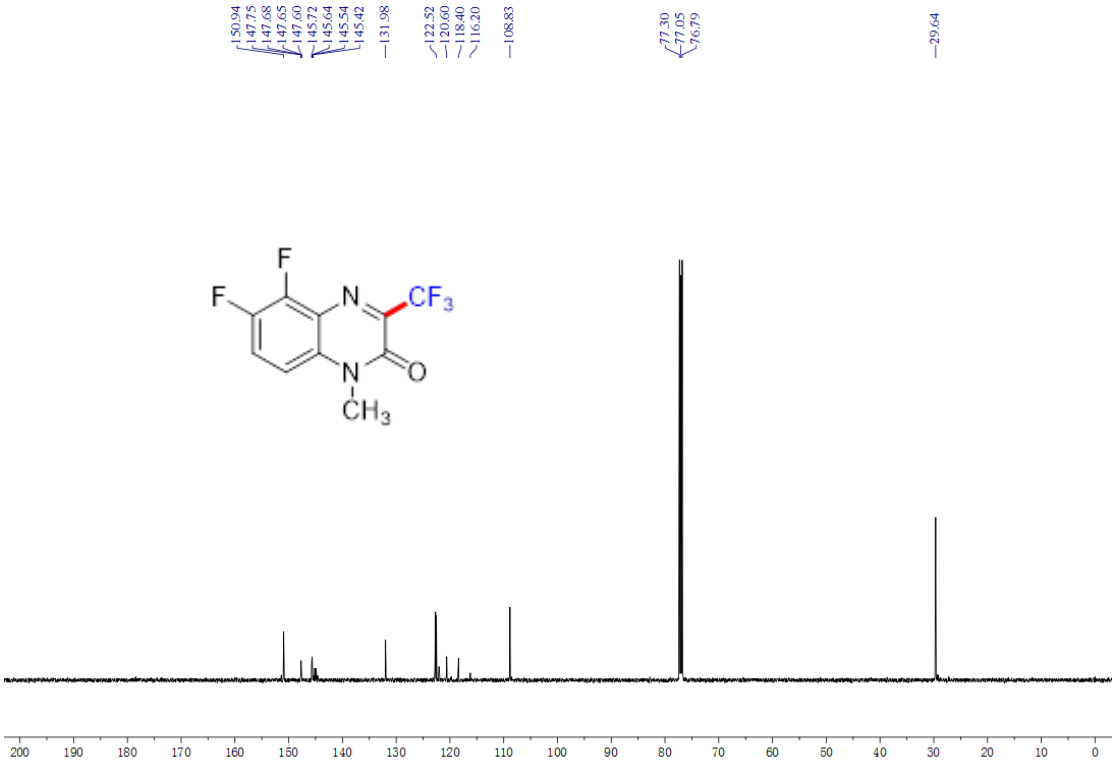
^{1}H NMR spectrum of compound 5t and 5t'



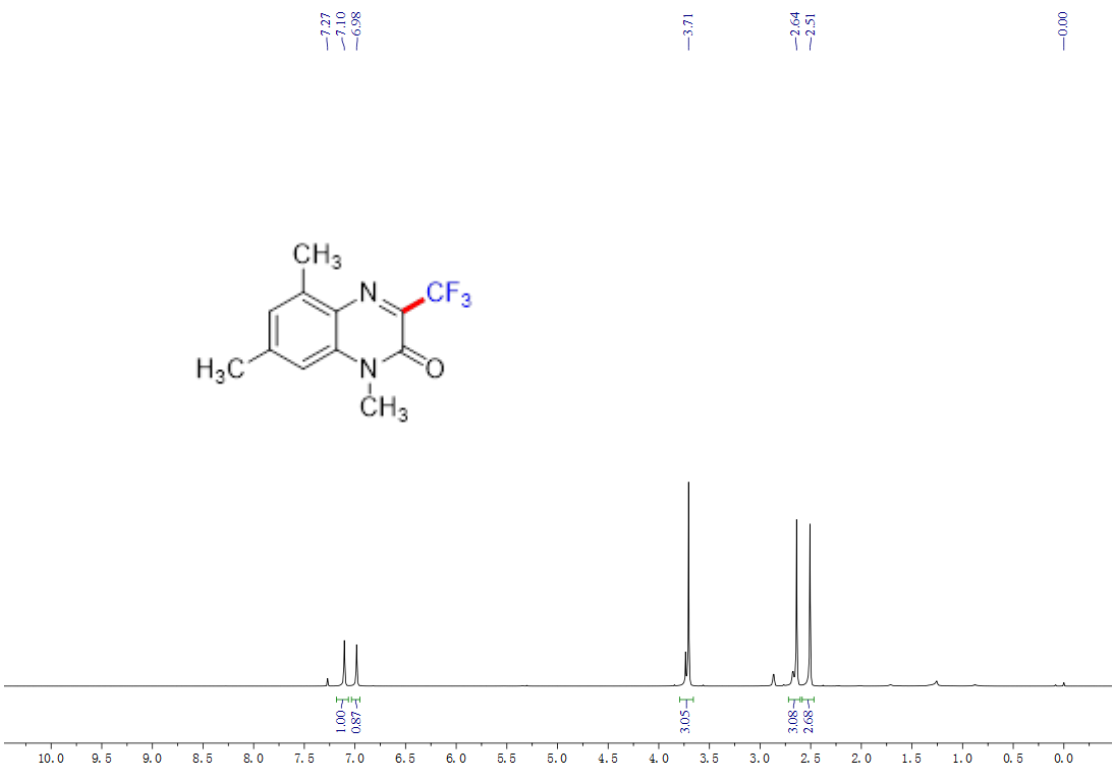
^{13}C NMR spectrum of compound 5t and 5t'



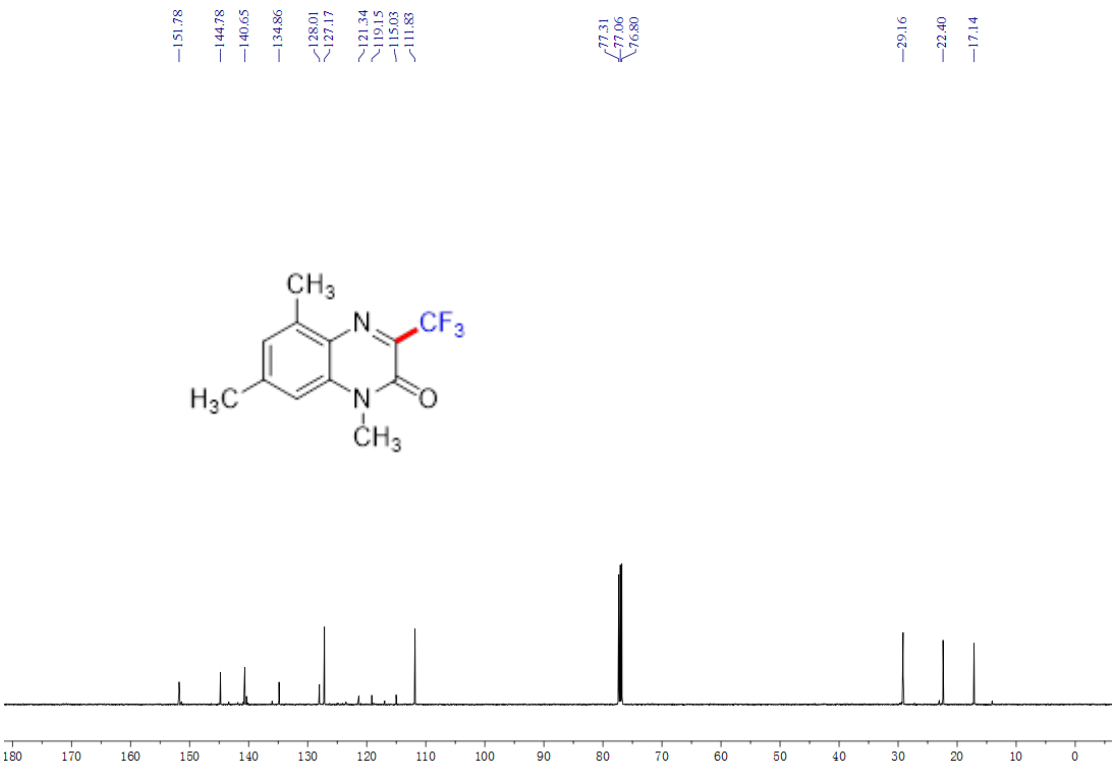
^{1}H NMR spectrum of compound 5u



^{13}C NMR spectrum of compound 5u



^{1}H NMR spectrum of compound 5v



^{13}C NMR spectrum of compound 5v