Electronic Supplementary Material (ESI) for Organic & Biomolecular Chemistry.

Supporting Information

$K_2S_2O_8$ Mediated Direct C-H Heteroarylation/Hydroxylation of Indolin-2-ones with Quinoxalin-2(1*H*)-ones

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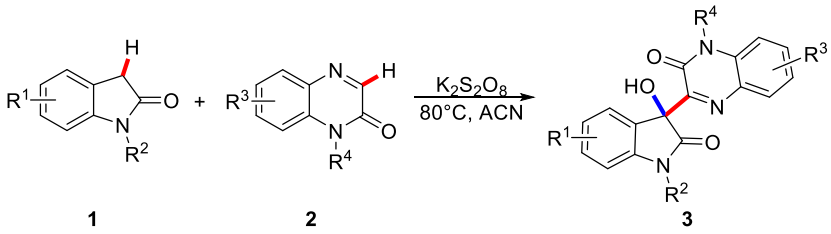
1. General information

Unless stated otherwise, all reactions for preparing compound **3a-3ak** were carried out under an air atmosphere. All reagents and solvents were of commercial quality and were used without further purification. Purification was carried out according to standard laboratory methods[1]. All reactions were monitored by TLC analysis with silica gel-coated plates with fluorescent indicator UV254. ^{1}H and ^{13}C NMR spectra were obtained on either a Bruker AV 400 at 400 MHz and 100 MHz, respectively. Chemical shifts are reported in ppm and coupling constants are reported in Hz with TMS at 0.0 ppm (^{1}H and ^{13}C) and DMSO-d_6 referenced at 2.50 (^{1}H) and 39.5 (^{13}C). Mass spectra were measured with an AB4500 and Orbitrap Exploris™ 120 mass spectrometer using ESI ionization.

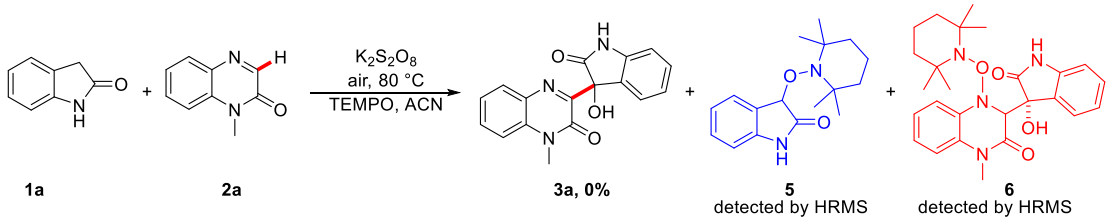
2. General procedure for the synthesis of 3a-ak



1 **2** **3**

Different substituted oxindole **1** (0.2 mmol, 1.0 equiv.) and various quinoxalin-2-one **2** (0.24 mmol, 1.2 equiv.) was dissolved with 2 mL acetonitrile (ACN) and was treated with $K_2S_2O_8$ (0.4 mmol, 2.0 equiv.) at 80 °C under air atmosphere in a 10 mL thick-walled ground test tube. Then mixture was stirred until the reaction completed. The progress of the reaction was monitored by TLC. After that, reaction product was purified using column chromatography on silica gel with petroleum ether/ethyl acetate (2:1 to 1:2) or dichloromethane/methanol (100:0 to 100:1).

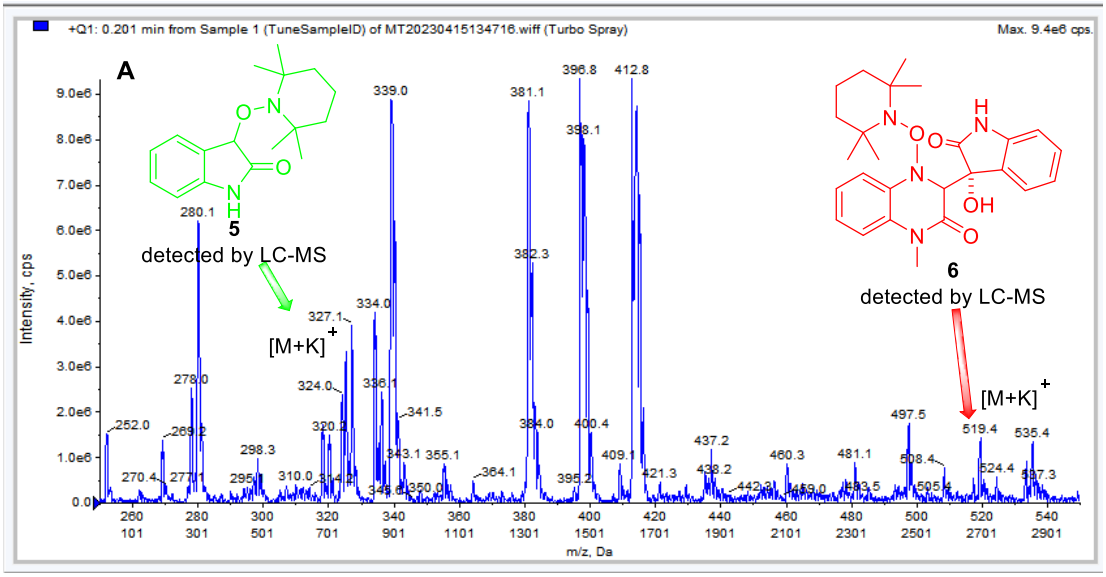
3. Free radical-trapping experiment

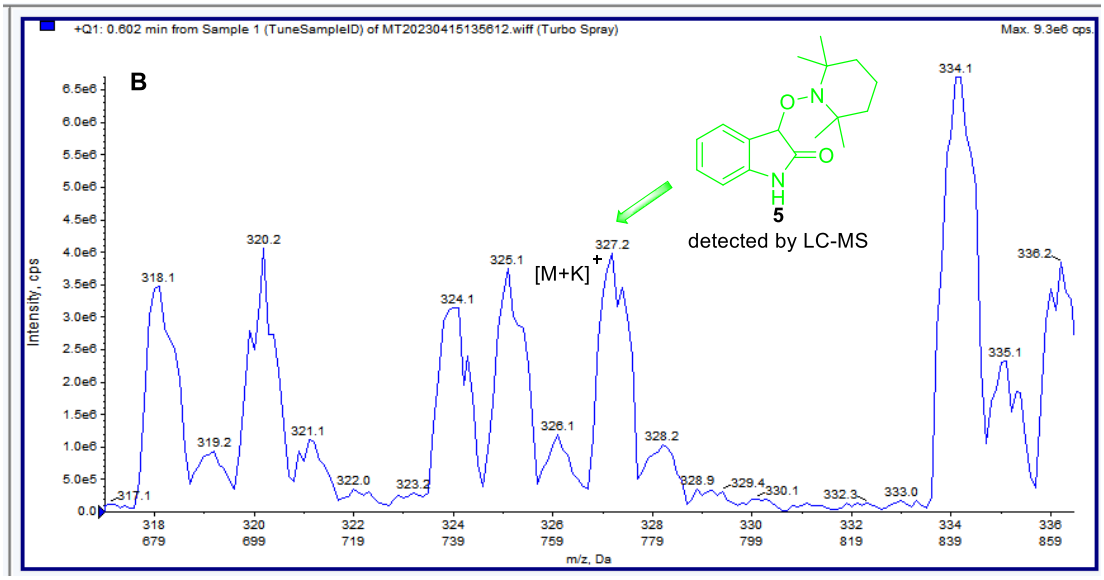


1a **2a** **3a, 0%** **5** detected by HRMS **6** detected by HRMS

Oxindole (**1a**, 0.2 mmol), quinoxalin-2-one (**2a**, 0.24 mmol, 1.2 equiv.), $K_2S_2O_8$ (0.4 mmol, 2.0 equiv.) and 2,2,6,6-tetramethyl-1-piperidinyloxy (TEMPO, 0.4 mmol, 2.0 equiv.) were

added to a 10 mL thick-walled ground test tube with a magnetic stirring bar, then the reaction mixture was stirred at 80 ℃ for 4 h until the reaction completed. the desired product **3a** was not observed in reaction process via TLC monitored, but a free radical-trapping adduct **5** and **6** was detected by LC-MS and HRMS of the reaction solution, indicating that was proposed to go through a radical process (Figure S1 and S2).





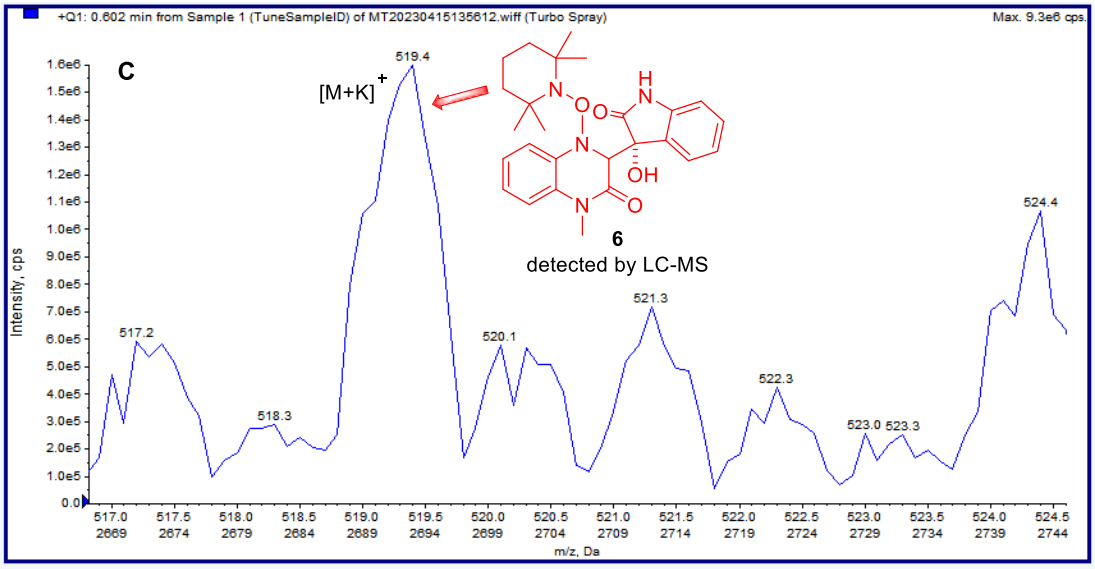
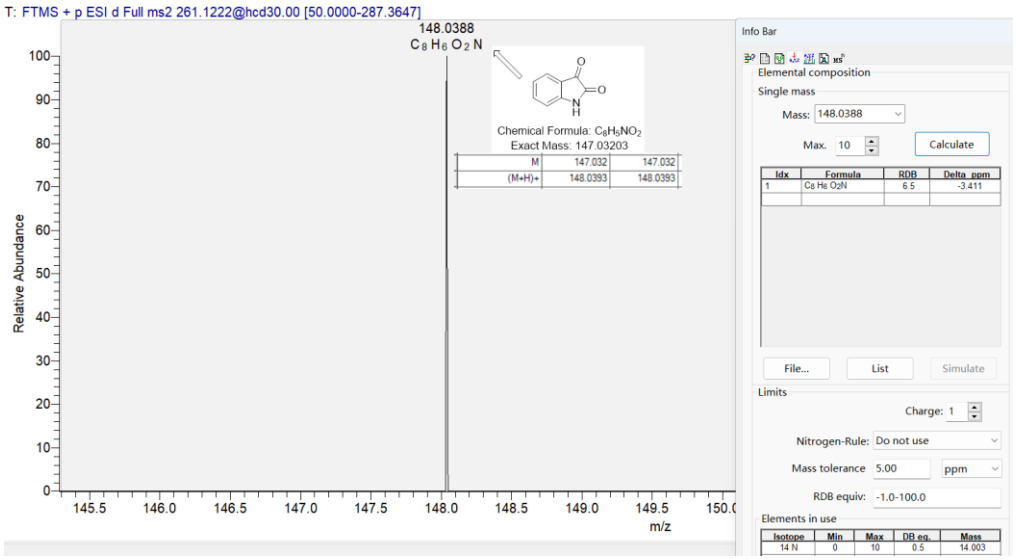
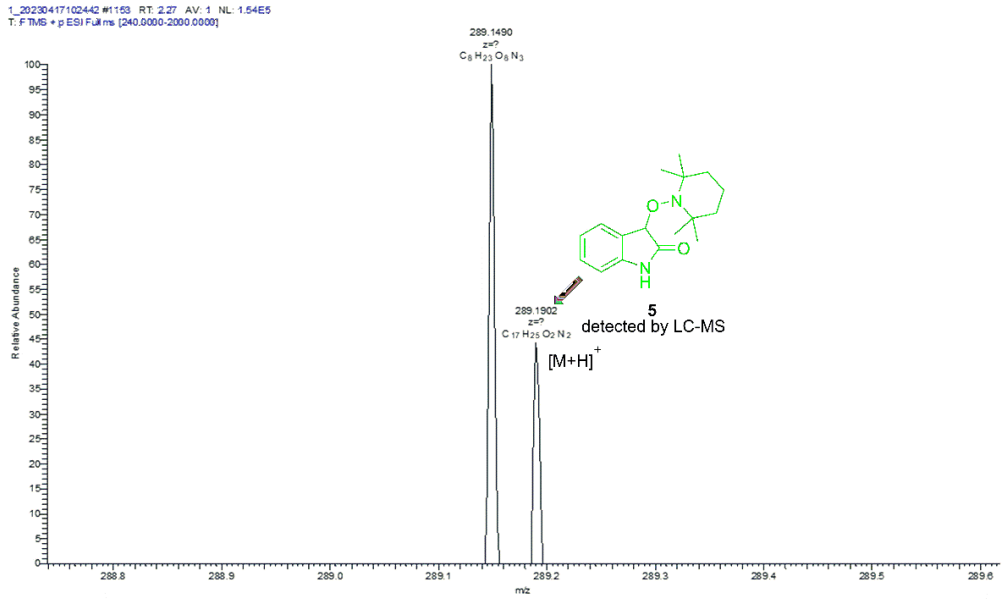


Figure S1. LC-MS analysis of the adduct **5** and **6**





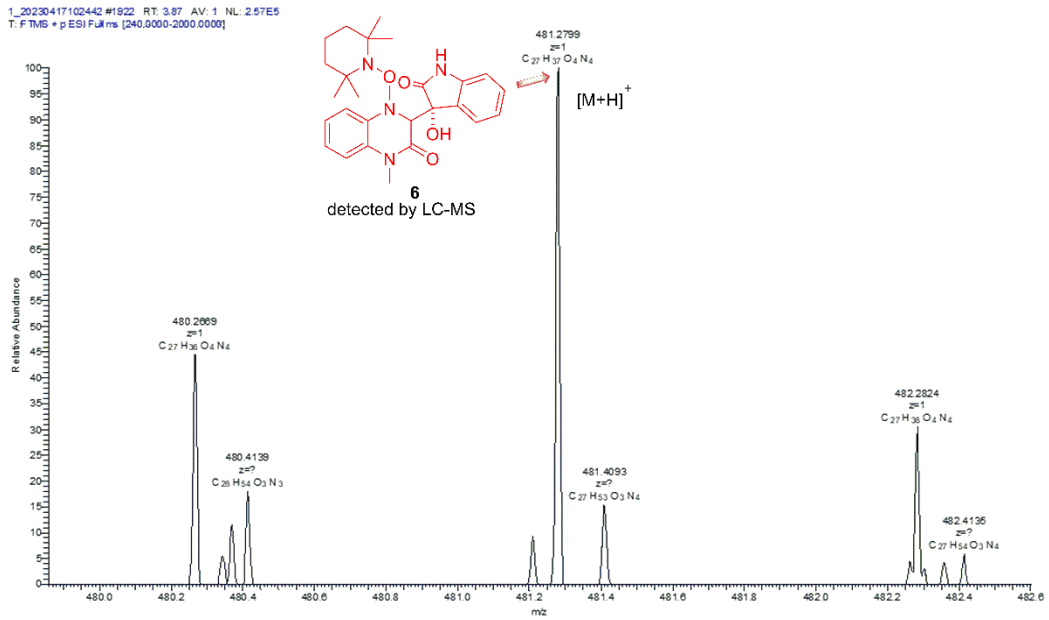
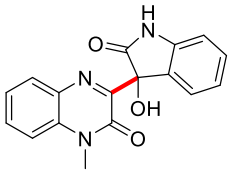


Figure S2. HRMS analysis of the adduct **1a′, 5** and **6**

4. Characterization of products

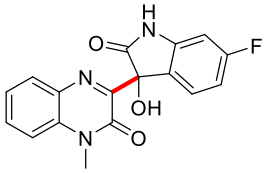


3-Hydroxy-3-(1-methylquinoxalin-2-one) indolin-2-one (3a) was purified by silica column with dichloromethane/methanol = 100:0-100:1, orange solid, 51.6 mg, 83% yield;

^{1}H NMR (300 MHz, DMSO-d_6): δ = 10.50 (s, 1H, NH), 8.02 (d, J = 8.00 Hz, 1H, ArH), 7.71 (t, J = 7.88 Hz, 1H, ArH), 7.61 (d, J = 8.36 Hz, 1H, ArH), 7.49 (d, J = 7.64 Hz, 1H, ArH), 7.18-7.24 (m, 1H, ArH), 6.94 (d, J = 5.5 Hz, 1H, ArH), 6.82-6.88 (m, 2H, ArH), 6.64 (s, 1H, OH), 3.54 (s, 3H, NCH_3);

^{13}C NMR (75 MHz, DMSO-d_6): δ = 176.27, 156.24, 152.43, 144.48, 133.71, 131.69, 131.54, 130.73, 130.00, 129.88, 124.40, 123.98, 121.78, 115.48, 110.13, 77.85, 29.25;

HRMS (ESI-TOF) calcd for $C_{17}H_{14}N_3O_3$ $[M + H]^+$: 308.1030; found: 308.1036.

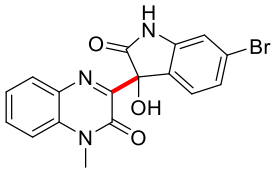


6-Fluoro-3-hydroxy-3-(1-methylquinoxalin-2-one) indolin-2-one (3b) was purified by silica column with dichloromethane/methanol = 100:0-100:1, orange solid, 36.8 mg, 54% yield;

^{1}H NMR (400 MHz, DMSO-d_6): δ = 10.69 (s, 1H, NH), 8.01 (dd, J = 1.52, 8.01 Hz, 1H, ArH), 7.71 (dt, J = 1.52, 7.84 Hz, 1H, ArH), 7.61 (d, J = 8.51 Hz, 1H, ArH), 7.48 (t, J = 8.32 Hz, 1H, ArH), 6.96-6.98 (m, 1H, ArH), 6.75 (s, 1H, OH), 6.68-6.71 (m, 1H, ArH), 6.60-6.65 (m, 1H, ArH), 3.54 (s, 3H, NCH_3);

^{13}C NMR (100 MHz, DMSO-d_6): δ = 176.56, 162.30-164.71 (d, $J_{C\text{-}F}$ = 241.42 Hz), 155.94, 152.45, 146.20-146.32 (d, $J_{C\text{-}F}$ = 12.63 Hz), 133.69, 131.72, 131.57, 129.90, 126.67-126.70 (d, $J_{C\text{-}F}$ = 2.72 Hz), 124.42, 120.93-121.26 (d, $J_{C\text{-}F}$ = 32.73 Hz), 115.49, 107.58-107.80 (d, $J_{C\text{-}F}$ = 22.17 Hz), 98.26-98.53 (d, $J_{C\text{-}F}$ = 27.11 Hz), 77.33, 29.28;

HRMS (ESI-TOF) calcd for $C_{17}H_{13}FN_3O_3$ $[M + H]^+$: 326.0935; found: 326.0931.

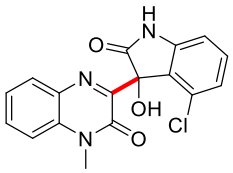


6-Bromo-3-hydroxy-3-(1-methylquinoxalin-2-one) indolin-2-one (3c) was purified by silica column with dichloromethane/methanol = 100:0-100:1, orange solid, 34.7 mg, 45% yield;

^{1}H NMR (400 MHz, DMSO-d_6): δ = 10.68 (s, 1H, NH), 8.01 (dd, J = 1.52, 8.01 Hz, 1H, ArH), 7.72 (dt, J = 1.61, 7.84 Hz, 1H, ArH), 7.61 (dd, J = 1.32, 8.54 Hz, 1H, ArH), 7.49 (dt, J = 1.22, 7.63 Hz, 1H, ArH), 7.00-7.02 (m, 1H, ArH), 6.96-6.98 (m, 1H, ArH), 6.91 (d, J = 7.82 Hz, 1H, ArH), 6.81 (s, 1H, OH), 3.54 (s, 3H, NCH_3);

^{13}C NMR (100 MHz, DMSO-d_6): δ = 176.08, 155.71, 152.46, 146.14, 133.69, 131.77, 131.64, 130.09, 129.93, 125.82, 124.47, 124.39, 122.63, 115.54, 112.92, 77.44, 29.30;

HRMS (ESI-TOF) calcd for $C_{17}H_{13}BrN_3O_3$ $[M + H]^+$: 386.0135; found: 386.0147.

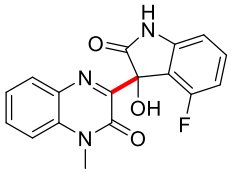


4-Chloro-3-hydroxy-3-(1-methylquinoxalin-2-one) indolin-2-one (3d) was purified by silica column with dichloromethane/methanol = 100:0-100:1, yellow solid, 27.1 mg, 42% yield;

^{1}H NMR (400 MHz, DMSO-d_6): δ = 10.89 (s, 1H, NH), 7.91 (brs, 1H, ArH), 7.70 (t, J = 7.62 Hz, 1H, ArH), 7.61 (d, J = 7.24 Hz, 1H, ArH), 7.43 (brs, 1H, ArH), 7.25 (t, J = 8.03 Hz, 1H, ArH), 6.93 (d, J = 8.31 Hz, 1H, ArH), 6.89 (d, J = 7.72 Hz, 1H, ArH), 5.00 (brs, 1H, OH), 3.61 (s, 3H, NCH_3);

^{13}C NMR (100 MHz, DMSO-d_6): δ = 174.67, 155.48, 145.69, 133.60, 132.36, 131.57, 130.35, 129.85, 129.20, 124.38, 121.92, 115.53, 108.79, 29.60;

HRMS (ESI-TOF) calcd for $C_{17}H_{13}ClN_3O_3$ $[M + H]^+$: 342.0640; found: 342.0637.

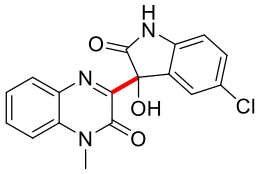


4-Fluoro-3-hydroxy-3-(1-methylquinoxalin-2-one) indolin-2-one (3e) was purified by silica column with dichloromethane/methanol = 100:0-100:1, yellow solid, 37.4 mg, 56% yield;

^{1}H NMR (400 MHz, DMSO-d_6): δ = 10.77 (s, 1H, NH), 8.03 (dd, J = 1.53, 8.02 Hz, 1H, ArH), 7.74 (td, J = 7.81, 1.54 Hz, 1H, ArH), 7.64 (d, J = 8.00 Hz, 1H, ArH), 7.51 (t, J = 8.21 Hz, 1H, ArH), 7.25-7.31 (m, 1H, ArH), 6.97-6.98 (m, 1H, ArH), 6.81 (s, 1H, OH), 6.75 (d, J = 7.62 Hz, 1H, ArH), 6.65 (t, J = 8.92 Hz, 1H, ArH), 3.57 (s, 3H, NCH_3);

^{13}C NMR (100 MHz, DMSO-d_6): δ = 175.65, 157.22-159.68 (d, $J_{C\text{-}F}$ = 245.32 Hz), 154.84, 152.40, 146.67-146.75 (d, $J_{C\text{-}F}$ = 8.72 Hz), 133.67, 132.15-132.24 (d, $J_{C\text{-}F}$ = 9.02 Hz), 131.77, 131.58, 129.91, 124.56, 116.16-116.36 (d, $J_{C\text{-}F}$ = 19.33 Hz), 115.62, 109.21-109.41 (d, $J_{C\text{-}F}$ = 20.00 Hz), 106.80-106.83 (d, $J_{C\text{-}F}$ = 2.92 Hz), 76.83, 29.34;

HRMS (ESI-TOF) calcd for $C_{17}H_{13}FN_3O_3$ $[M + H]^+$: 326.0935; found: 326.0933.

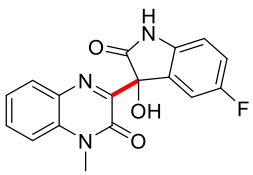


5-Chloro-3-hydroxy-3-(1-methylquinoxalin-2-one) indolin-2-one (3f) was purified by silica column with dichloromethane/methanol = 100:0-100:1, yellow solid, 38.2 mg, 53% yield;

^{1}H NMR (400 MHz, DMSO-d_6): δ = 10.67 (s, 1H, NH), 8.01 (dd, J = 1.52, 8.01 Hz, 1H, ArH), 7.72 (dt, J = 1.62, 7.83 Hz, 1H, ArH), 7.62 (dd, J = 1.22, 8.52 Hz, 1H, ArH), 7.49 (dt, J = 1.21, 7.63 Hz, 1H, ArH), 7.28 (dd, J = 2.22, 8.34 Hz, 1H, ArH), 6.98-6.99 (m, 1H, ArH), 6.90 (d, J = 8.21 Hz, 1H, ArH), 6.84 (s, 1H, OH), 3.55 (s, 3H, NCH_3);

^{13}C NMR (100 MHz, DMSO-d_6): δ = 175.92, 155.57, 152.52, 143.35, 133.80, 132.76, 131.81, 131.61, 129.95, 129.72, 125.63, 124.40, 124.19, 115.51, 111.53, 77.81, 29.31;

HRMS (ESI-TOF) calcd for $C_{17}H_{13}ClN_3O_3$ $[M + H]^+$: 342.0640; found: 342.0648.



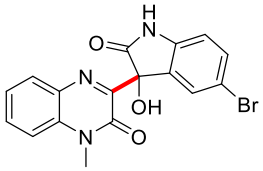
5-Fluoro-3-hydroxy-3-(1-methylquinoxalin-2-one) indolin-2-one (3g) was purified by silica column with dichloromethane/methanol = 100:0-100:1, yellow solid, 42.4 mg, 65% yield;

^{1}H NMR (400 MHz, DMSO-d_6): δ = 10.54 (s, 1H, NH), 8.01 (dd, J = 1.51, 8.00 Hz, 1H, ArH),

7.72 (td, J = 7.82, 1.52 Hz, 1H, ArH), 7.60 (dd, J = 8.53, 1.31 Hz, 1H, ArH), 7.50 (td, J = 7.62, 1.23 Hz, 1H, ArH), 7.03-7.09 (m, 1H, ArH), 6.87 (t, J = 4.22 Hz, 1H, ArH), 6.84 (dd, J = 2.31, 2.94 Hz, 1H, ArH), 6.79 (s, 1H, OH), 3.55 (s, 3H, NCH_3);

^{13}C NMR (100 MHz, DMSO-d_6): δ = 176.19, 156.97-159.32 (d, $J_{C\text{-}F}$ = 235.52 Hz), 155.66, 152.49, 140.65-140.67 (d, $J_{C\text{-}F}$ = 1.82 Hz), 133.78, 132.31-132.39 (d, $J_{C\text{-}F}$ = 7.73 Hz), 131.74, 131.60, 129.93, 124.38, 115.90-116.13 (d, $J_{C\text{-}F}$ = 23.02 Hz), 115.47, 111.82-112.07 (d, $J_{C\text{-}F}$ = 24.52 Hz), 110.73-110.81 (d, $J_{C\text{-}F}$ = 7.71 Hz), 78.04-78.06 (d, $J_{C\text{-}F}$ = 1.62 Hz), 29.28;

HRMS (ESI-TOF) calcd for $C_{17}H_{13}FN_3O_3$ $[M + H]^+$: 326.0935; found: 326.0937.

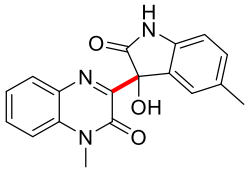


5-Bromo-3-hydroxy-3-(1-methylquinoxalin-2-one) indolin-2-one (3h) was purified by silica column with dichloromethane/methanol = 100:0-100:1, orange solid, 37.4 mg, 48% yield;

^{1}H NMR (400 MHz, DMSO-d_6): δ = 10.69 (s, 1H, NH), 8.01 (dd, J = 1.51, 8.02 Hz, 1H, ArH), 7.72 (dt, J = 1.62, 7.81 Hz, 1H, ArH), 7.62 (dd, J = 1.21, 8.43 Hz, 1H, ArH), 7.49 (dt, J = 1.23, 7.62 Hz, 1H, ArH), 7.41 (dd, J = 2.12, 8.31 Hz, 1H, ArH), 7.10 (d, J = 2.11 Hz, 1H, ArH), 6.97-6.98 (m, 1H, ArH), 6.84 (s, 1H, OH), 3.55 (s, 3H, NCH_3);

^{13}C NMR (100 MHz, DMSO-d_6): δ = 175.80, 155.57, 152.52, 143.76, 133.79, 133.15, 132.58, 131.82, 131.61, 129.95, 126.85, 124.40, 115.50, 113.29, 112.11, 77.76, 29.32;

HRMS (ESI-TOF) calcd for $C_{17}H_{13}BrN_3O_3$ $[M + H]^+$: 386.0135; found: 386.0143.

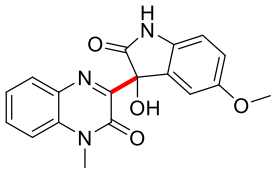


5-Methyl-3-hydroxy-3-(1-methylquinoxalin-2-one) indolin-2-one (3i) was purified by silica column with dichloromethane/methanol = 100:0-100:1, yellow solid, 23.1 mg, 35% yield;

^{1}H NMR (400 MHz, DMSO-d_6): δ = 10.41 (s, 1H, NH), 8.01 (dd, J = 1.52, 8.01 Hz, 1H, ArH), 7.70 (dt, J = 7.82, 1.64 Hz, 1H, ArH), 7.60 (dd, J = 1.22, 8.54 Hz, 1H, ArH), 7.48 (dt, J = 1.21, 7.63 Hz, 1H, ArH), 7.00-7.03 (m, 1H, ArH), 6.75-6.78 (m, 2H, ArH), 6.59 (s, 1H, OH), 3.54 (s, 3H, NCH_3), 2.14 (s, 3H, CH_3);

^{13}C NMR (100 MHz, DMSO-d_6): δ = 176.28, 156.32, 152.41, 142.01, 133.71, 131.67, 131.50, 130.78, 130.59, 130.13, 129.86, 124.62, 124.37, 115.46, 109.88, 77.94, 29.25, 20.95;

HRMS (ESI-TOF) calcd for $C_{18}H_{16}N_3O_3$ $[M + H]^+$: 322.1186; found: 322.1189.

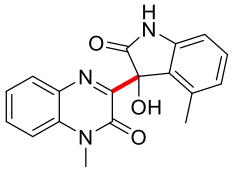


5-Methoxy-3-hydroxy-3-(1-methylquinoxalin-2-one) indolin-2-one (3j) was purified by silica column with dichloromethane/methanol = 100:0-100:1, yellow solid, 33.8 mg, 48% yield;

^{1}H NMR (400 MHz, DMSO-d_6): δ = 10.33 (s, 1H, NH), 8.01 (dd, J = 1.52, 8.01 Hz, 1H, ArH), 7.71 (dt, J = 1.53, 7.82 Hz, 1H, ArH), 7.61 (dd, J = 1.22, 8.53 Hz, 1H, ArH), 7.48 (dt, J = 1.22, 7.64 Hz, 1H, ArH), 6.77 (s, 2H, ArH), 6.62 (s, 1H, OH), 6.56 (s, 1H, ArH), 3.60 (s, 3H, OCH_3), 3.54 (s, 3H, NCH_3);

^{13}C NMR (100 MHz, DMSO-d_6): δ = 176.13, 156.15, 155.01, 152.44, 137.69, 133.80, 131.91, 131.69, 131.52, 129.90, 124.36, 115.48, 114.44, 110.98, 110.45, 78.25, 55.81, 29.26;

HRMS (ESI-TOF) calcd for $C_{18}H_{16}N_3O_4$ $[M + H]^+$: 338.1135; found: 338.1139.

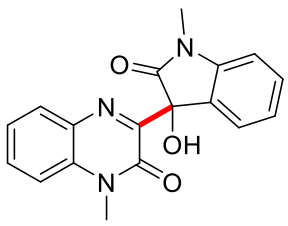


4-Methyl-3-hydroxy-3-(1-methylquinoxalin-2-one) indolin-2-one (3k) was purified by silica column with dichloromethane/methanol = 100:0-100:1, yellow solid, 35.2 mg, 54% yield;

^{1}H NMR (400 MHz, DMSO-d_6): δ = 10.49 (s, 1H, NH), 7.84 (s, 1H, ArH), 7.68 (t, J = 7.77 Hz, 1H, ArH), 7.58-7.60 (d, J = 8.24 Hz, 1H, ArH), 7.42 (t, J = 7.88 Hz, 1H, ArH), 7.06-7.12 (m, 2H, ArH), 6.98 (s, 1H, OH), 6.68-6.74 (m, 2H, ArH), 3.60 (s, 3H, NCH_3), 1.92 (s, 3H, CH_3);

^{13}C NMR (100 MHz, DMSO-d_6): δ = 176.22, 156.08, 152.32, 144.01, 134.16, 133.64, 132.30, 131.39, 129.71, 128.65, 128.45, 124.24, 123.39, 115.46, 109.02, 78.38, 29.29, 18.60;

HRMS (ESI-TOF) calcd for $C_{18}H_{16}N_3O_3$ $[M + H]^+$: 322.1186; found: 322.1187.



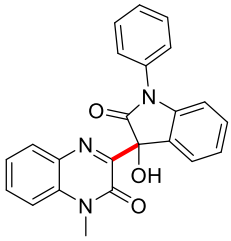
1-Methyl-3-hydroxy-3-(1-methylquinoxalin-2-one) indolin-2-one (3l) was purified by silica column with dichloromethane/methanol = 100:0-100:1, red solid, 22.2 mg, 34% yield;

^{1}H NMR (400 MHz, DMSO-d_6): δ = 8.02 (dd, J = 1.5, 8.0 Hz, 1H, ArH), 7.70 (td, J = 7.93, 1.51 Hz, 1H, ArH), 7.57-7.59 (m, 1H, ArH), 7.49 (t, J = 7.61 Hz, 1H, ArH), 7.32 (td, J = 7.72, 1.33 Hz, 1H, ArH), 7.00-7.06 (m, 2H, ArH), 6.92 (t, J = 7.54 Hz, 1H, ArH), 3.51 (s, 3H, NCH_3), 3.20 (s, 3H,

NCH_3);

^{13}C NMR (100 MHz, DMSO-d_6): δ = 174.71, 156.10, 152.38, 145.81, 133.68, 131.73, 131.58, 130.15, 129.90, 129.81, 124.43, 123.65, 122.50, 115.36, 109.04, 77.43, 29.03, 26.65;

HRMS (ESI-TOF) calcd for $C_{18}H_{16}N_3O_3$ $[M + H]^+$: 322.1186; found: 322.1188.

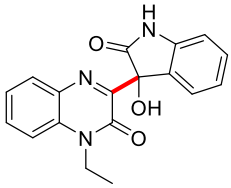


1-Phenyl-3-hydroxy-3-(1-methylquinoxalin-2-one) indolin-2-one (3m) was purified by silica column with dichloromethane/methanol = 100:0-100:1, pale solid, 40.4 mg, 54% yield;

^{1}H NMR (400 MHz, DMSO-d_6): δ = 8.06 (dd, J = 1.52, 8.02 Hz, 1H, ArH), 7.73 (td, J = 7.81, 1.54 Hz, 1H, ArH), 7.61-7.65 (m, 3H, ArH), 7.47-7.55 (m, 4H, ArH), 7.27 (td, J = 7.82, 1.42 Hz, 1H, ArH), 7.12 (dd, J = 7.44, 1.32 Hz, 1H, ArH), 6.98 (t, J = 7.52 Hz, 1H, ArH), 6.78 (d, J = 7.84 Hz, 1H, ArH), 3.58 (s, 3H, NCH_3);

^{13}C NMR (100 MHz, DMSO-d_6): δ = 174.29, 156.15, 152.64, 145.62, 135.12, 133.68, 131.87, 131.69, 130.23, 130.12, 130.00, 129.51, 128.49, 127.08, 124.53, 124.39, 123.14, 115.59, 109.52, 77.51, 29.47;

HRMS (ESI-TOF) calcd for $C_{23}H_{18}N_3O_3$ $[M + H]^+$: 384.1343; found: 384.1347.

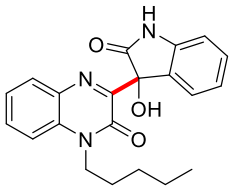


3-Hydroxy-3-(1-ethylquinoxalin-2-one) indolin-2-one (3ab) was purified by silica column with dichloromethane/methanol = 100:0-100:1, pale solid, 49.2 mg, 75% yield;

^{1}H NMR (400 MHz, DMSO-d_6): δ = 10.50 (s, 1H, NH), 8.02 (d, J = 8.12 Hz, 1H, ArH), 7.65-7.73 (m, 2H, ArH), 7.48 (t, J = 8.32 Hz, 1H, ArH), 7.22 (t, J = 6.62 Hz, 1H, ArH), 6.98 (d, J = 7.41 Hz, 1H, ArH), 6.82-6.88 (m, 2H, ArH), 6.65 (brs, 1H, OH), 4.13-4.19 (m, 2H, NCH_2), 1.13 (t, J = 7.1 Hz, 3H, CH_3);

^{13}C NMR (100 MHz, DMSO-d_6): δ = 176.26, 156.22, 152.01, 144.45, 132.50, 131.96, 131.64, 130.77, 130.22, 130.00, 124.31, 123.96, 121.82, 115.13, 110.16, 77.83, 37.21, 12.79;

HRMS (ESI-TOF) calcd for $C_{18}H_{16}N_3O_3$ $[M + H]^+$: 322.1186; found: 322.1189.

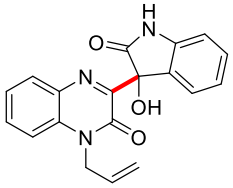


3-Hydroxy-3-(1-pentylquinoxalin-2-one) indolin-2-one (3ac) was purified by silica column with dichloromethane/methanol = 100:0-100:1, orange solid, 39.8 mg, 54% yield;

^{1}H NMR (400 MHz, DMSO-d_6): δ = 10.50 (s, 1H, NH), 8.02 (dd, J = 1.51, 8.04 Hz, 1H, ArH), 7.68-7.72 (m, 1H, ArH), 7.63-7.65 (m, 1H, ArH), 7.47 (td, J = 7.52, 1.31 Hz, 1H, ArH), 7.22 (td, J = 7.71, 1.31 Hz, 1H, ArH), 6.96 (d, J = 7.43 Hz, 1H, ArH), 6.88 (d, J = 7.72 Hz, 1H, ArH), 6.83 (t, J = 7.50 Hz, 1H, ArH), 6.62 (brs, 1H, OH), 4.08-4.13 (m, 2H, NCH_2), 1.50-1.54 (m, 2H, $NCH_2C\underline{H_2}$), 1.23-1.24 (m, 4H, NCH_2 $CH_2C\underline{H_2}C\underline{H_2}$), 0.79 (t, J = 6.62 Hz, 3H, CH_3);

^{13}C NMR (100 MHz, DMSO-d_6): δ = 176.25, 156.21, 152.25, 144.46, 132.69, 131.94, 131.60, 130.77, 130.19, 129.97, 124.30, 123.89, 121.78, 115.26, 110.16, 77.83, 41.83, 28.71, 26.99, 22.20, 14.33;

HRMS (ESI-TOF) calcd for $C_{21}H_{22}N_3O_3$ $[M + H]^+$: 364.1656; found: 364.1652.

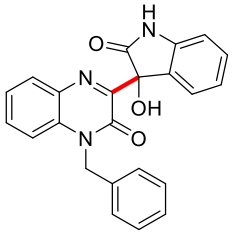


3-Hydroxy-3-(1-allylquinoxalin-2-one) indolin-2-one (3ad) was purified by silica column with dichloromethane/methanol = 100:0-100:1, red solid, 38.4 mg, 55% yield;

^{1}H NMR (400 MHz, DMSO-d_6): δ = 10.50 (s, 1H, NH), 8.02 (d, J = 8.02 Hz, 1H, ArH), 7.67 (t, J = 8.02 Hz, 1H, ArH), 7.55 (d, J = 8.43 Hz, 1H, ArH), 7.47 (t, J = 7.62 Hz, 1H, ArH), 7.22 (t, J = 7.72 Hz, 1H, ArH), 6.99 (d, J = 7.22 Hz, 1H, ArH), 6.82-6.99 (m, 2H, ArH), 6.66 (brs, 1H, OH), 5.78-5.86 (m, 1H, $C\underline{H}$=CH_2), 5.13 (d, J = 10.72 Hz, 1H, CH=$C\underline{H_2}$)), 4.94 (d, J = 17.22 Hz, 1H, CH=$C\underline{H_2}$)), 4.78-4.79 (m, 2H, NCH_2);

^{13}C NMR (100 MHz, DMSO-d_6): δ = 176.23, 156.33, 152.09, 144.46, 132.73, 131.88, 131.64, 131.48, 130.74, 130.09, 130.02, 124.44, 123.95, 121.83, 117.71, 115.71, 110.17, 77.88, 44.03;

HRMS (ESI-TOF) calcd for $C_{19}H_{16}N_3O_3$ $[M + H]^+$: 334.1186; found: 334.1187.



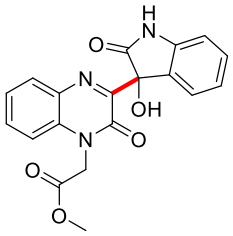
3-Hydroxy-3-(1-benzylquinoxalin-2-one) indolin-2-one (3ae) was purified by silica column with

dichloromethane/methanol = 100:0-100:1, red solid, 57.2 mg, 72% yield;

^{1}H NMR (400 MHz, DMSO-d_6): δ = 10.48 (s, 1H, NH), 8.03 (dd, J = 1.52, 7.91 Hz, 1H, ArH), 7.60 (td, J = 7.83, 1.61 Hz, 1H, ArH), 7.51 (d, J = 8.74 Hz, 1H, ArH), 7.45 (td, J = 7.60, 1.22 Hz, 1H, ArH), 7.31-7.32 (m, 1H, ArH),7.22-7.27 (m, 4H, ArH), 7.09-7.12 (m, 1H, ArH), 7.04 (d, J = 6.64 Hz, 1H, ArH), 6.89 (d, J = 7.41 Hz, 2H, ArH), 6.72 (brs, 1H, OH), 5.49 d, J = 16.04 Hz, 1H, NCH_2), 5.38 d, J = 15.76 Hz, 1H, NCH_2);

^{13}C NMR (100 MHz, DMSO-d_6): δ = 176.31, 156.53, 152.69, 144.50, 135.99, 132.74, 132.04, 131.53, 130.74, 130.19, 130.08, 129.17, 127.93, 127.10, 124.57, 124.00, 121.85, 115.73, 110.23, 78.01, 44.96;

HRMS (ESI-TOF) calcd for $C_{23}H_{18}N_3O_3$ $[M + H]^+$: 384.1343; found: 384.1341.

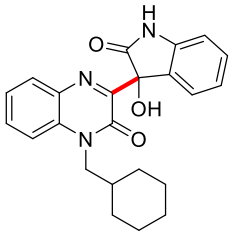


3-Hydroxy-3-(1-methylacetatequinoxalin-2-one) indolin-2-one (3af) was purified by silica column with dichloromethane/methanol = 100:0-100:1, orange solid, 52.6 mg, 70% yield;

^{1}H NMR (300 MHz, DMSO-d_6): δ = 10.51 (s, 1H, NH), 8.05 (dd, J = 0.91, 4.82 Hz, 1H, ArH), 7.68 (td, J = 4.73, 0.92 Hz, 1H, ArH), 7.49-7.55 (m, 2H, ArH), 7.23 (td, J = 4.62, 0.81 Hz, 1H, ArH), 6.99 (d, J = 4.02 Hz, 1H, ArH), 6.84-6.88 (m, 2H, ArH), 6.72 (s, 1H, OH), 5.04 (d, J = 1.52 Hz, 2H, NCH_2), 3.65 (s, 3H, OCH_3);

^{13}C NMR (100 MHz, DMSO-d_6): δ = 176.28, 168.70, 156.78, 152.69, 139.27, 137.77, 127.87, 125.84, 125.67, 125.64, 124.97, 124.11, 122.63, 121.14, 116.87, 115.18, 109.67, 77.15, 44.60;

HRMS (ESI-TOF) calcd for $C_{19}H_{16}N_3O_5$ $[M + H]^+$: 366.1084; found: 366.1082.

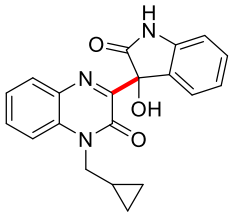


3-Hydroxy-3-(1-cyclohexylmethylquinoxalin-2-one) indolin-2-one (3ag) was purified by silica column with dichloromethane/methanol = 100:0-100:1, orange solid, 34.2 mg, 43% yield;

^{1}H NMR (400 MHz, DMSO-d_6): δ = 10.49 (s, 1H, NH), 8.01 (d, J = 8.12 Hz, 1H, ArH), 7.63-7.71 (m, 2H, ArH), 7.46 (t, J = 8.12 Hz, 1H, ArH), 7.21 (t, J = 7.62 Hz, 1H, ArH), 6.93-6.98 (m, 2H, ArH and OH), 6.80-6.87 (m, 2H, ArH), 3.94-4.10 (m, 2H, CH_2), 1.75 (m, 1H), 1.44-1.59 (m, 6H), 1.03-1.13 (m, 4H);

^{13}C NMR (100 MHz, DMSO-d_6): δ = 176.26, 156.26, 152.69, 144.46, 133.06, 131.90, 131.46, 130.77, 130.17, 129.96, 124.26, 123.82, 121.71, 115.67, 110.15, 77.85, 47.20, 36.30, 30.43, 30.36, 26.35, 26.18, 25.66;

HRMS (ESI-TOF) calcd for $C_{23}H_{24}N_3O_3$ $[M + H]^+$: 390.1812; found: 390.1809.

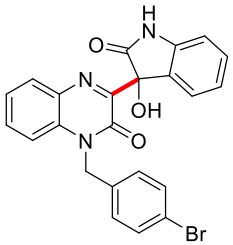


3-Hydroxy-3-(1-cyclopropylmethylquinoxalin-2-one) indolin-2-one (3ah) was purified by silica column with dichloromethane/methanol = 100:0-100:1, orange solid, 22.8 mg, 32% yield;

^{1}H NMR (400 MHz, DMSO-d_6): δ = 10.51 (s, 1H, NH), 8.02 (d, J = 8.03 Hz, 1H, ArH), 7.68-7.75 (m, 2H, ArH), 7.48 (t, J = 7.51 Hz, 1H, ArH), 7.21 (t, J = 7.71 Hz, 1H, ArH), 6.97 (d, J = 7.52 Hz, 1H, ArH), 6.81-6.87 (m, 2H, ArH), 4.03-4.13 (m, 2H, CH_2), 1.14-1.20 (m, 1H), 0.27-0.40 (m, 4H);

^{13}C NMR (100 MHz, DMSO-d_6): δ = 176.26, 156.42, 152.57, 144.45, 132.95, 131.88, 131.56, 130.75, 130.16, 129.98, 124.34, 123.86, 121.78, 115.59, 110.16, 77.87, 45.63, 10.01, 4.12;

HRMS (ESI-TOF) calcd for $C_{20}H_{18}N_3O_3$ $[M + H]^+$: 348.1343; found: 348.1340.

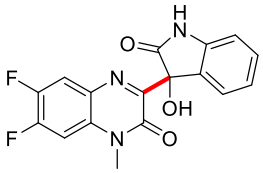


3-Hydroxy-3-(1-(4-bromobenzyl)-quinoxalin-2-one) indolin-2-one (3ai) was purified by silica column with dichloromethane/methanol = 100:0-100:1, orange solid, 56.4 mg, 58% yield;

^{1}H NMR (400 MHz, DMSO-d_6): δ = 10.53 (s, 1H, NH), 8.03 (dd, J = 1.52, 7.93 Hz, 1H, ArH), 7.62 (td, J = 7.84, 1.62 Hz, 1H, ArH), 7.47-7.51 (m, 4H, ArH), 7.23 (t, J = 7.73 Hz, 1H, ArH), 7.07 (d, J = 8.42 Hz, 2H, ArH), 7.03 (d, J = 6.84 Hz, 1H, ArH), 6.88 (d, J = 7.73 Hz, 1H, ArH), 6.71 (s, 1H, OH), 5.31-5.45 (m, 2H, NCH_2);

^{13}C NMR (100 MHz, DMSO-d_6): δ = 176.26, 156.51, 152.63, 144.46, 135.50, 132.63, 132.08, 131.62, 130.69, 130.25, 130.08, 129.40, 128.87, 124.67, 124.04, 121.86, 121.06, 115.64, 110.21, 77.99, 44.48;

HRMS (ESI-TOF) calcd for $C_{23}H_{17}BrN_3O_3$ $[M + H]^+$: 462.0448; found: 462.0448.

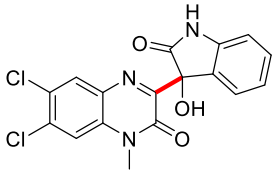


3-Hydroxy-3-(6, 7-difluoro-1-methylquinoxalin-2-one) indolin-2-one (3aj) was purified by silica column with dichloromethane/methanol = 100:0-100:1, pale solid, 45.1 mg, 62% yield;

^{1}H NMR (400 MHz, DMSO-d_6): δ = 10.52 (s, 1H, NH), 8.07 (dd, J = 8.32, 10.63 Hz, 1H, ArH), 7.81 (dd, J = 7.43, 12.31 Hz, 1H, ArH), 7.22 (td, J = 7.43, 1.32 Hz, 1H, ArH), 6.95 (d, J = 7.36 Hz, 1H, ArH), 6.85 (t, J = 7.61 Hz, 1H, ArH), 6.65 (brs, 1H, OH), 3.50 (s, 3H, NCH_3);

^{13}C NMR (100 MHz, DMSO-d_6): δ = 176.09, 157.06-157.09 (d, $J_{C\text{-}F}$ = 3.2 Hz), 152.48-152.62 and 150.00-150.14 (d, $J_{C\text{-}F}$ = 14.0, 248.6 Hz), 152.18, 147.48-147.62 and 145.05-145.19 (d, $J_{C\text{-}F}$ = 13.8, 242.8 Hz), 144.46, 131.53-131.63 (d, $J_{C\text{-}F}$ = 9.8 Hz), 130.50, 130.07, 128.24-128.34 (d, $J_{C\text{-}F}$ = 9.5 Hz), 124.08, 121.77, 117.30-117.48 (d, $J_{C\text{-}F}$ = 17.7 Hz), 110.16, 104.62-104.85 (d, $J_{C\text{-}F}$ = 23.3 Hz), 77.92, 30.03;

HRMS (ESI-TOF) calcd for $C_{17}H_{12}F_2N_3O_3$ $[M + H]^+$: 344.0841; found: 344.0847.

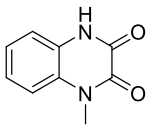


3-Hydroxy-3-(6, 7-difchloro-1-methylquinoxalin-2-one) indolin-2-one (3ak) was purified by silica column with dichloromethane/methanol = 100:0-100:1, light yellow solid, 36.3 mg, 47% yield;

^{1}H NMR (400 MHz, DMSO-d_6): δ = 10.54 (s, 1H, NH), 8.20 (s, 1H, ArH), 7.93 (s, 1H, ArH), 7.22 (dt, J = 1.32, 7.61 Hz, 1H, ArH), 6.95 (dd, J = 1.31, 7.42 Hz, 1H, ArH), 6.83-6.87 (m, 2H, ArH), 6.72 (s, 1H, ArH), 3.51 (s, 3H, NCH_3);

^{13}C NMR (100 MHz, DMSO-d_6): δ = 176.00, 158.17, 152.09, 144.44, 133.78, 133.71, 131.21, 130.45, 130.40, 130.15, 126.33, 124.16, 121.81, 117.49, 110.19, 78.02, 29.76;

HRMS (ESI-TOF) calcd for $C_{17}H_{12}F_2N_3O_3$ $[M + H]^+$: 376.0250; found: 376.0248.



1-Methyl-1, 4-dihydroquinoxaline-2, 3-dione (4)[2] was purified by silica column with dichloromethane/methanol = 100:0-100:1, pale solid, 16.2 mg, 36% yield;

^{1}H NMR (400 MHz, DMSO-d_6): δ = 12.02 (s, 1H, NH), 7.33-7.05 (m, 1H, ArH), 7.12-7.20 (m, 3H, ArH), 3.51 (s, 3H, NCH_3).

5. Reference

1. W. L. F. Armarego and C. Chai, in *Purification of Laboratory Chemicals (Seventh Edition)*, Butterworth-Heinemann, Boston, 2013, DOI: https://doi.org/10.1016/B978-0-12-382161-4.00004-2, pp. 103-554.
2. C. Liang, Y. Guo, Y. Zhang, Z. Wang, L. Li and W. Li, *Organic Chemistry Frontiers*, 2023, **10**, 611-623.

6. Copies of 1H NMR and 13C NMR Spectra

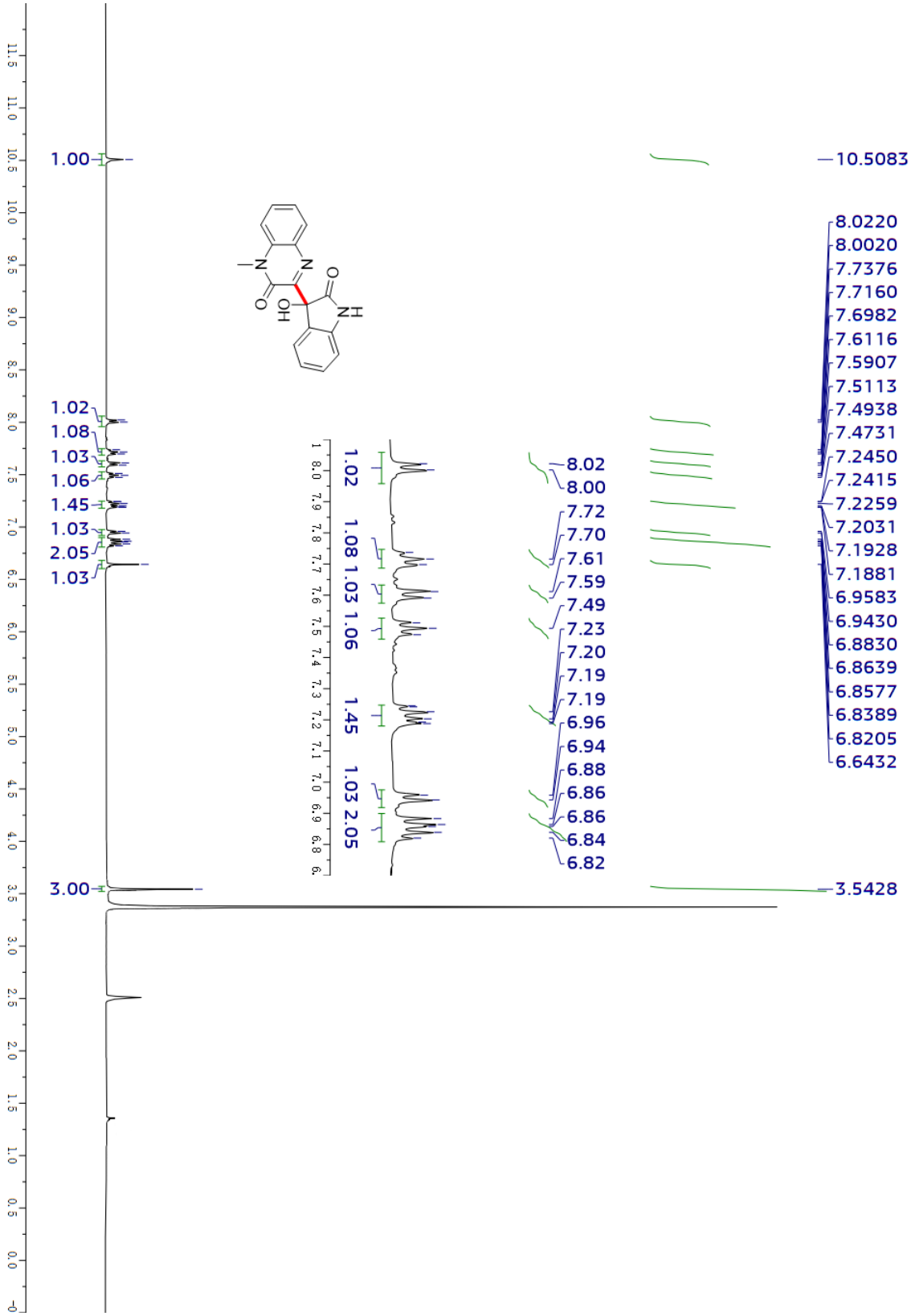


Figure S1. The ^{1}H NMR Spectrum of Compound **3a** in DMSO-d_6

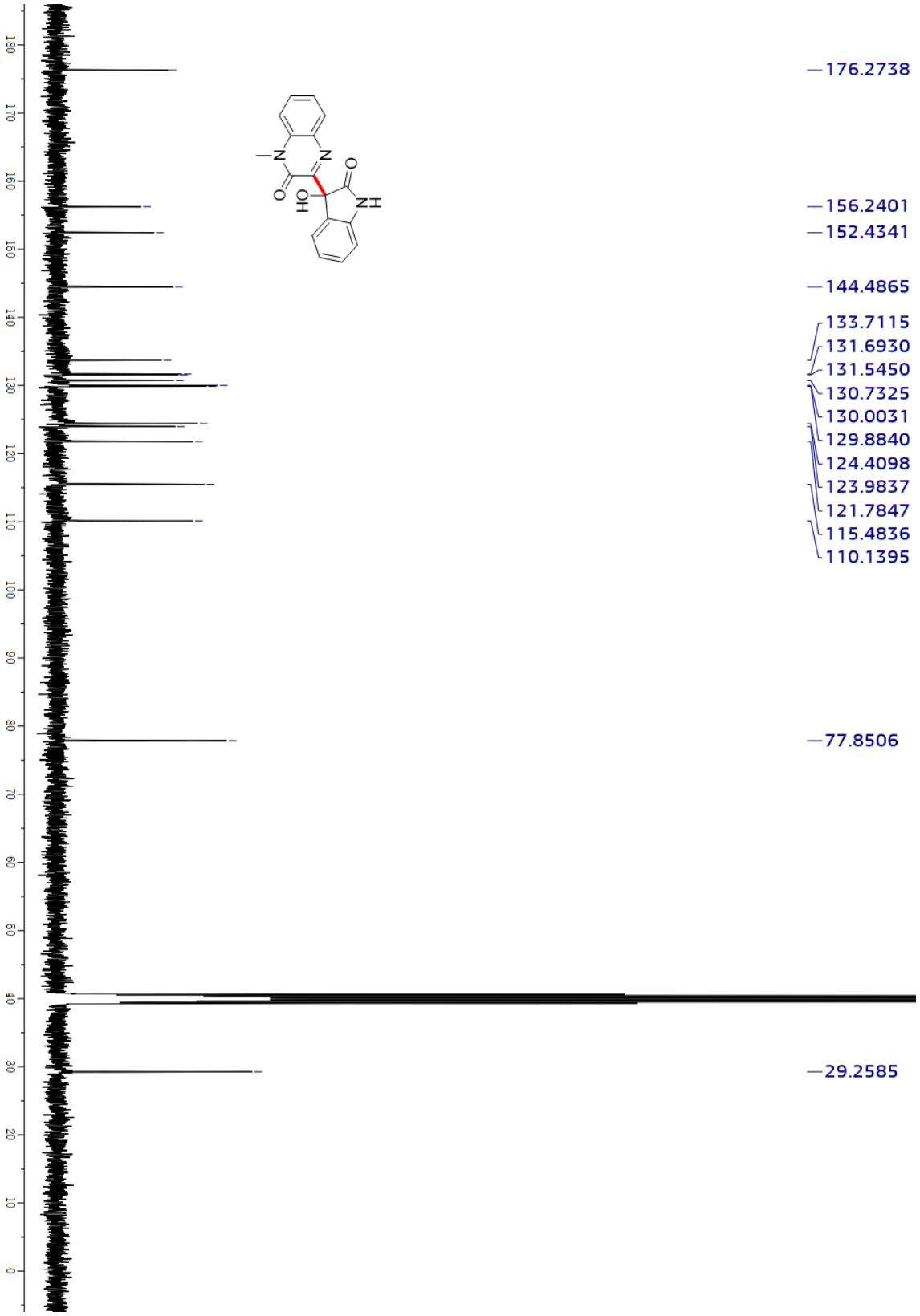


Figure S2. The ^{13}C NMR Spectrum of Compound **3a** in DMSO-d_6

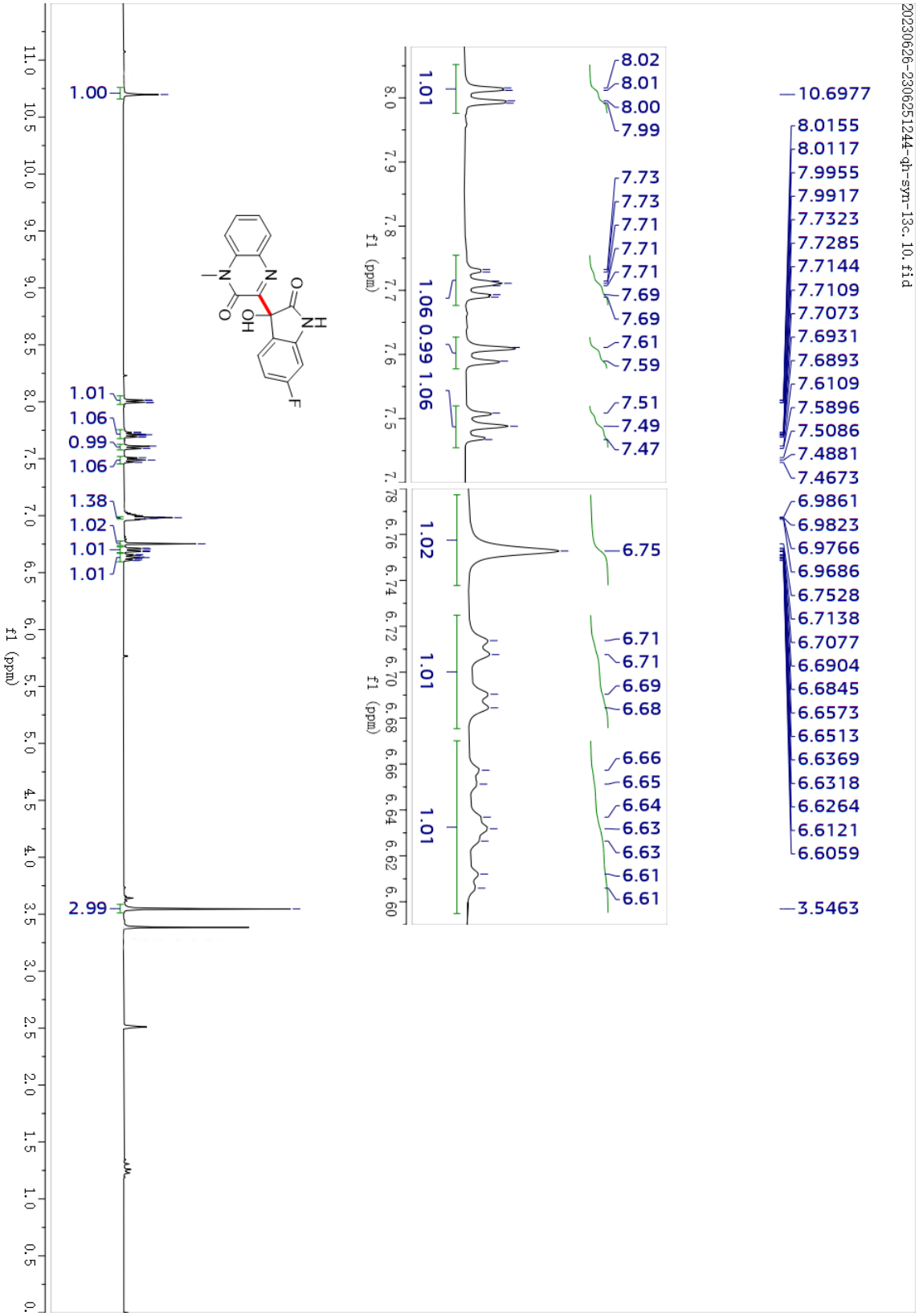


Figure S3. The ^{1}H NMR Spectrum of Compound **3b** in DMSO-d_6

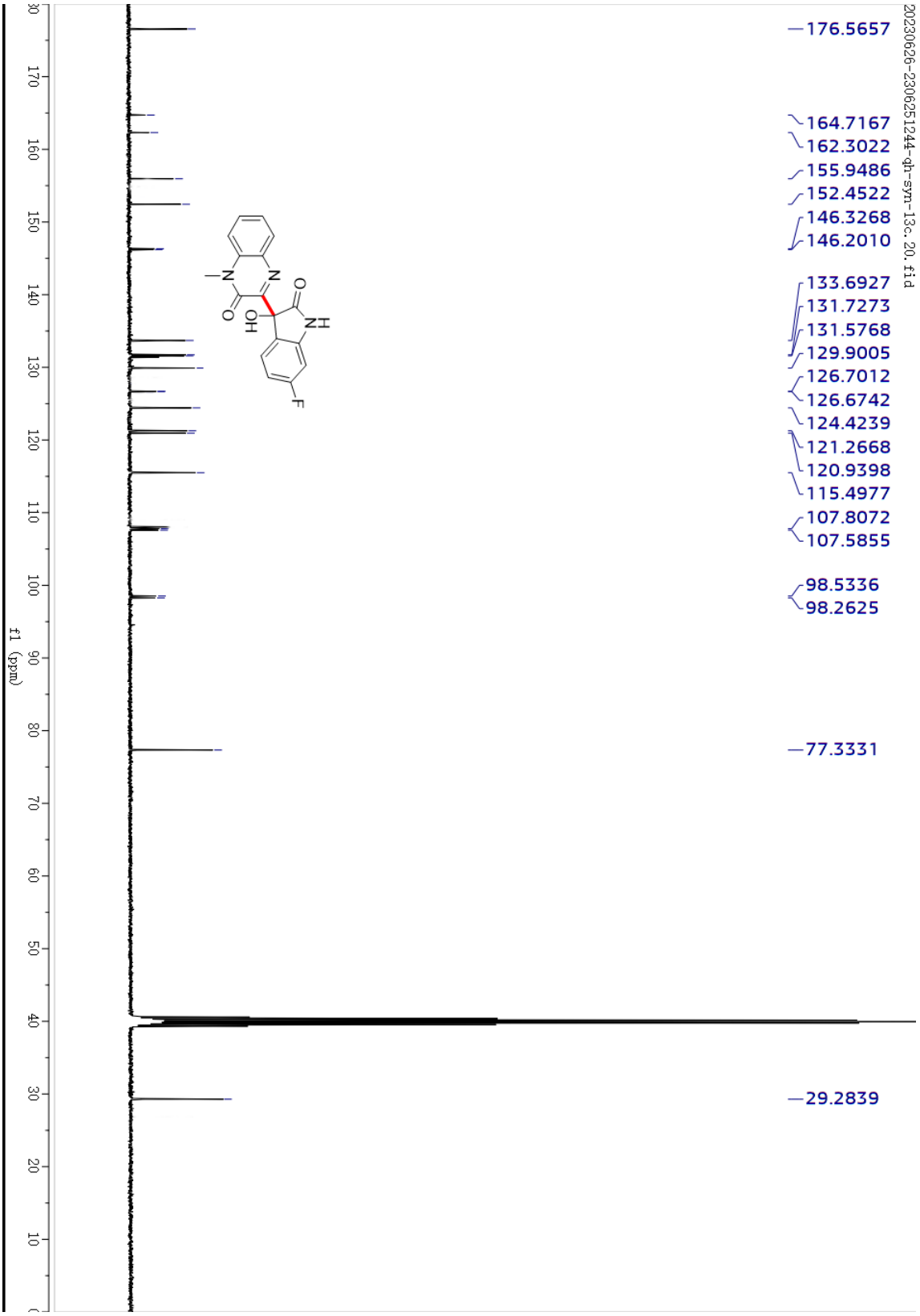


Figure S4. The ^{13}C NMR Spectrum of Compound **3b** in DMSO-d_6

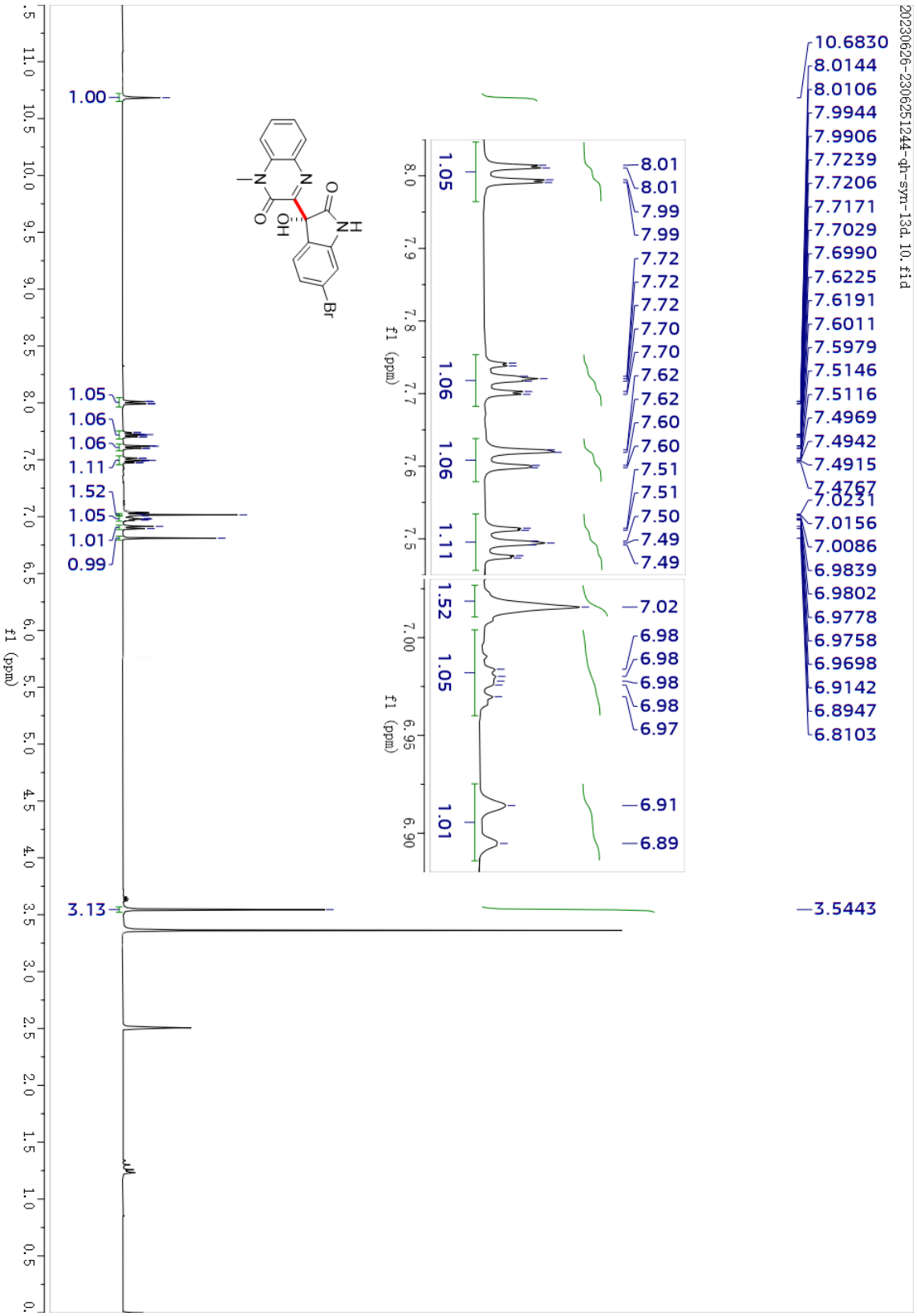


Figure S5. The ^{1}H NMR Spectrum of Compound **3c** in DMSO-d_6

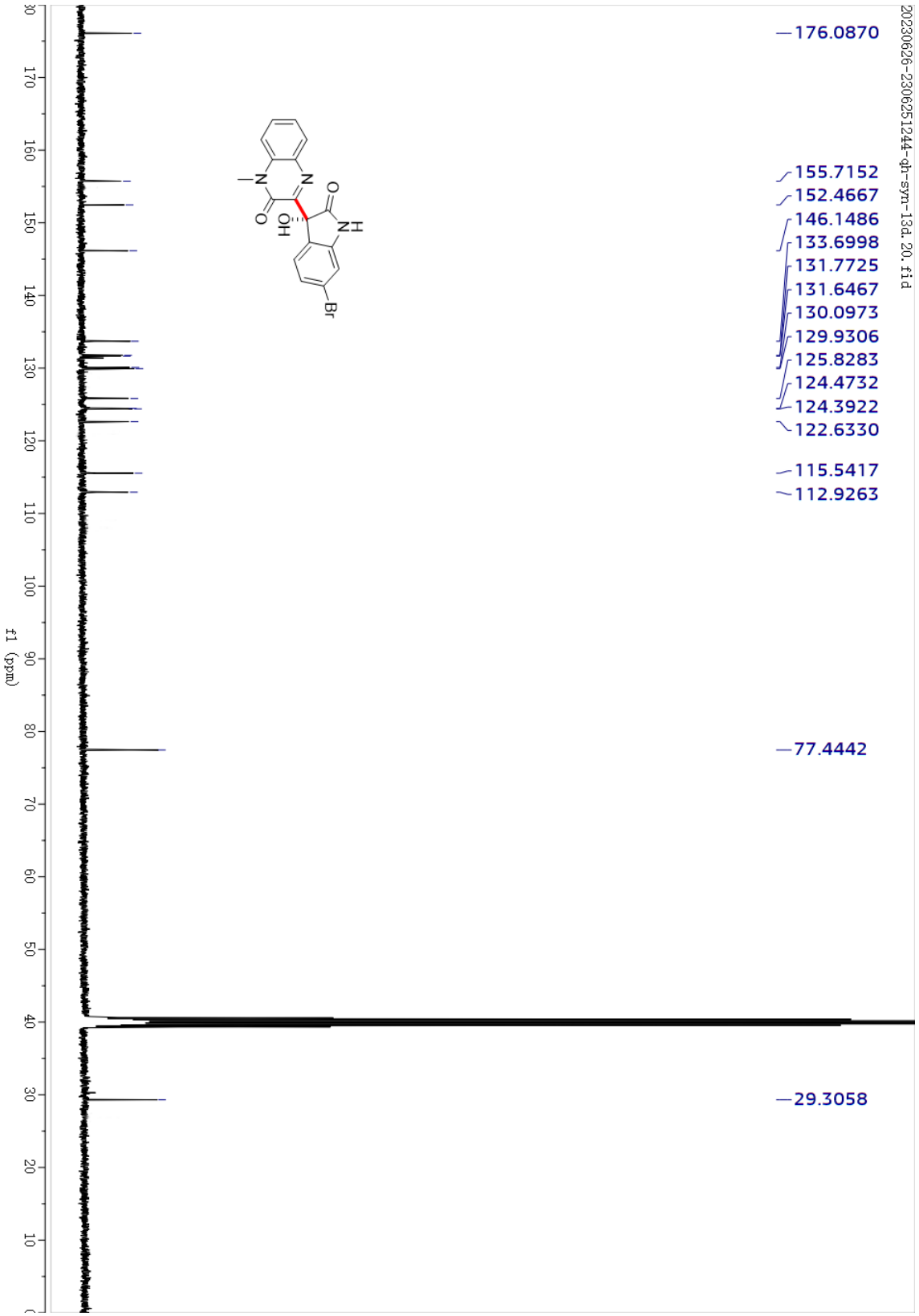


Figure S6. The ^{13}C NMR Spectrum of Compound **3c** in DMSO-d_6

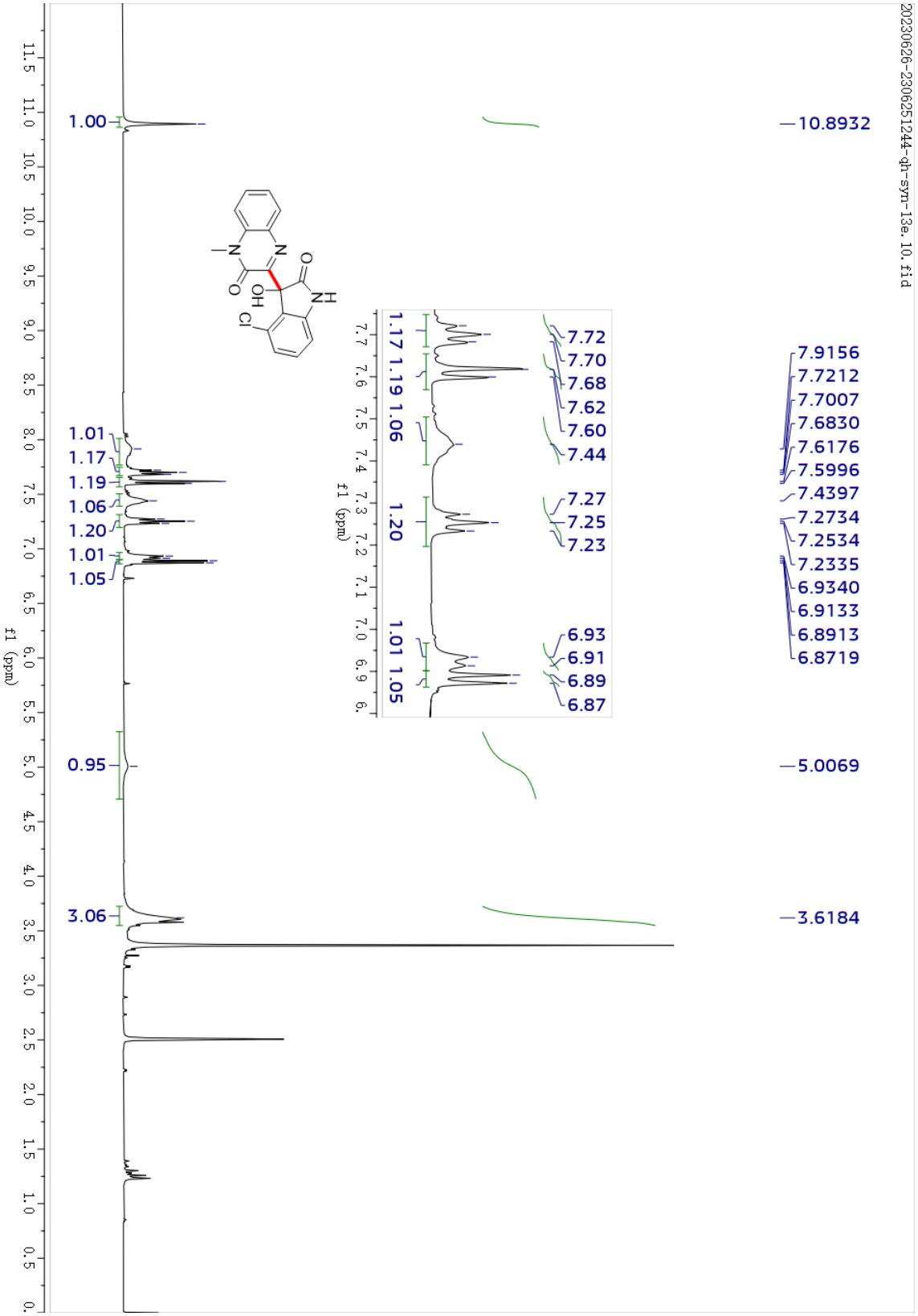


Figure S7. The ^{1}H NMR Spectrum of Compound **3d** in DMSO-d_6

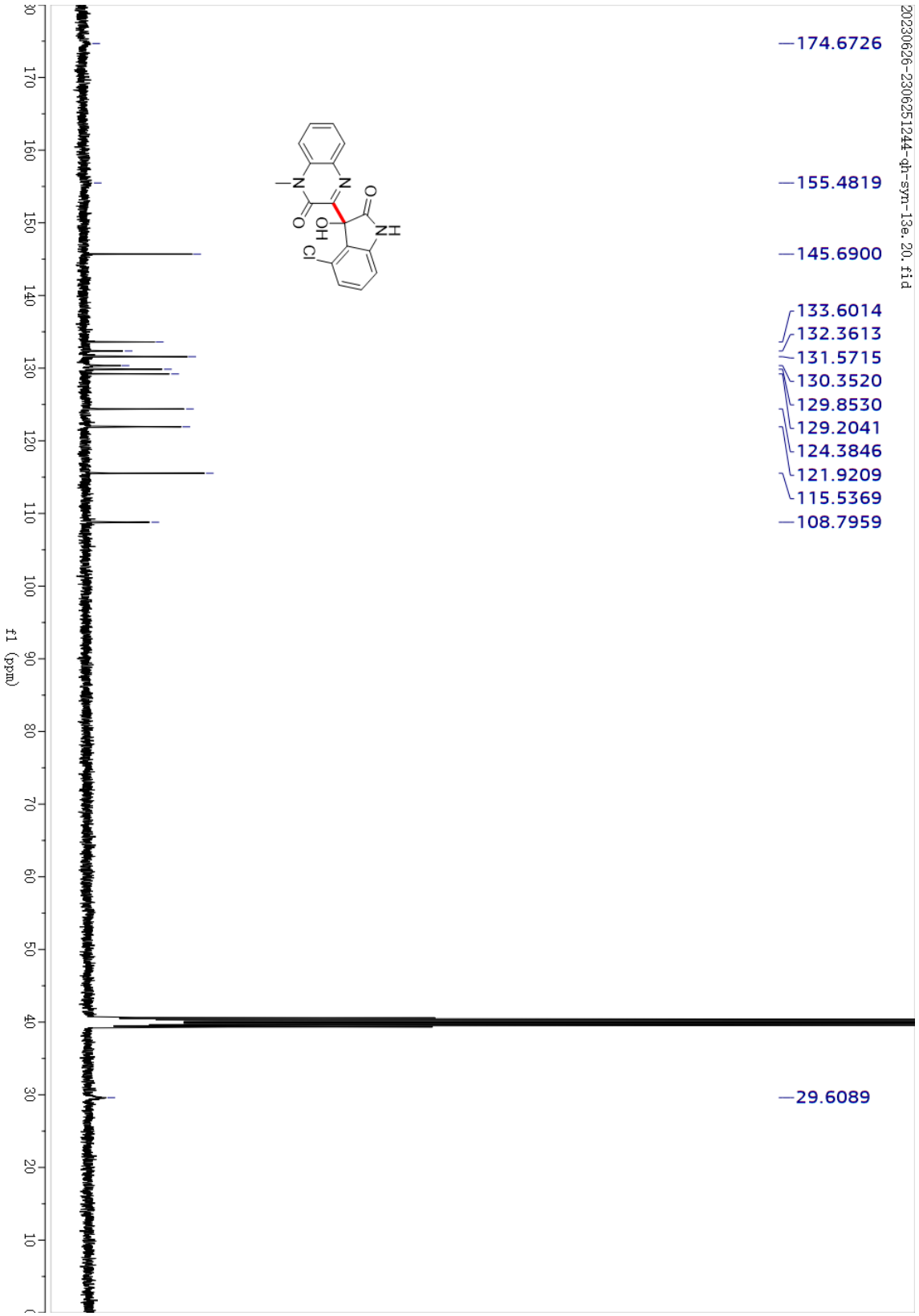


Figure S8. The ^{13}C NMR Spectrum of Compound **3d** in DMSO-d_6

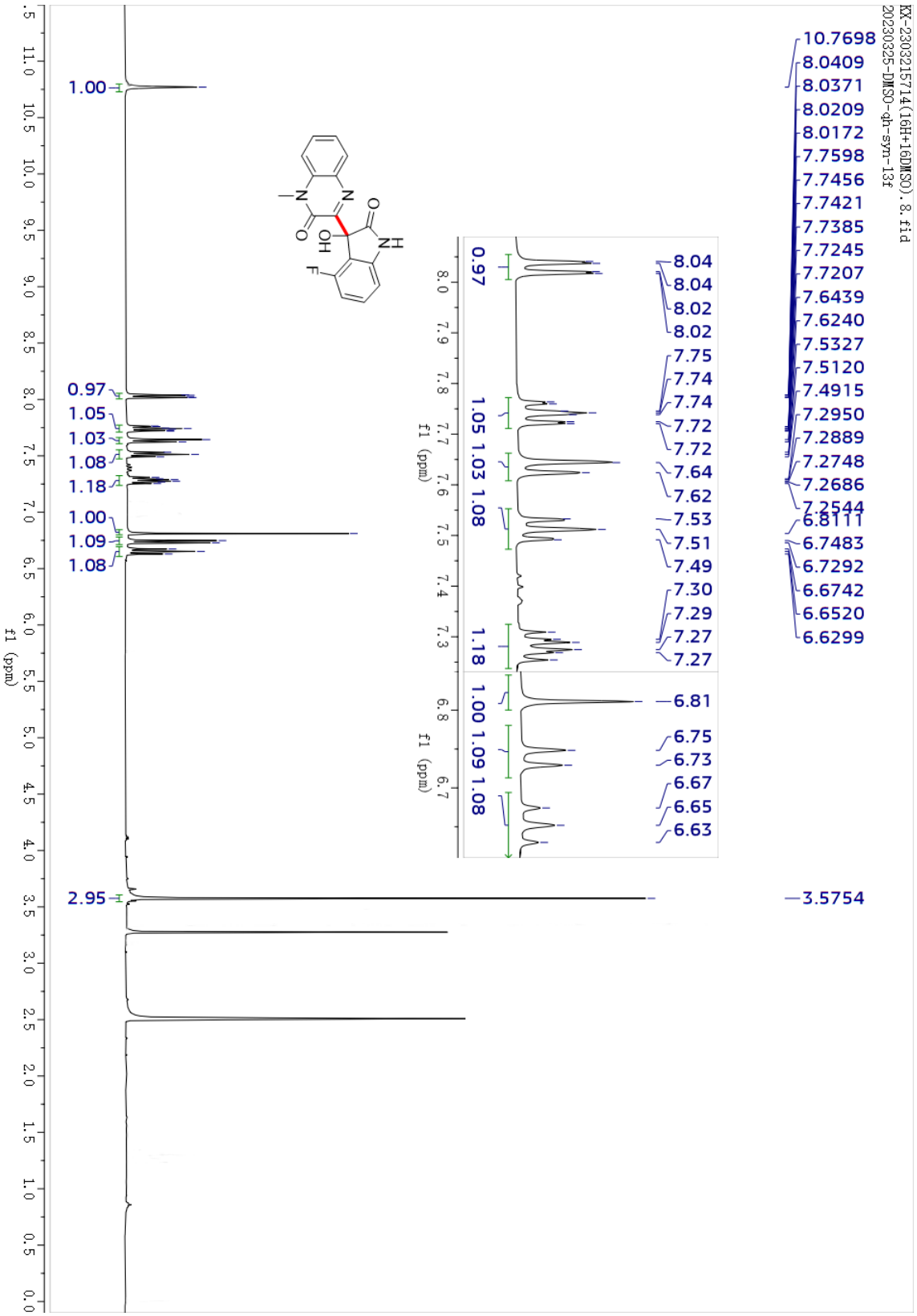


Figure S9. The ^{1}H NMR Spectrum of Compound **3e** in DMSO-d_6

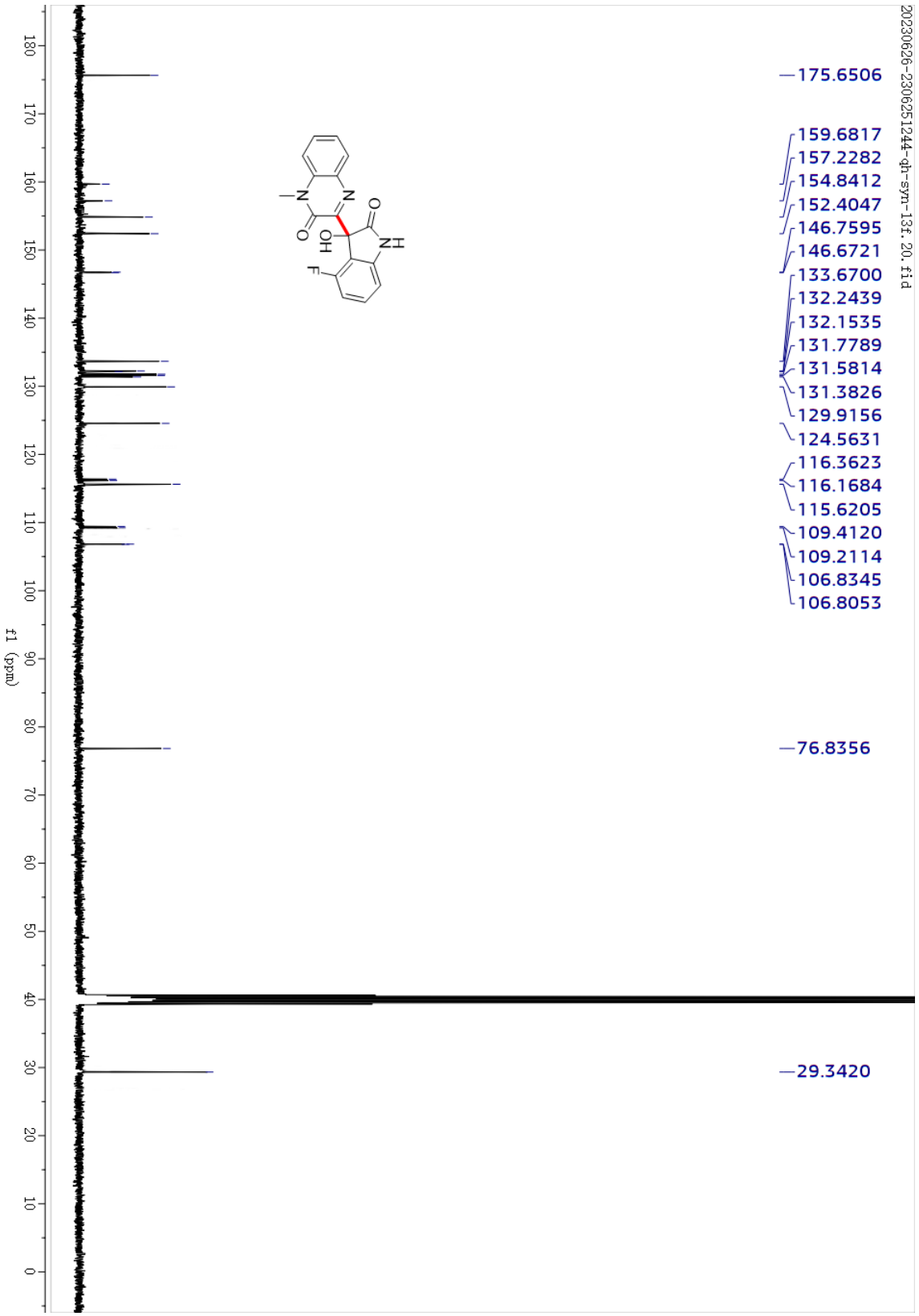


Figure S10. The ^{13}C NMR Spectrum of Compound **3e** in DMSO-d_6

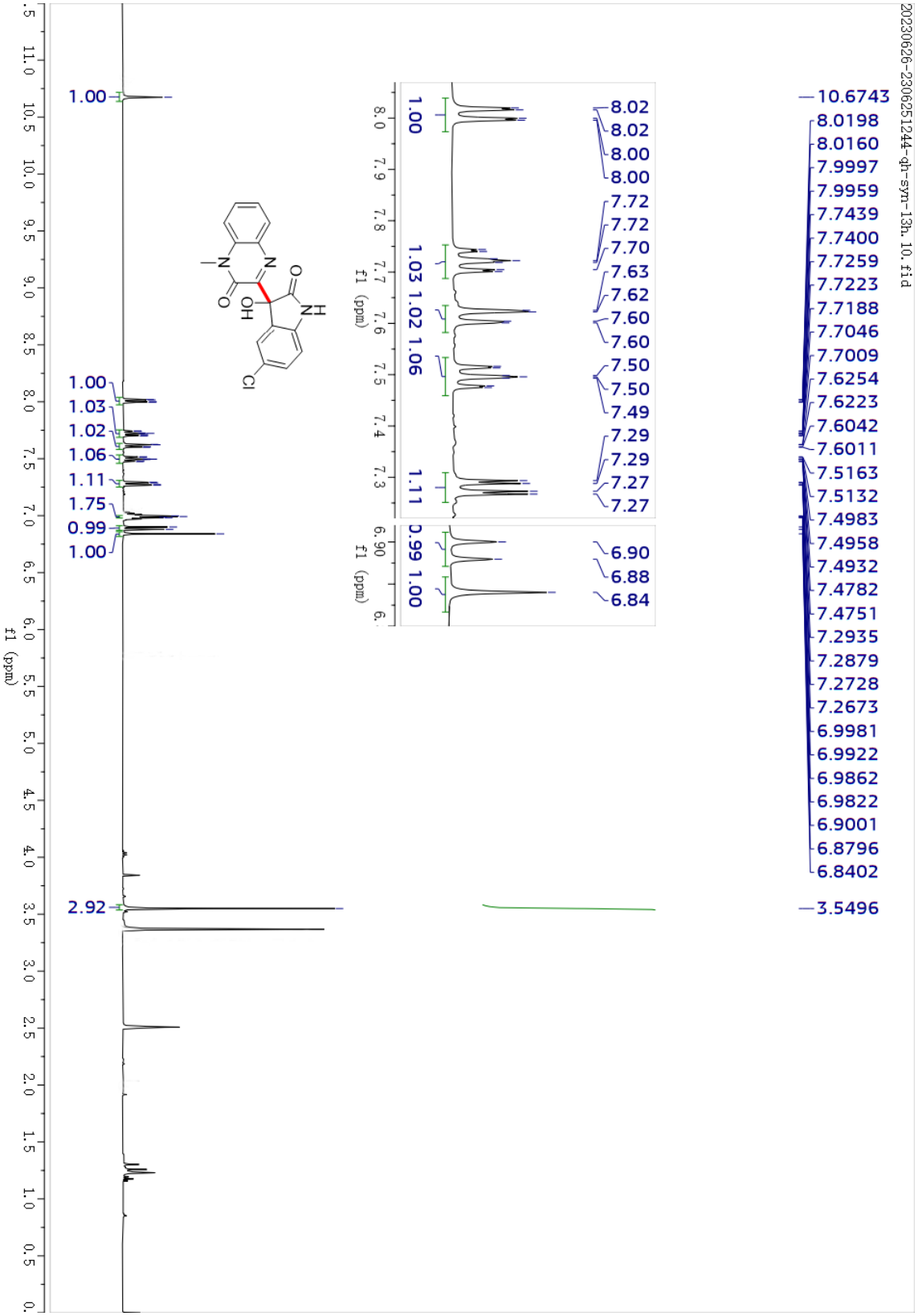


Figure S11. The ^{1}H NMR Spectrum of Compound **3f** in DMSO-d_6

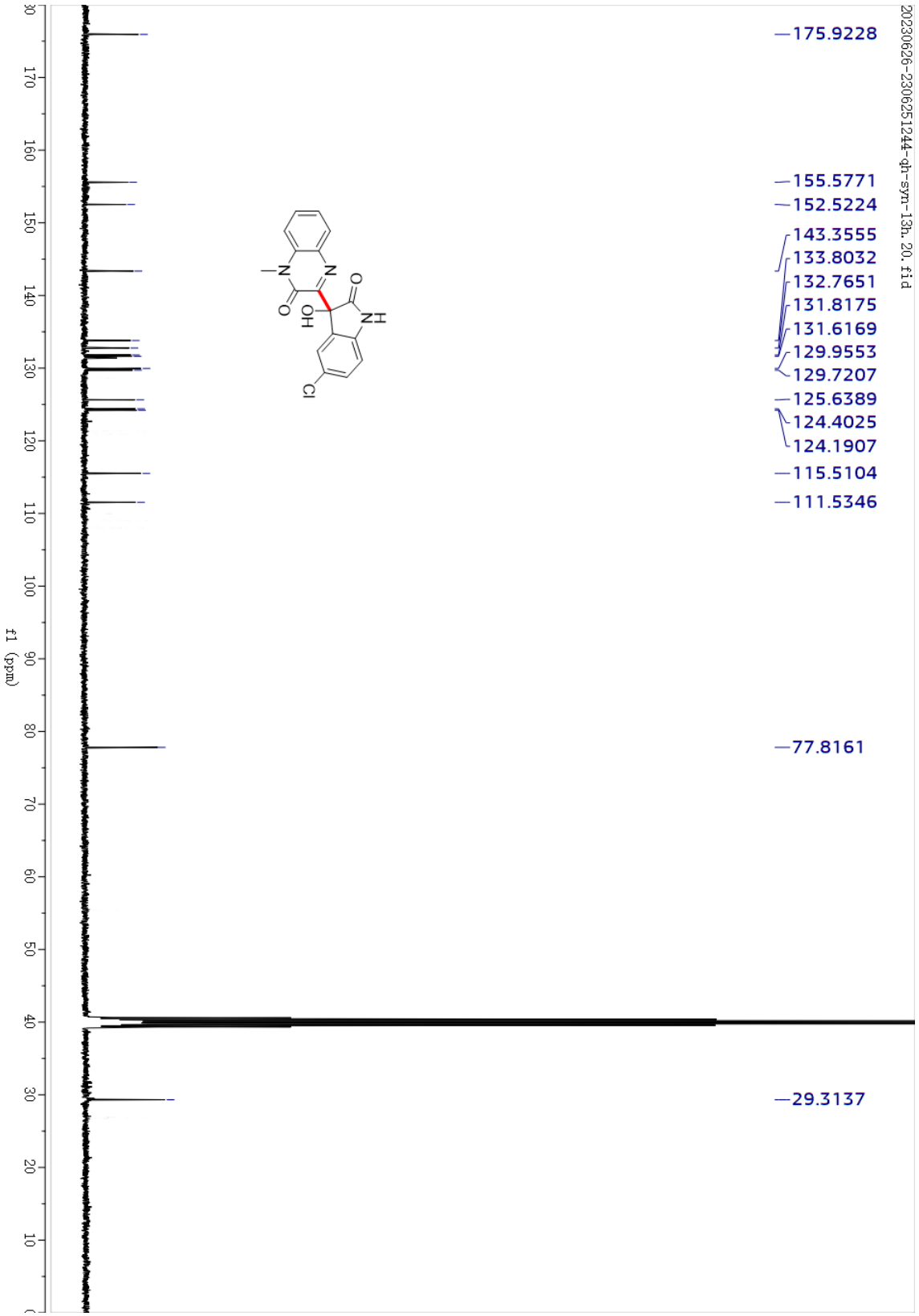


Figure S12. The ^{13}C NMR Spectrum of Compound **3f** in DMSO-d_6

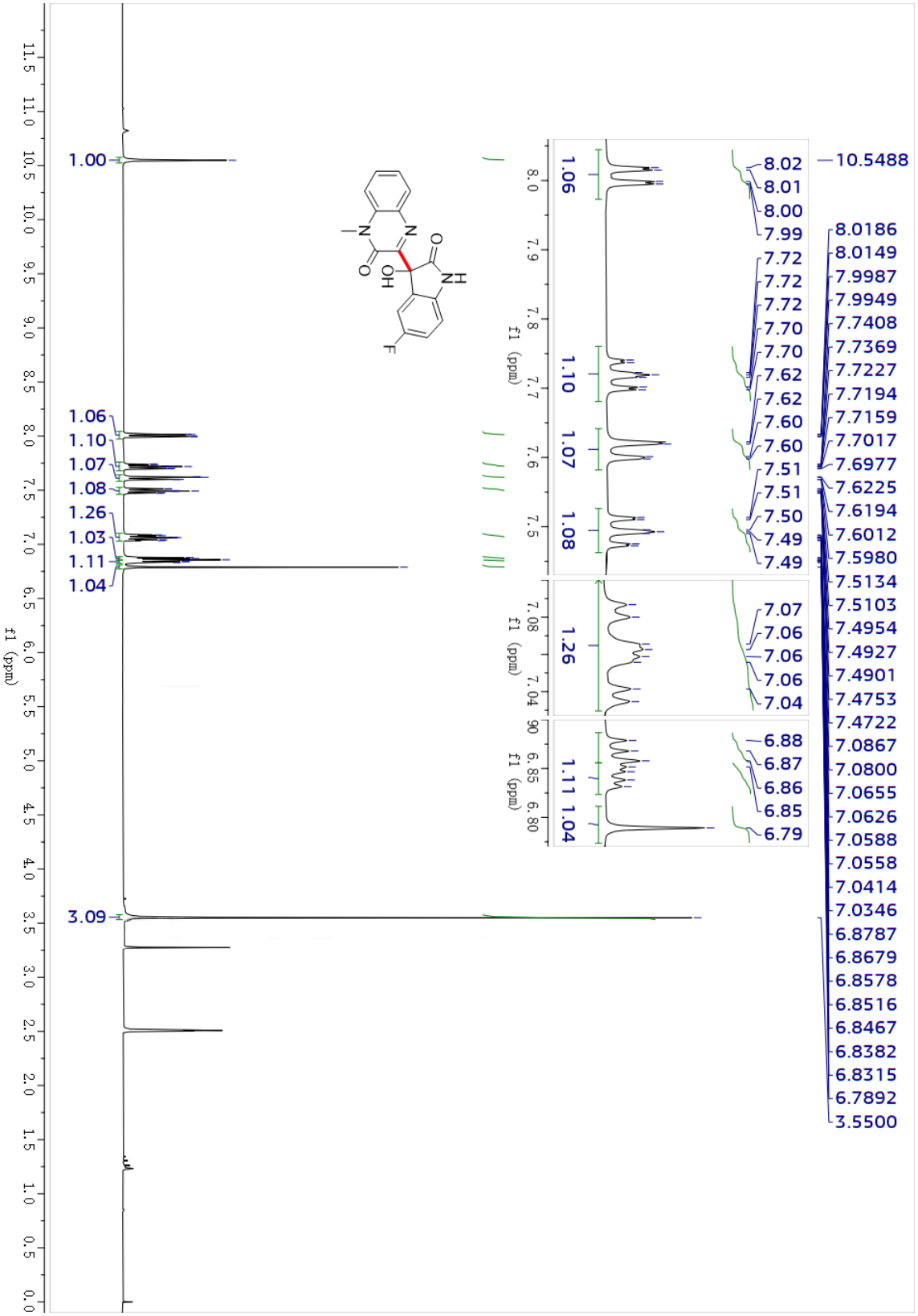


Figure S13. The ^{1}H NMR Spectrum of Compound **3g** in DMSO-d_6

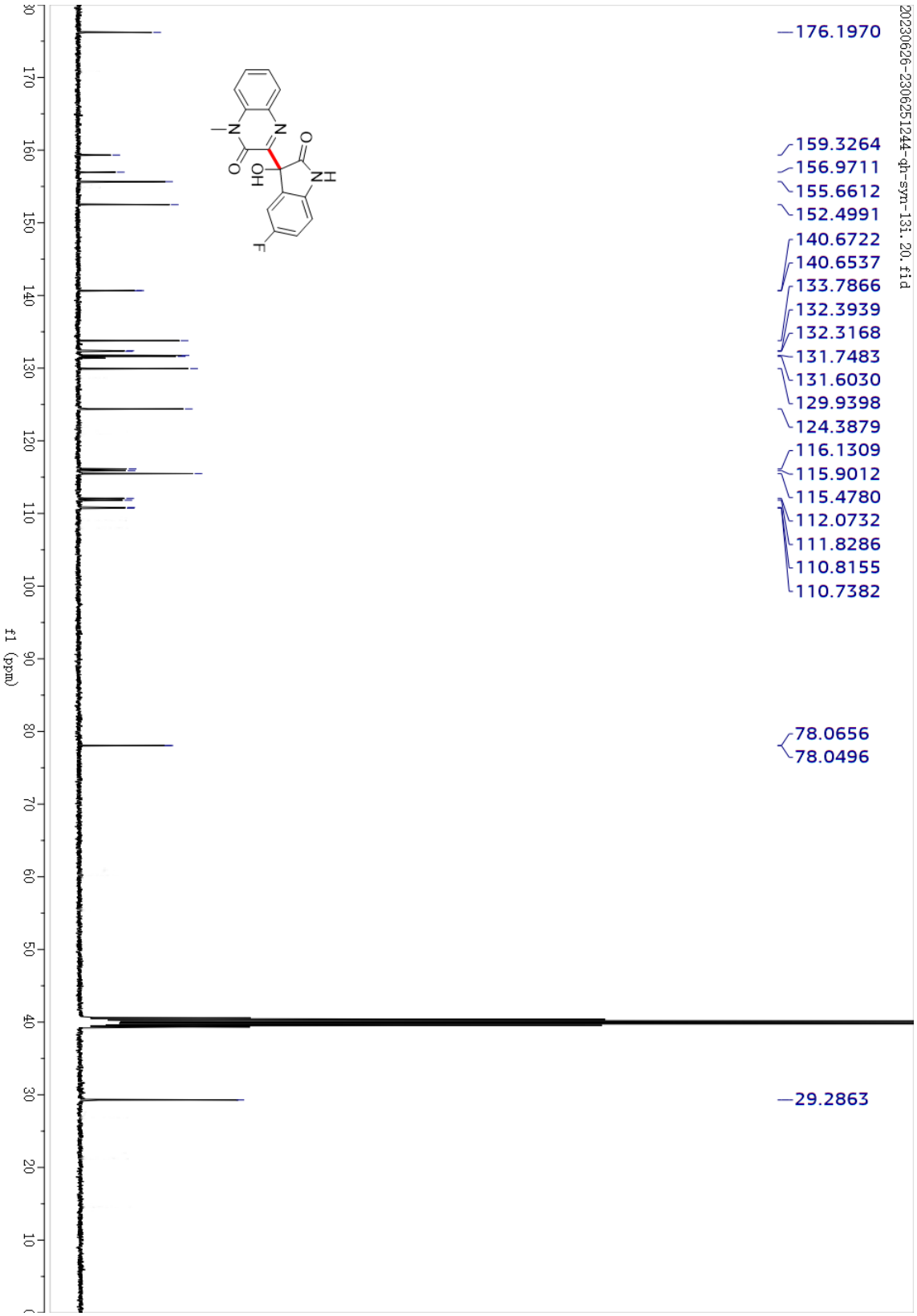


Figure S14. The ^{13}C NMR Spectrum of Compound **3g** in DMSO-d_6

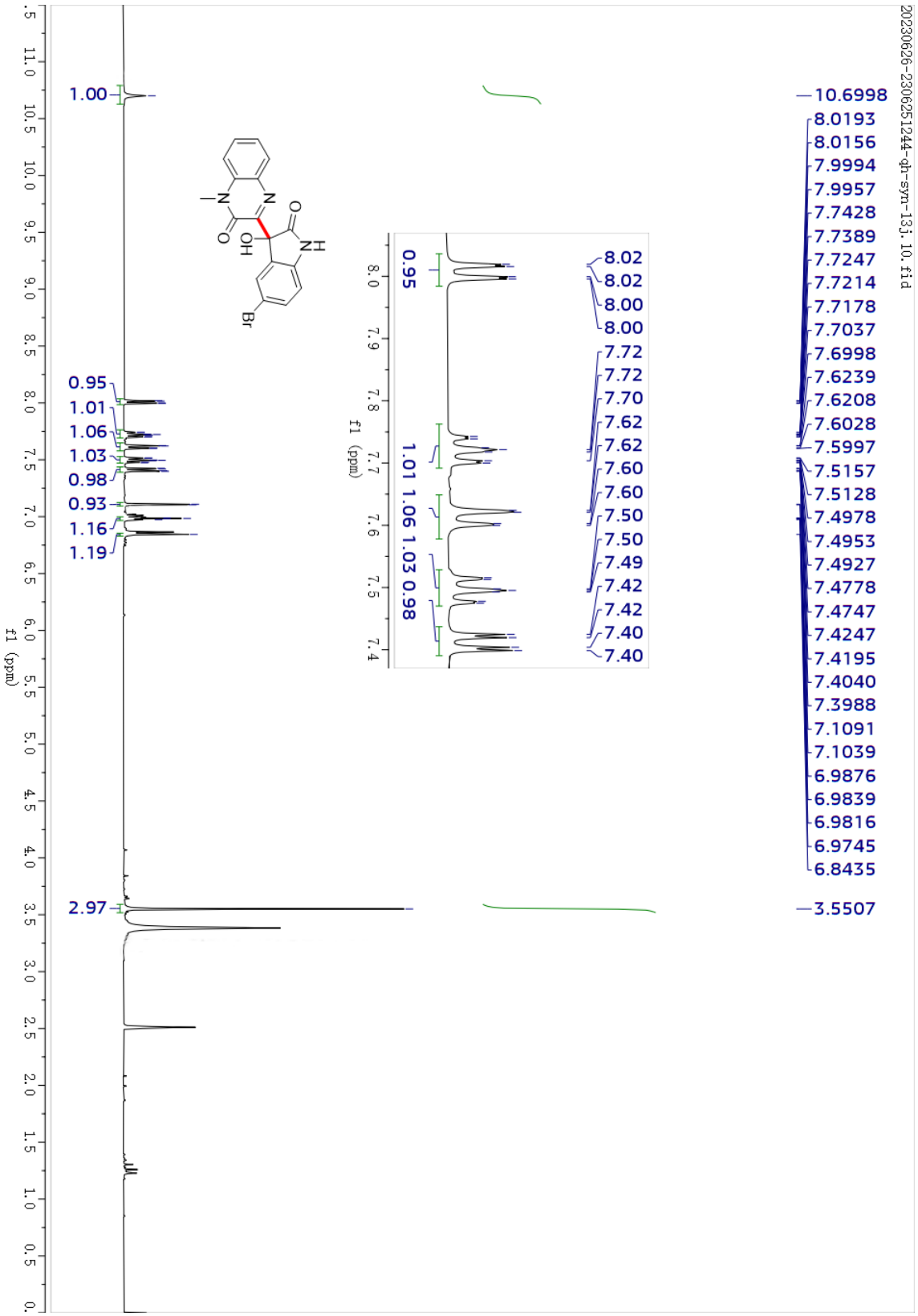


Figure S15. The ^{1}H NMR Spectrum of Compound **3h** in DMSO-d_6

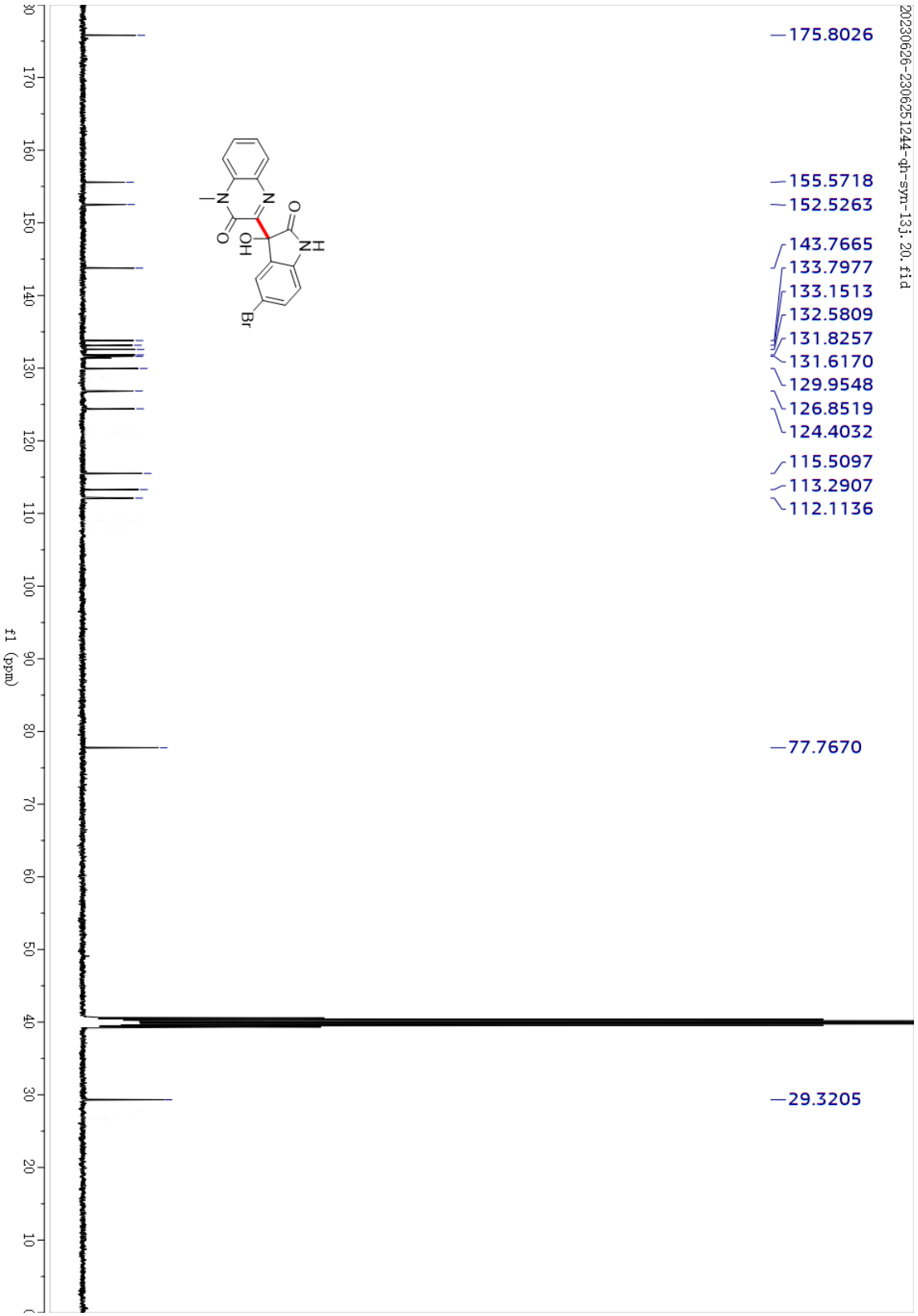


Figure S16. The ^{13}C NMR Spectrum of Compound **3h** in DMSO-d_6

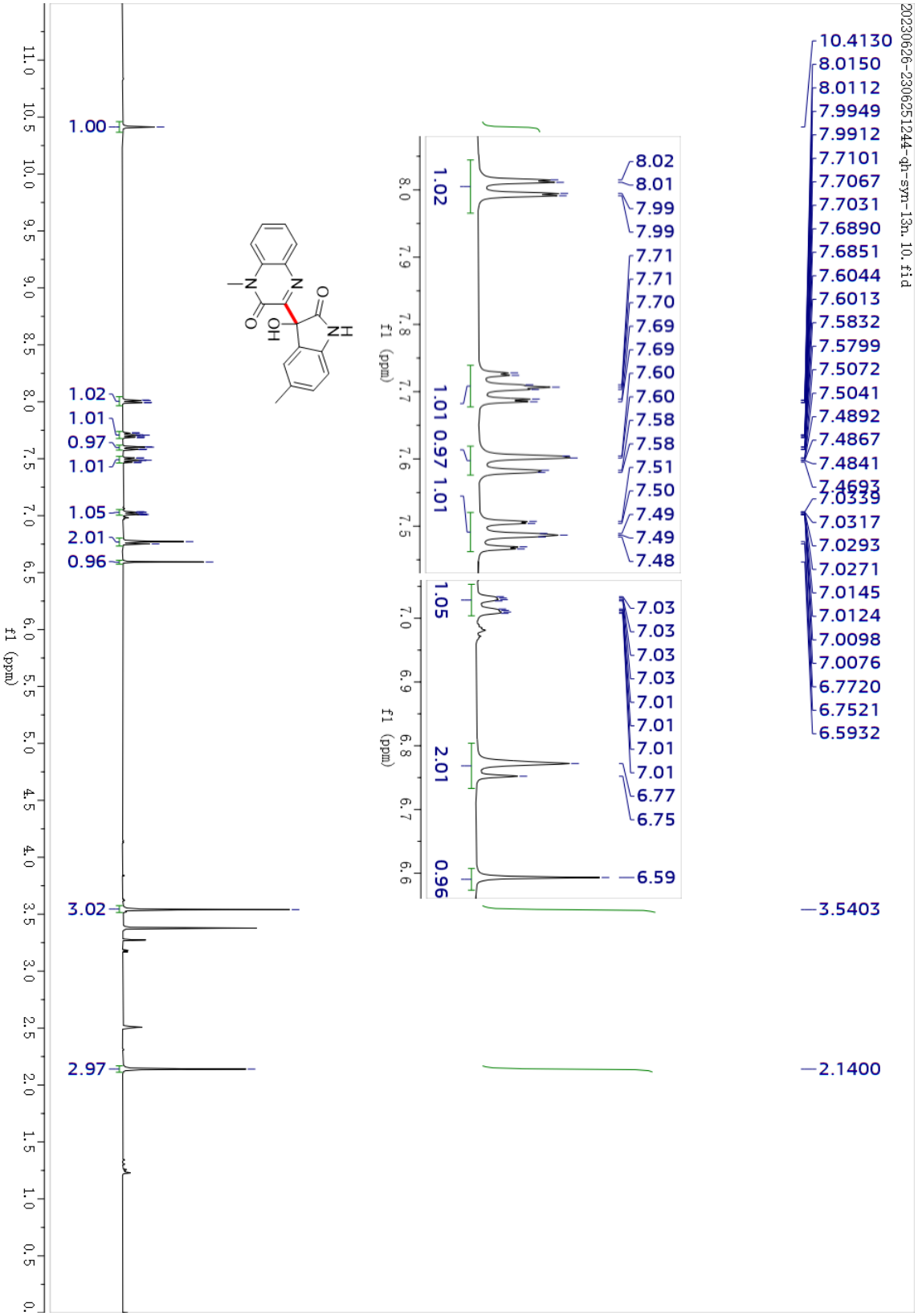


Figure S17. The ^{1}H NMR Spectrum of Compound **3i** in DMSO-d_6

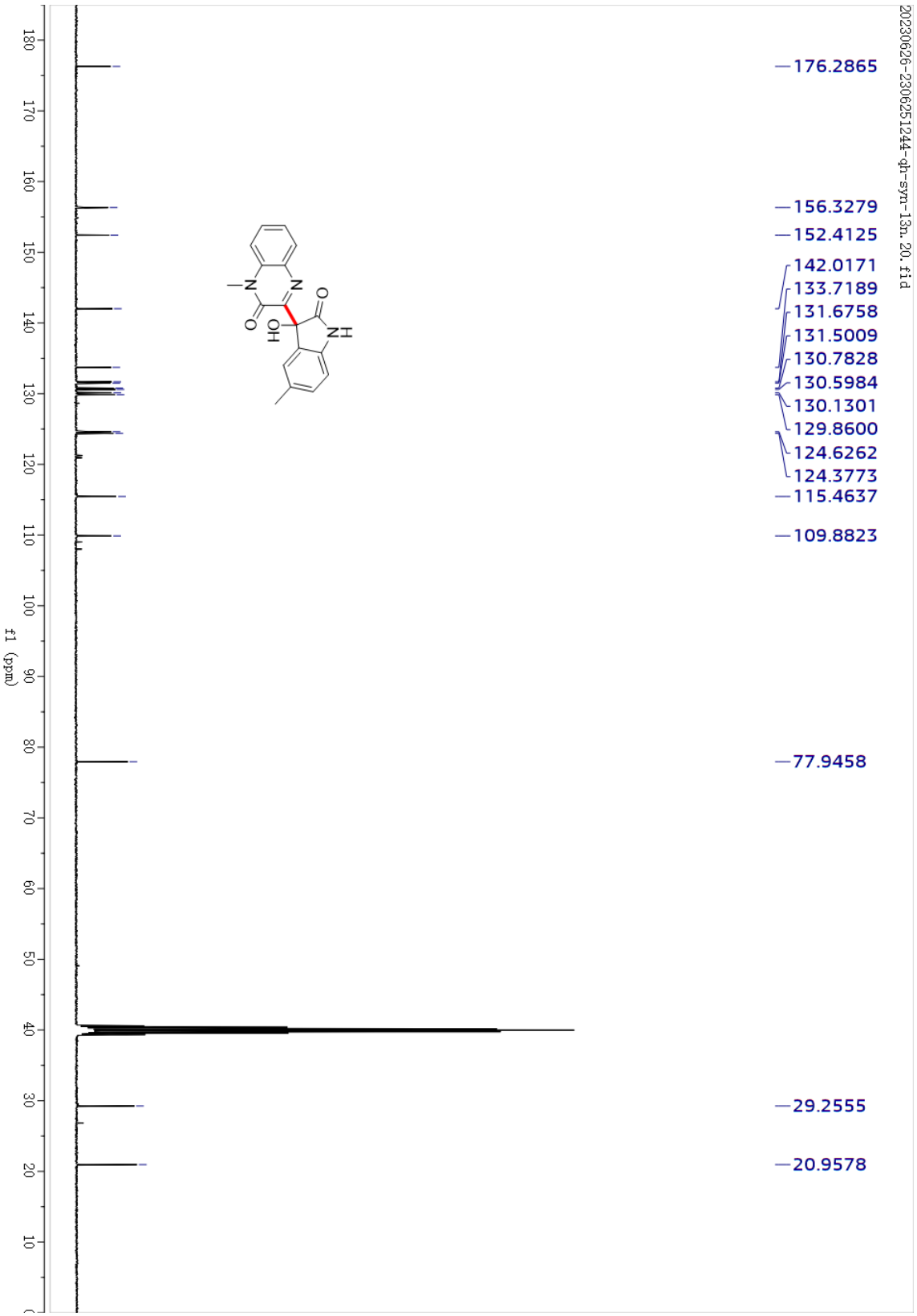


Figure S18. The ^{13}C NMR Spectrum of Compound 3**i** in DMSO-d_6

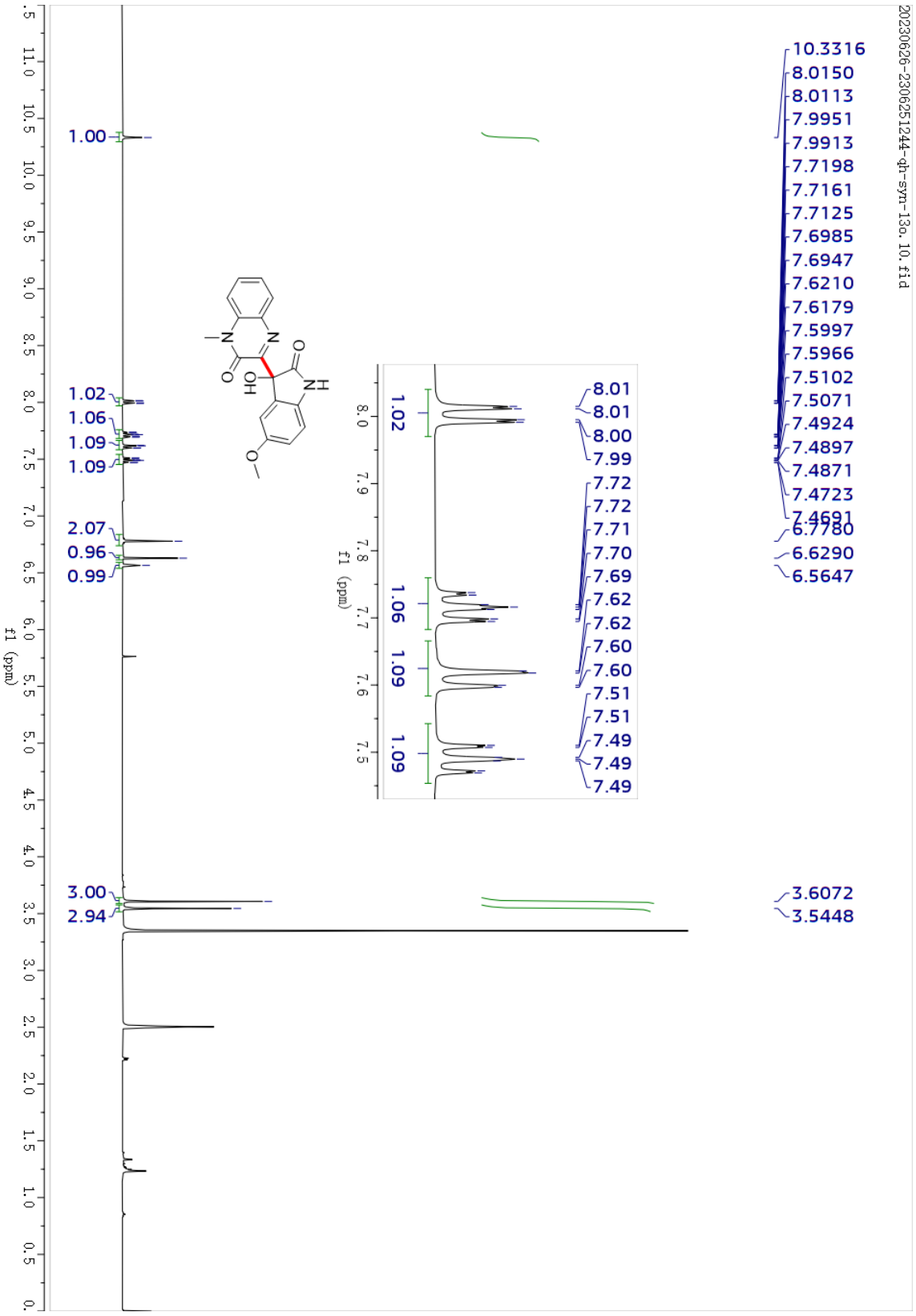


Figure S19. The ^{1}H NMR Spectrum of Compound **3j** in DMSO-d_6

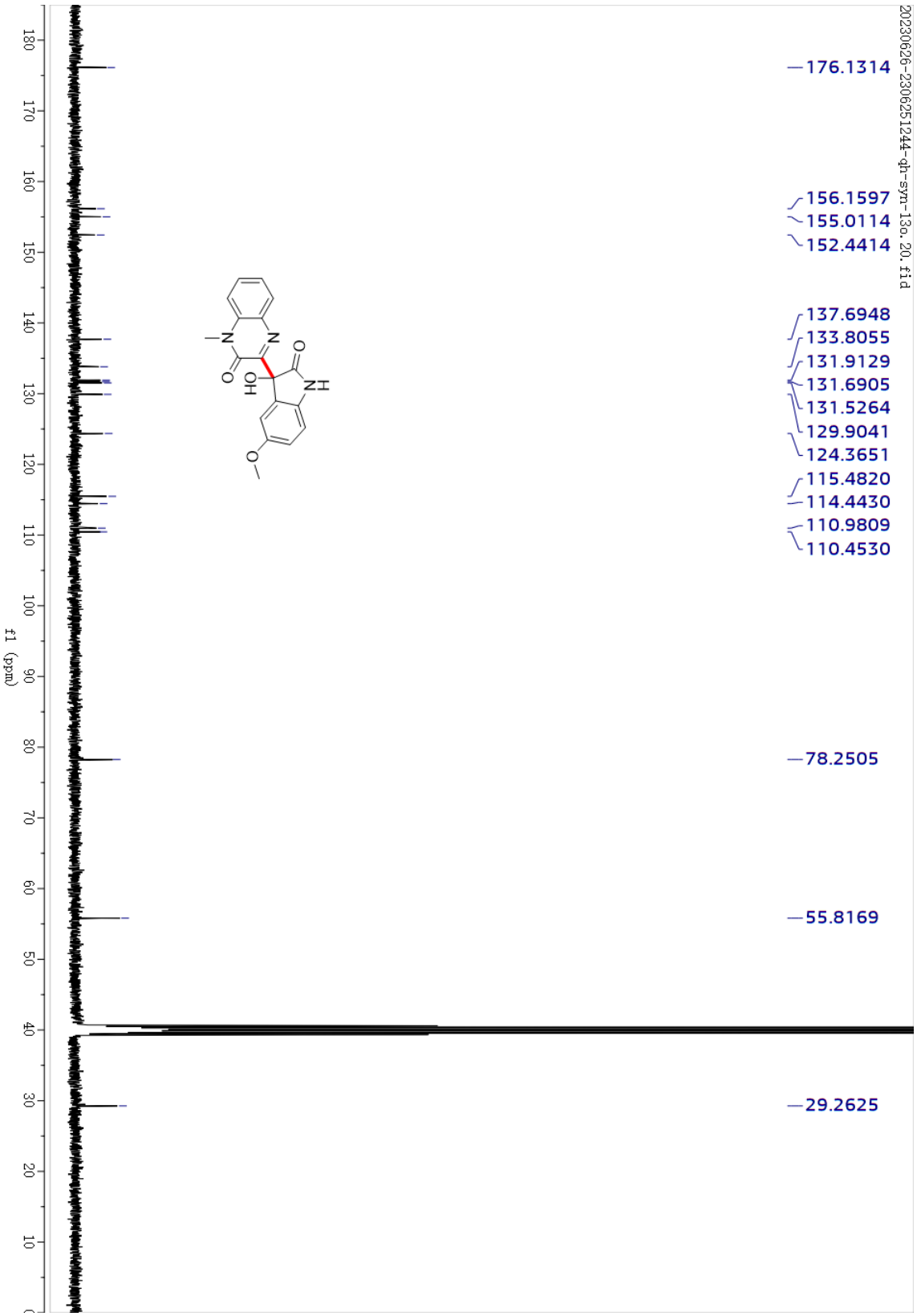


Figure S20. The ^{13}C NMR Spectrum of Compound **3j** in DMSO-d_6

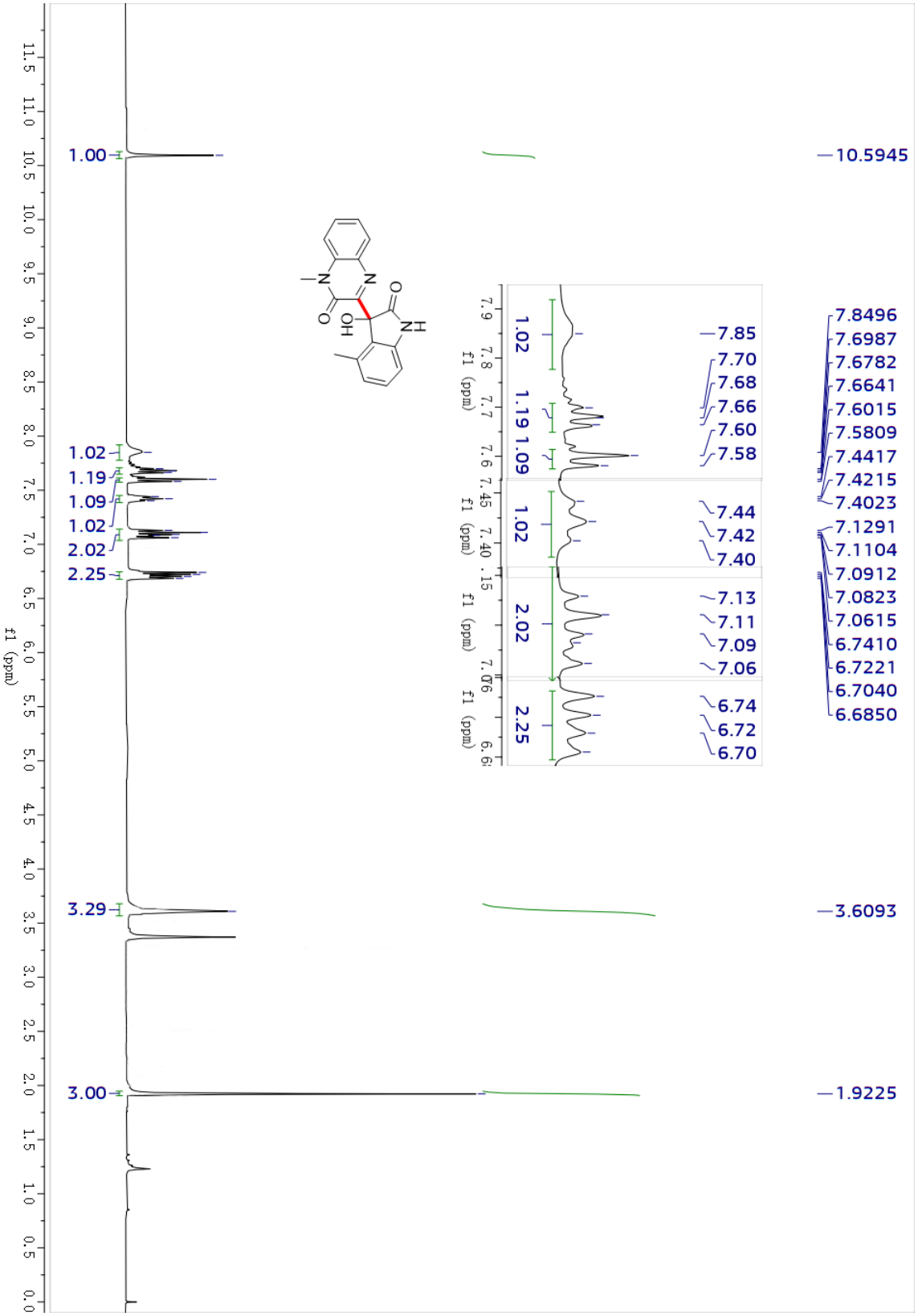


Figure S21. The ^{1}H NMR Spectrum of Compound **3k** in DMSO-d_6

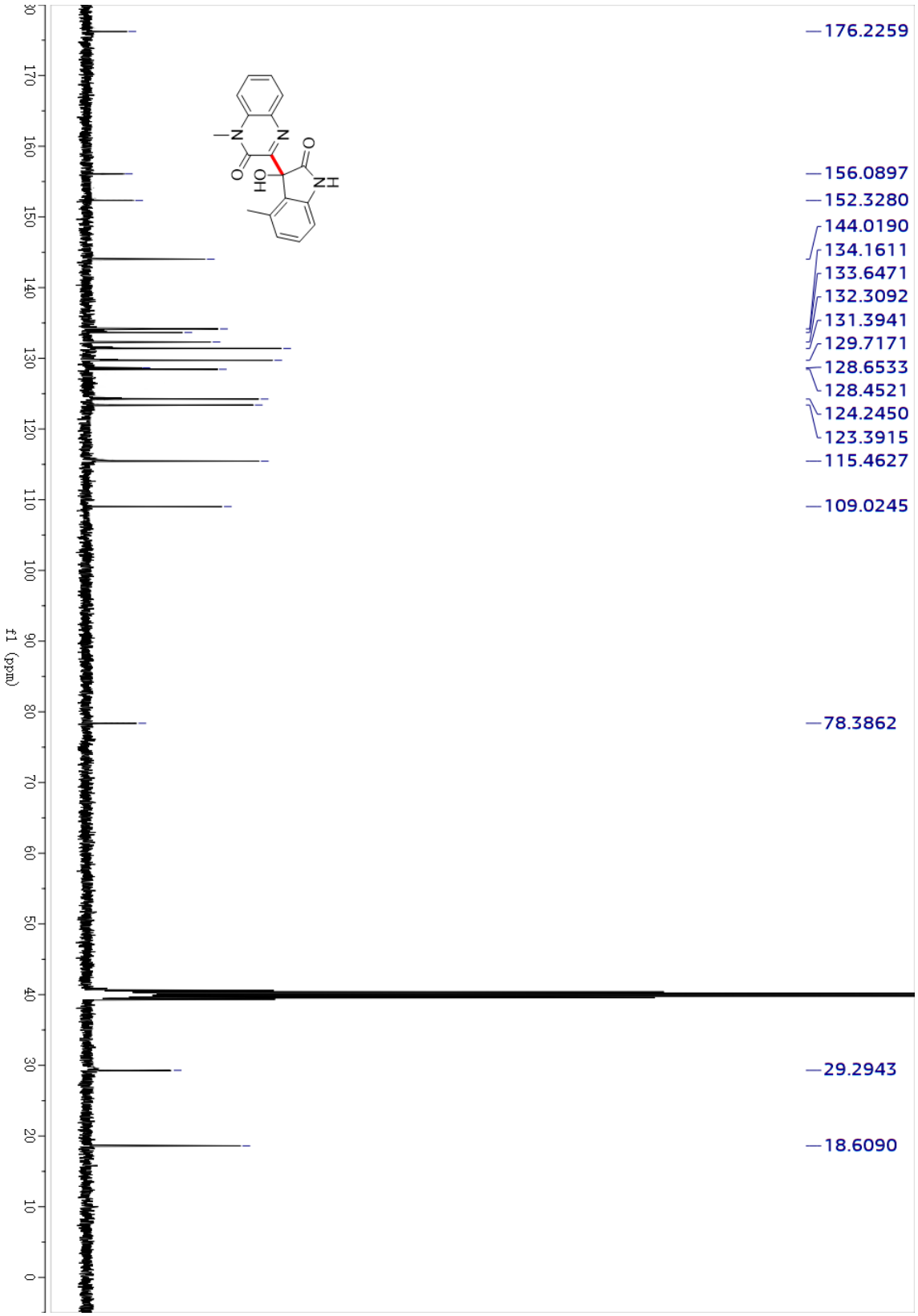


Figure S22. The ^{13}C NMR Spectrum of Compound **3k** in DMSO-d_6

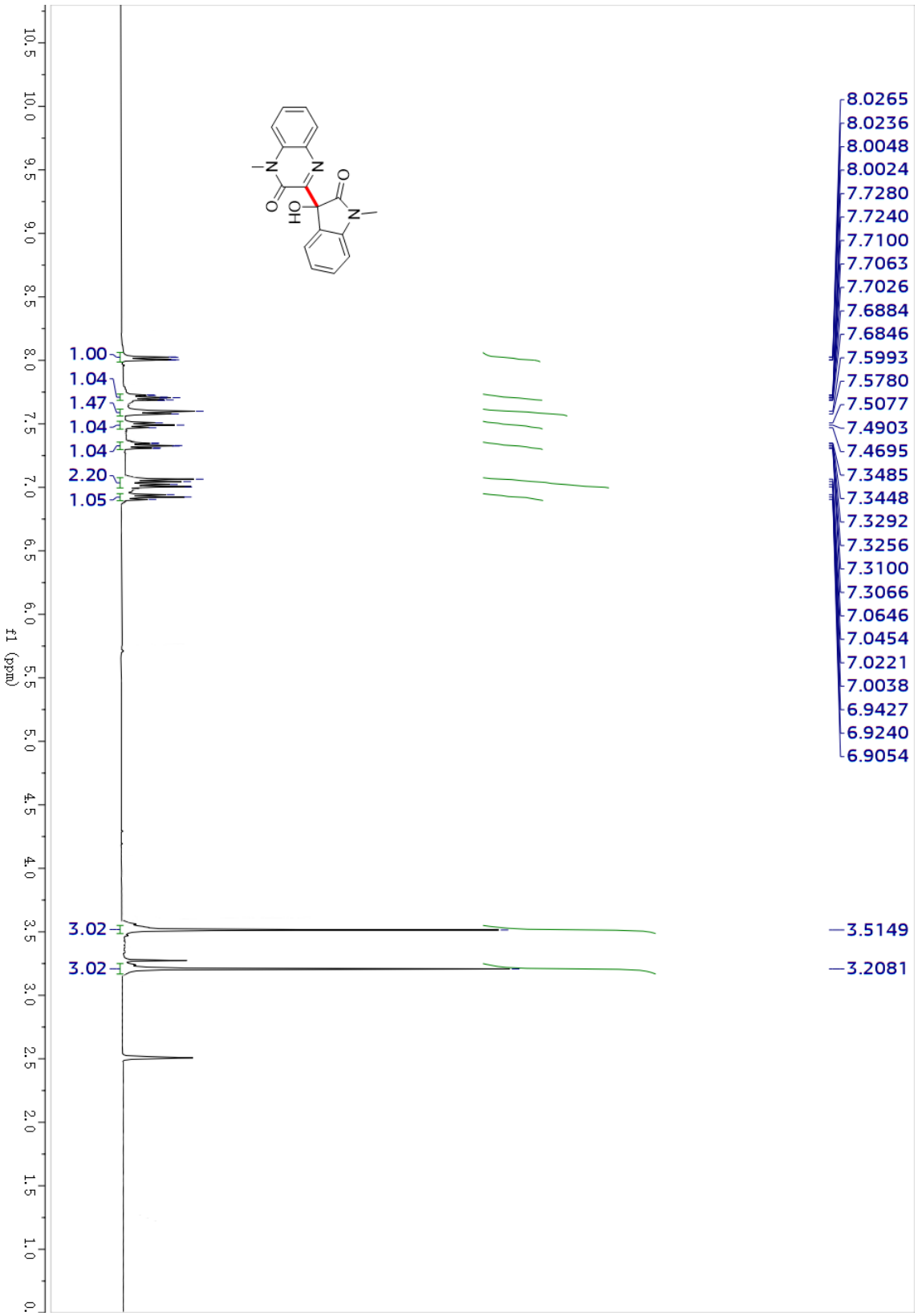


Figure S23. The ^{1}H NMR Spectrum of Compound **3l** in DMSO-d_6

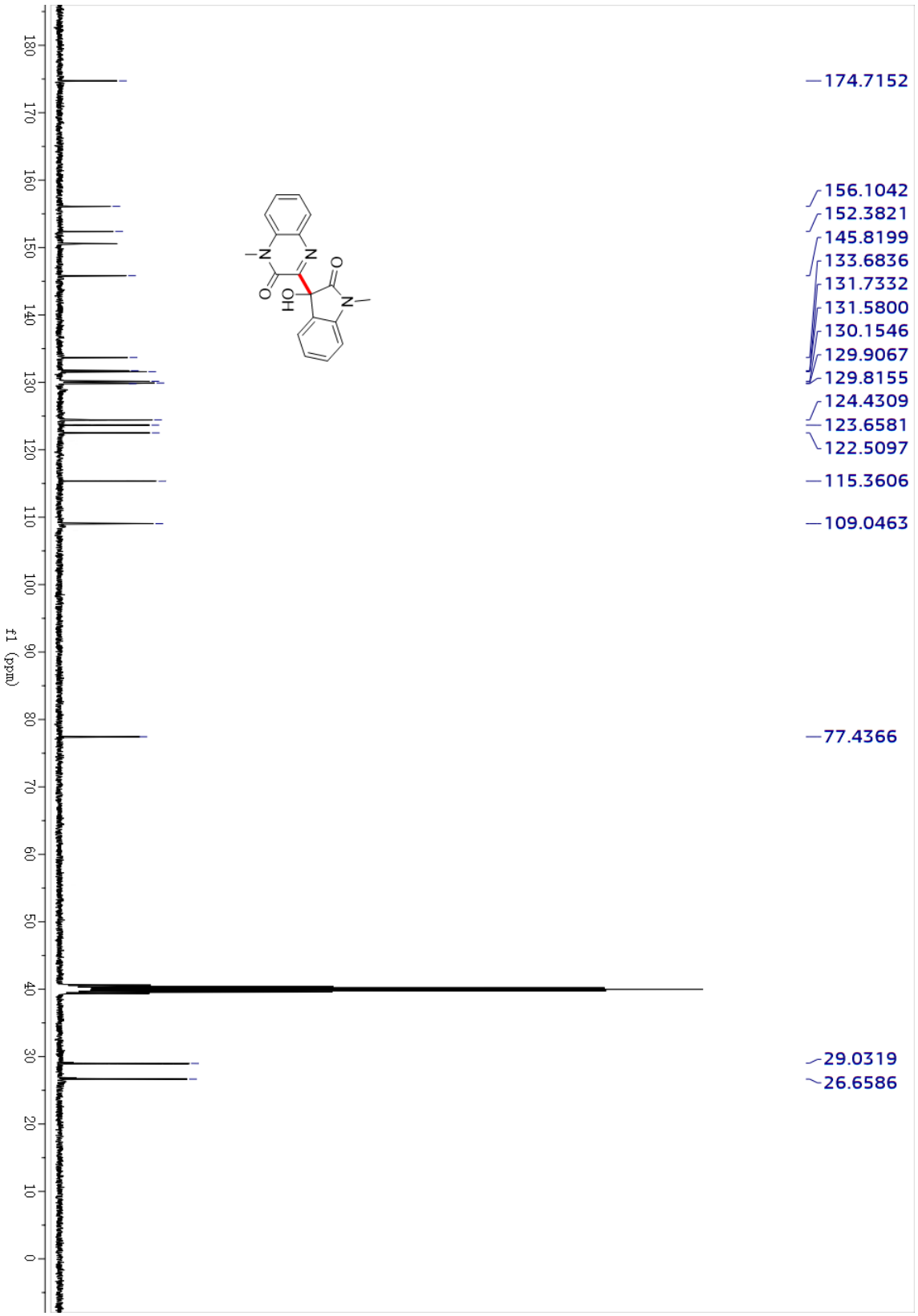


Figure S24. The ^{13}C NMR Spectrum of Compound **3l** in DMSO-d_6

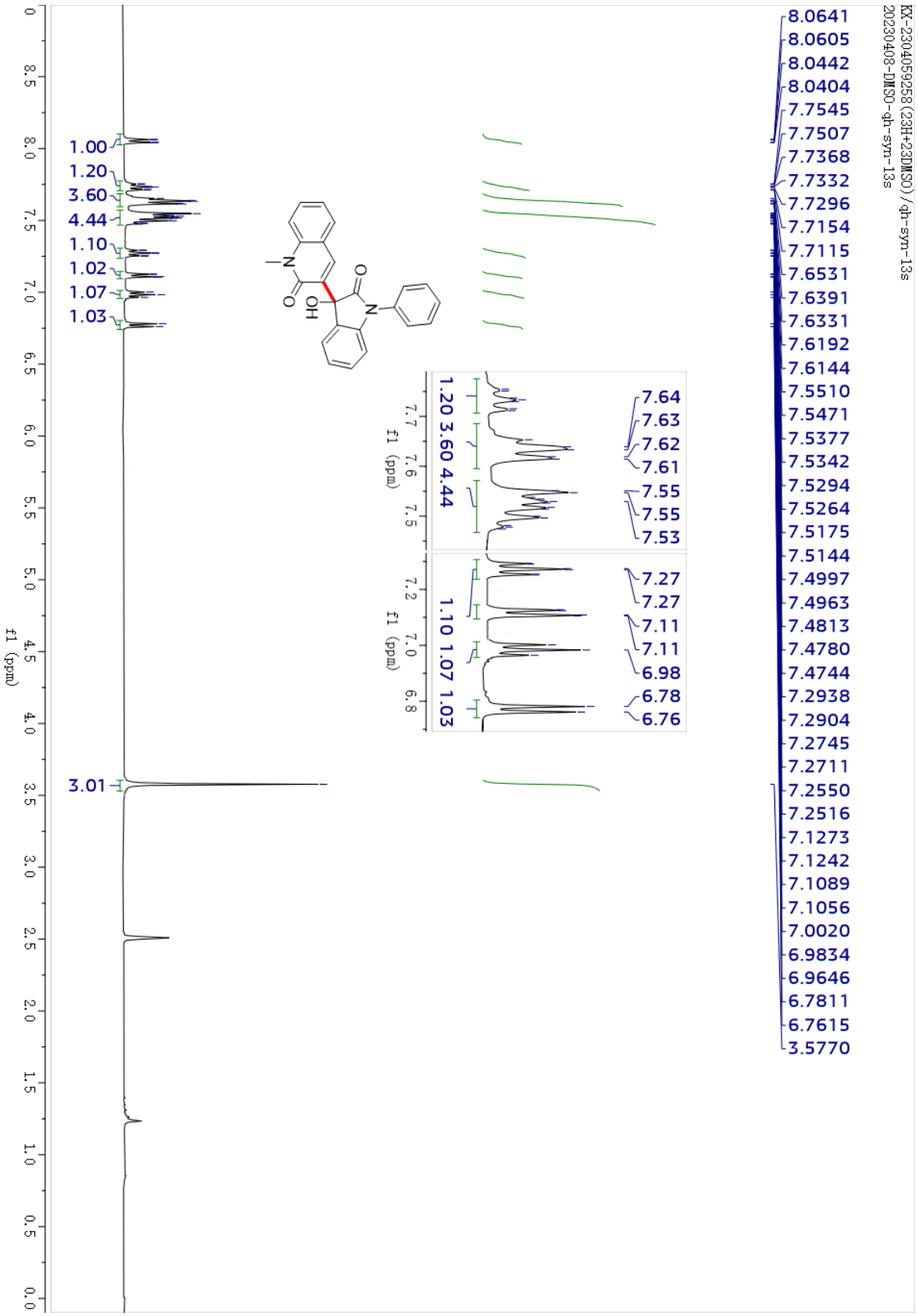


Figure S25. The ^{1}H NMR Spectrum of Compound **3m** in DMSO-d_6

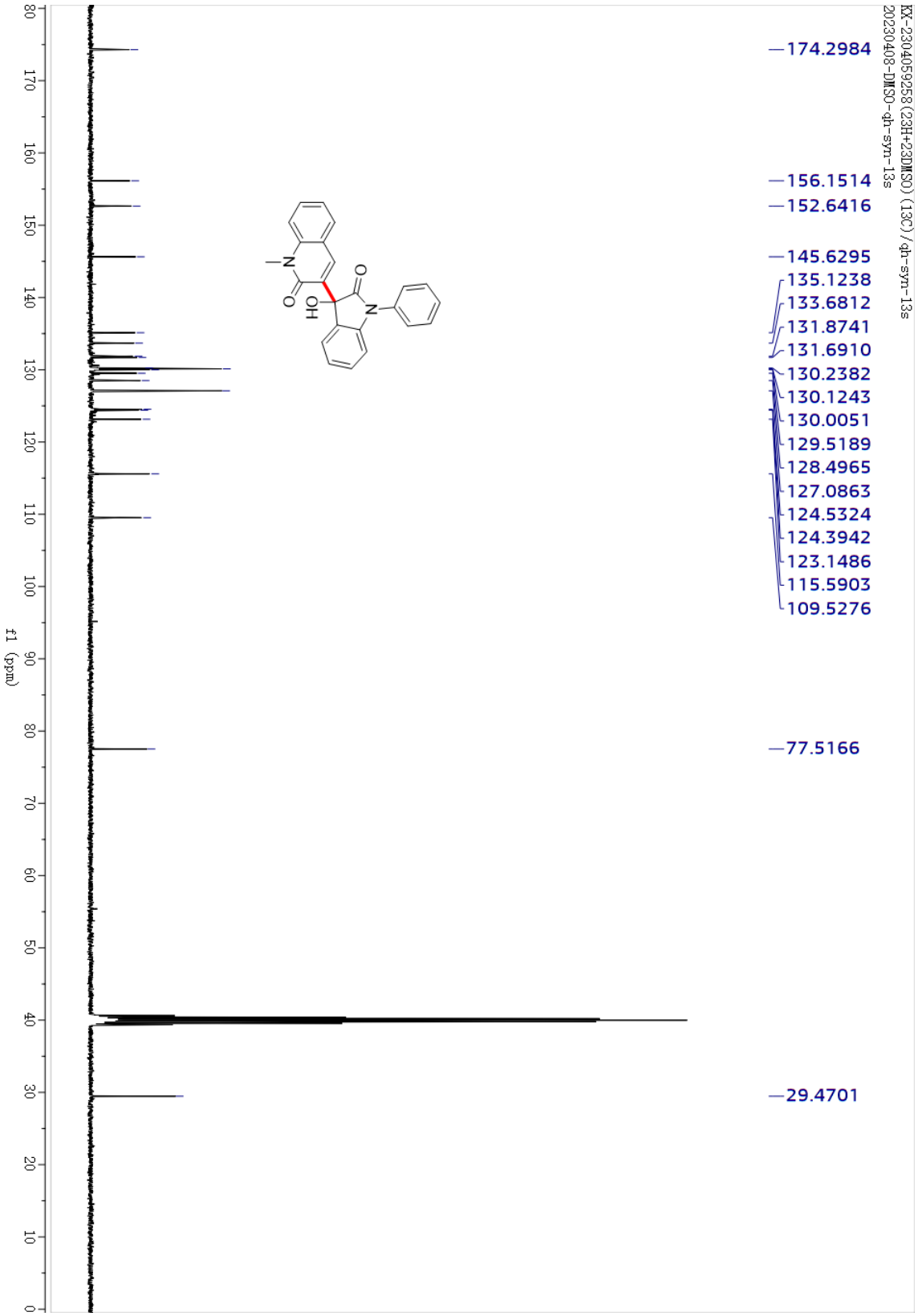


Figure S26. The ^{13}C NMR Spectrum of Compound **3m** in DMSO-d_6

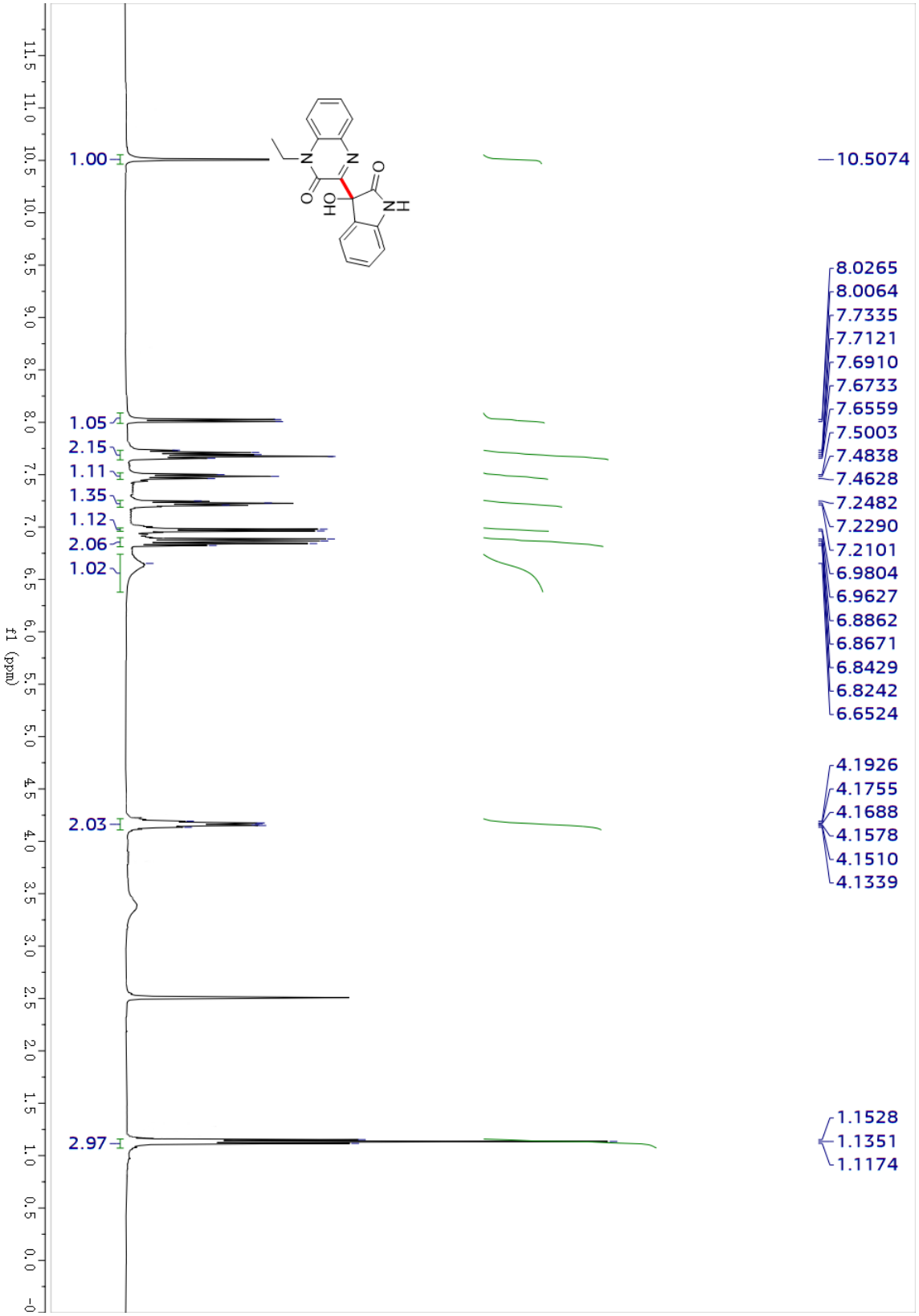


Figure S27. The ^{1}H NMR Spectrum of Compound **3ab** in DMSO-d_6

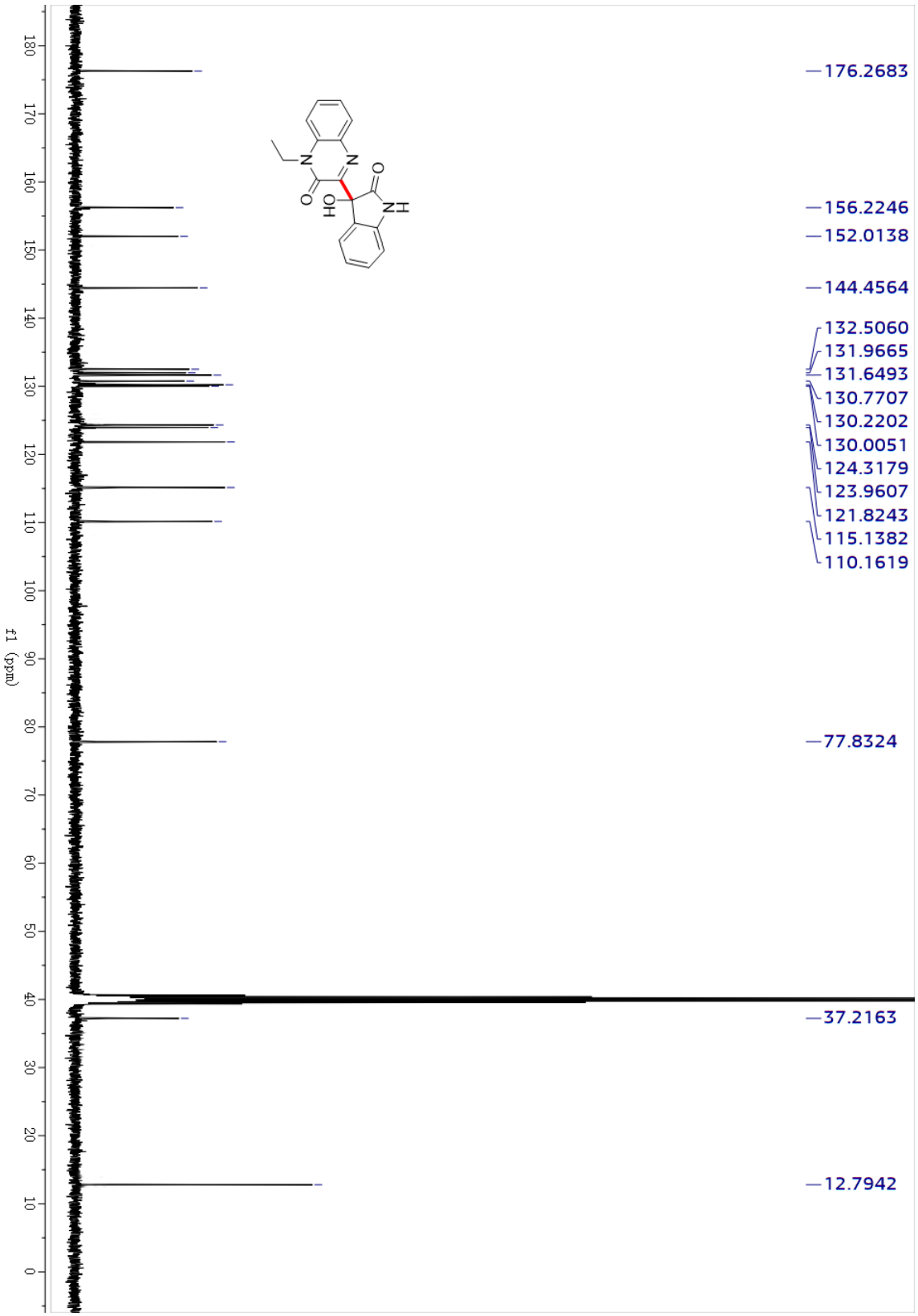


Figure S28. The ^{13}C NMR Spectrum of Compound **3ab** in DMSO-d_6

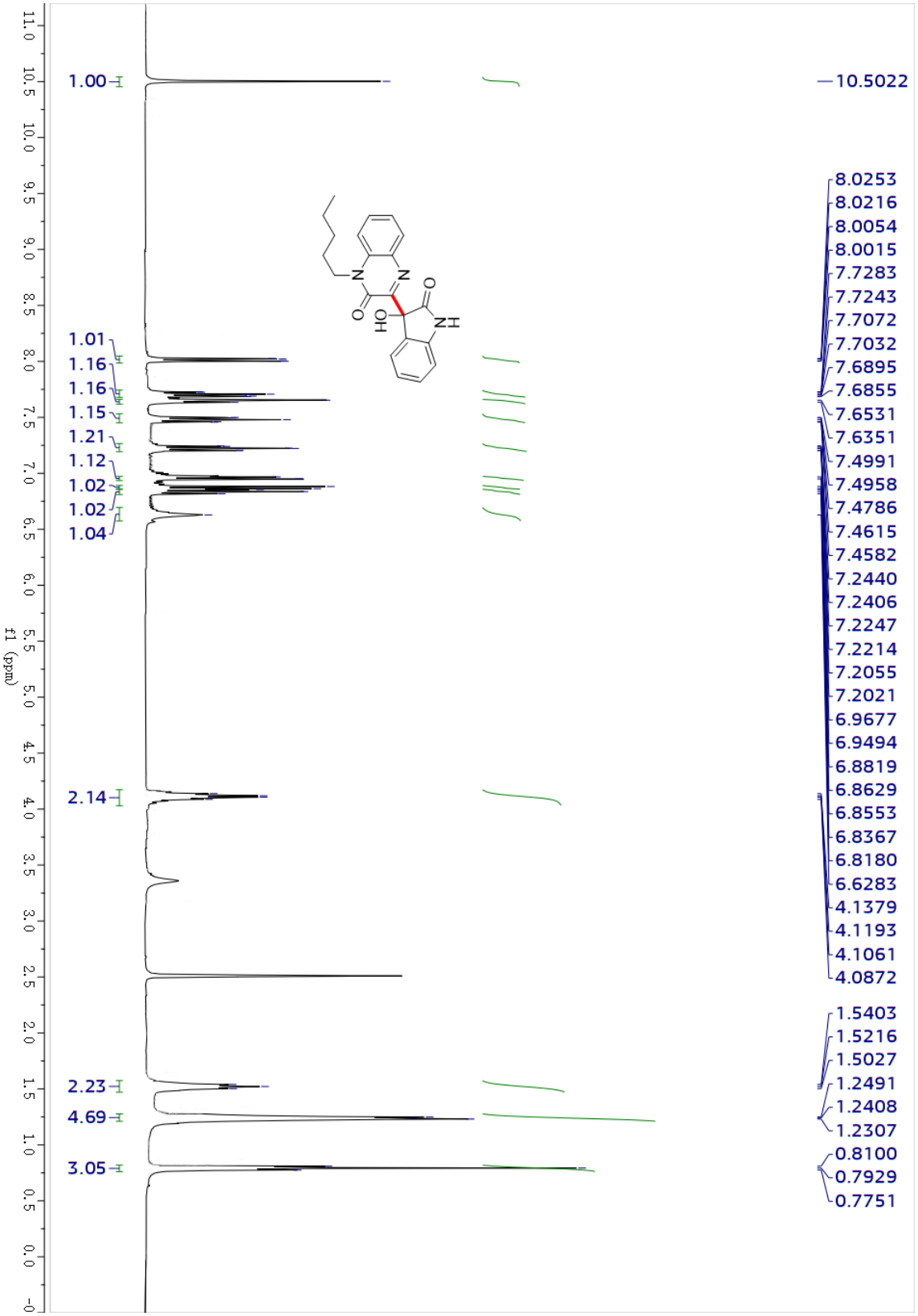


Figure S29. The ^{1}H NMR Spectrum of Compound **3ac** in DMSO-d_6

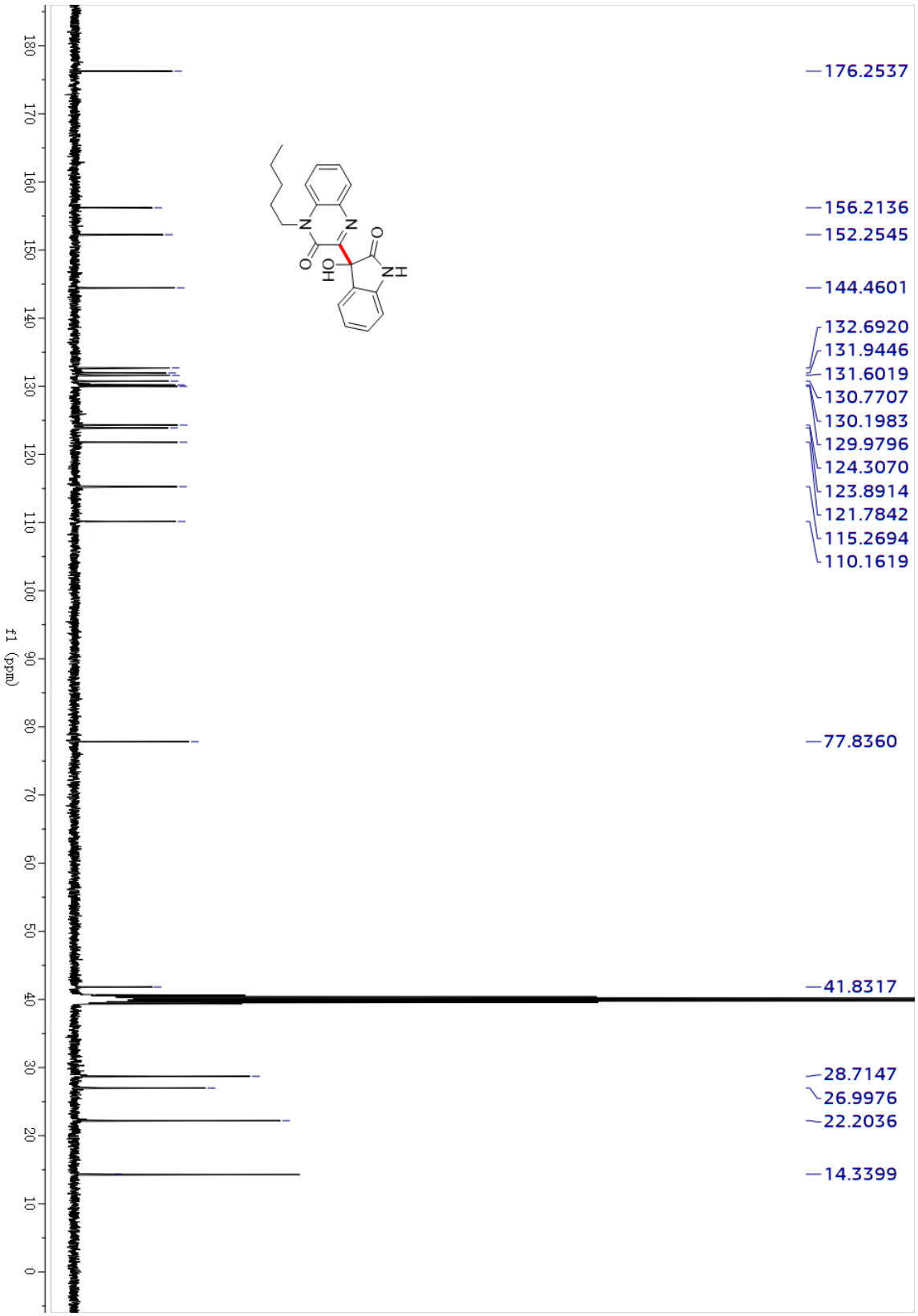


Figure S30. The ^{13}C NMR Spectrum of Compound **3ac** in DMSO-d_6

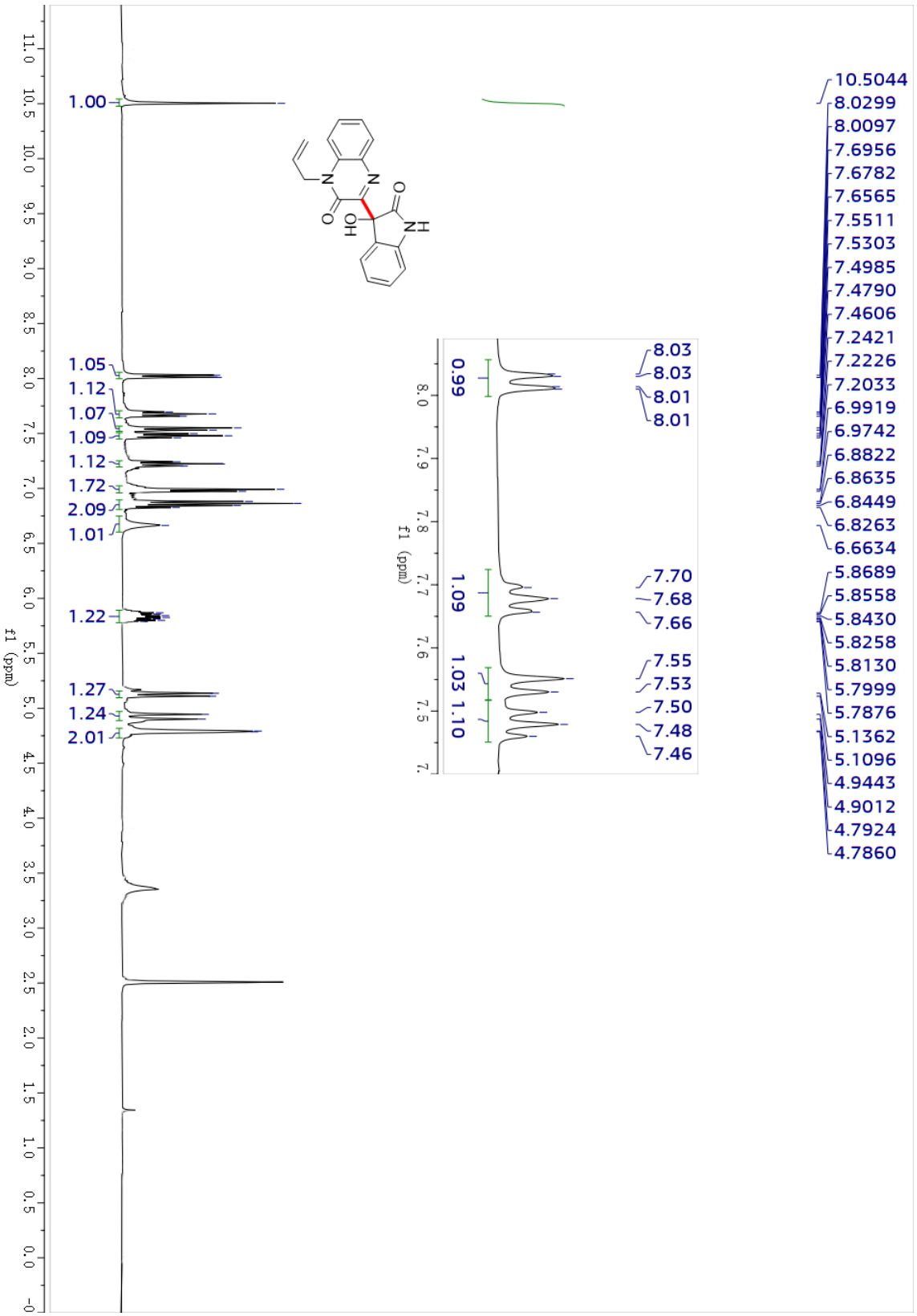


Figure S31. The ^{1}H NMR Spectrum of Compound **3ad** in DMSO-d_6

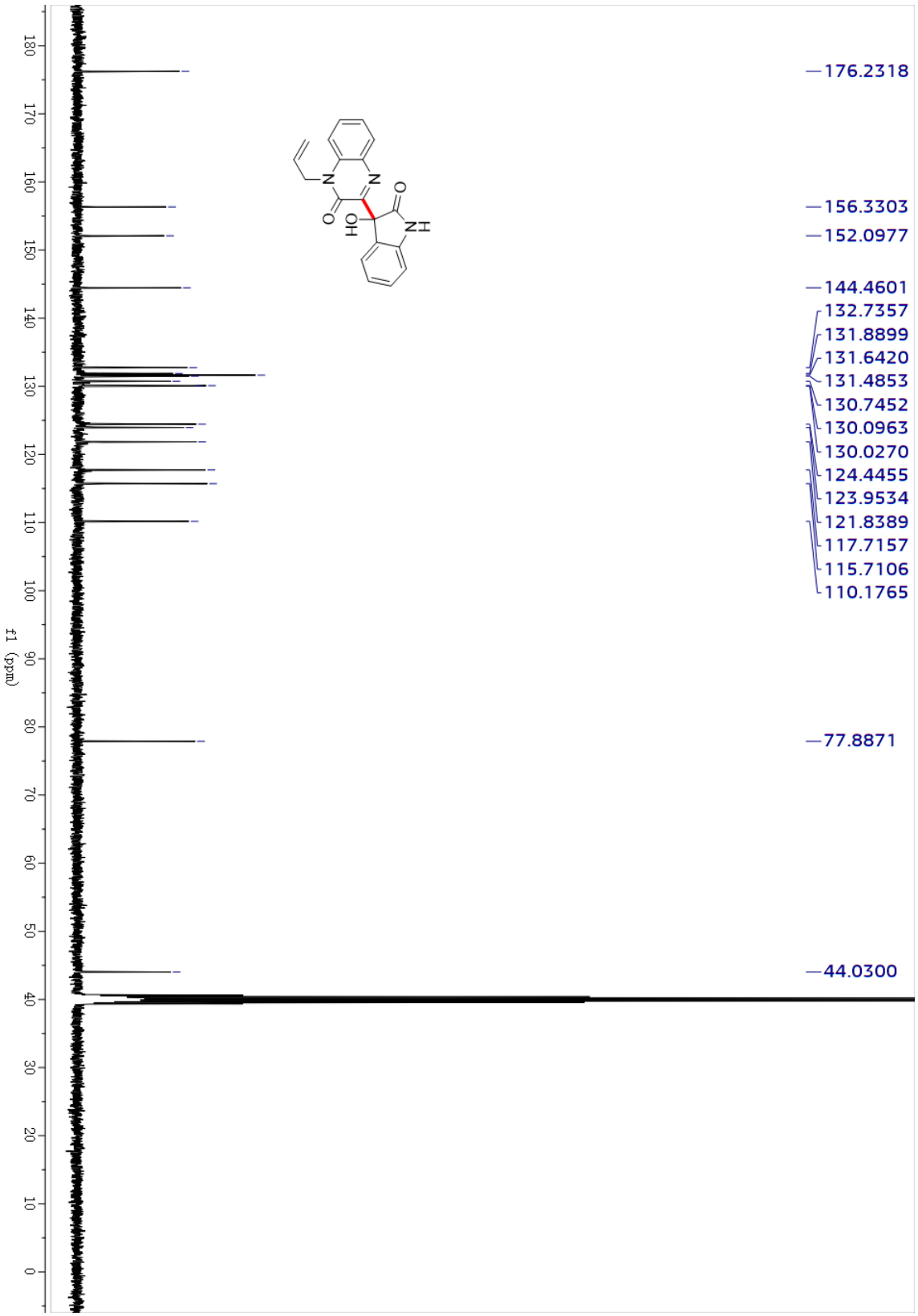


Figure S32. The ^{13}C NMR Spectrum of Compound **3ad** in DMSO-d_6

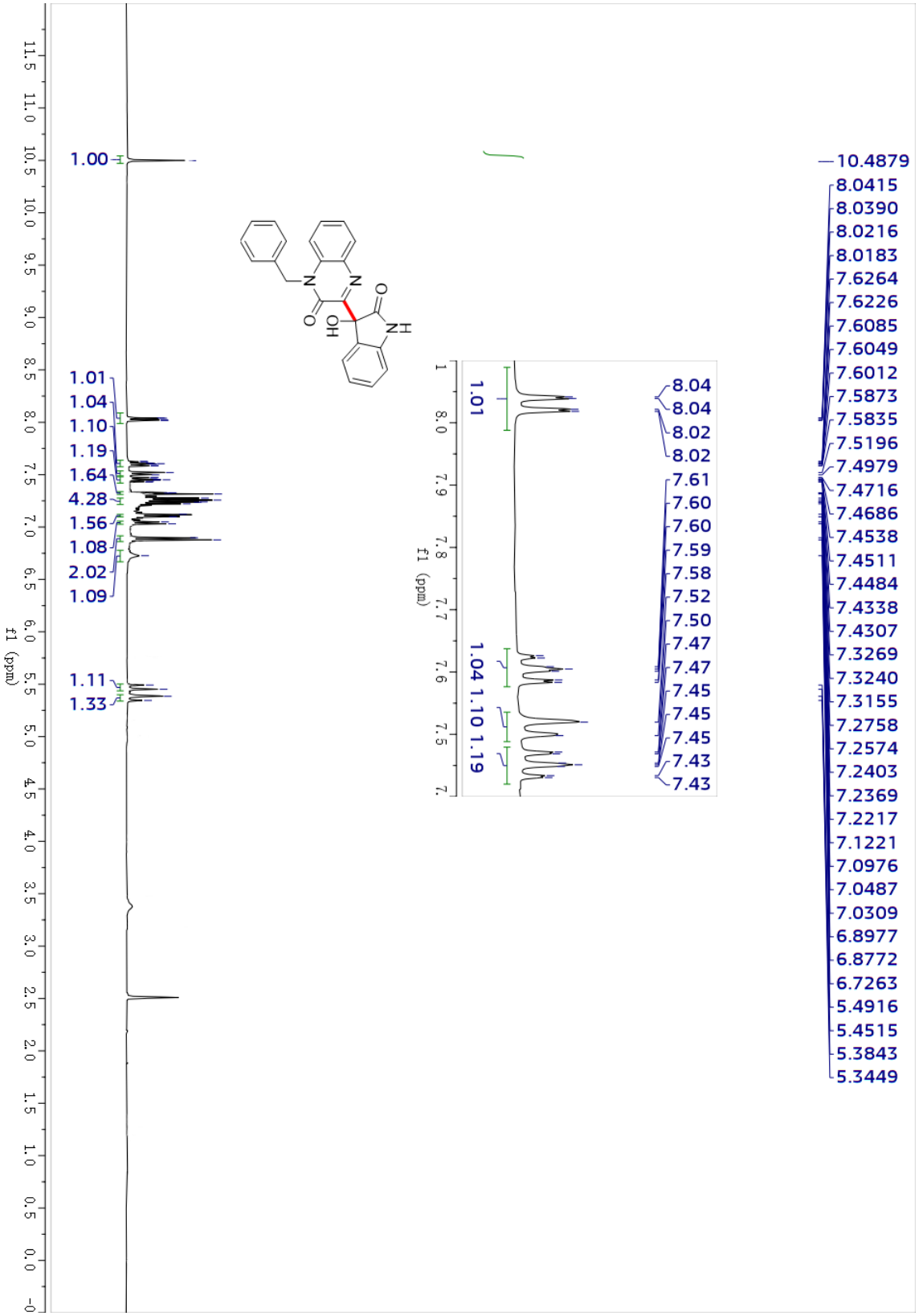


Figure S33. The ^{1}H NMR Spectrum of Compound **3ae** in DMSO-d_6

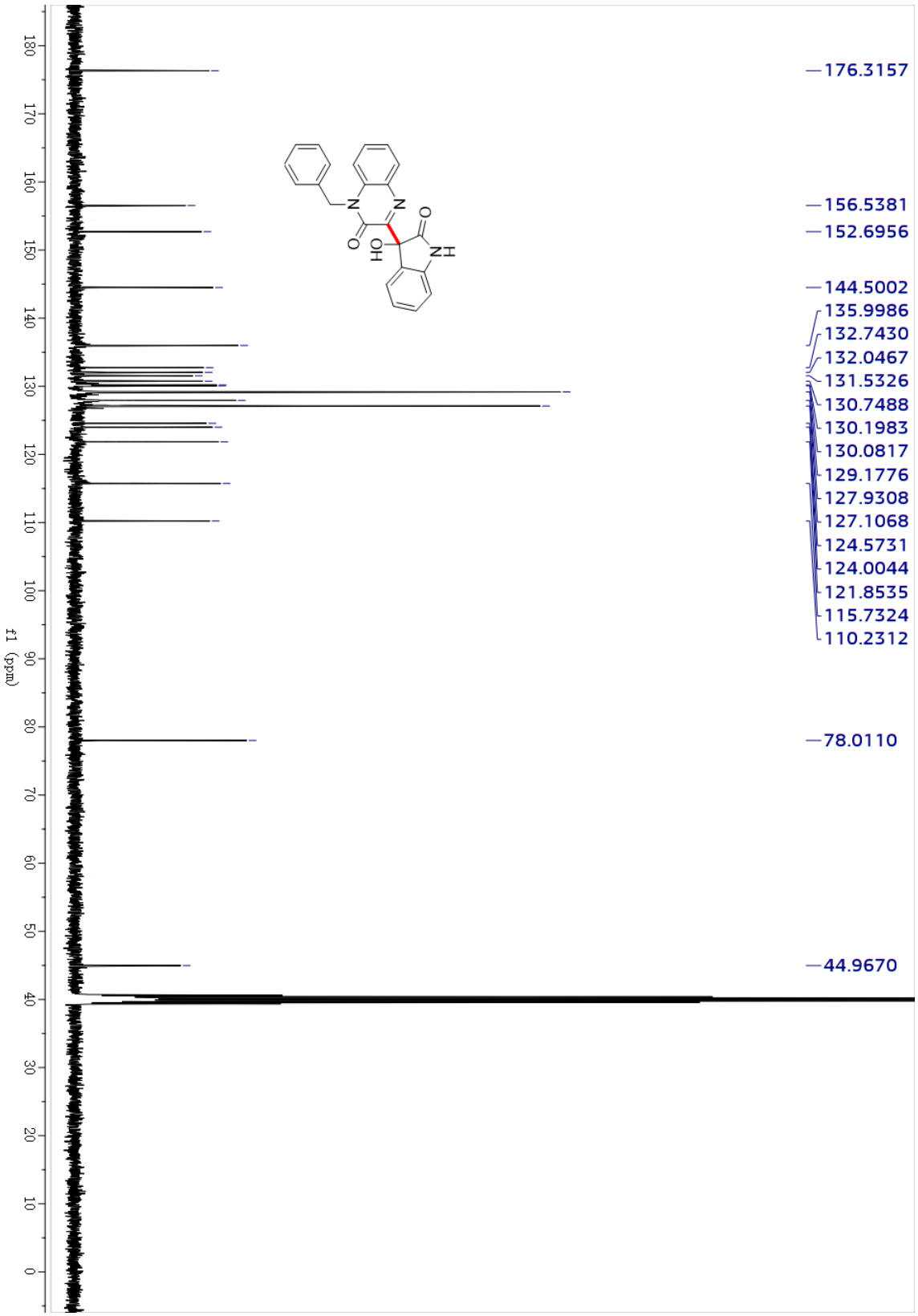


Figure S34. The ^{13}C NMR Spectrum of Compound **3ae** in DMSO-d_6

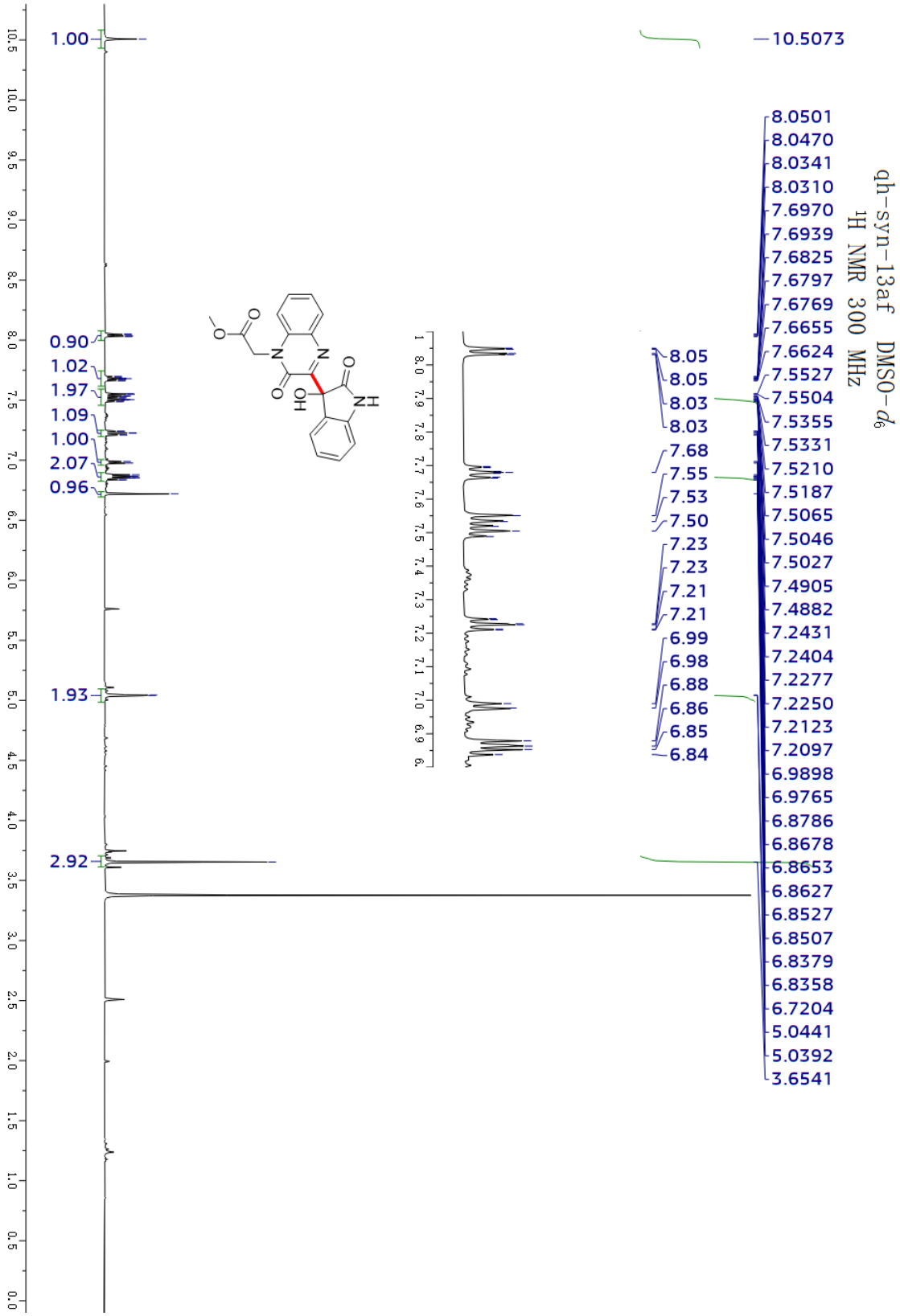


Figure S35. The ^{1}H NMR Spectrum of Compound **3af** in DMSO-d_6

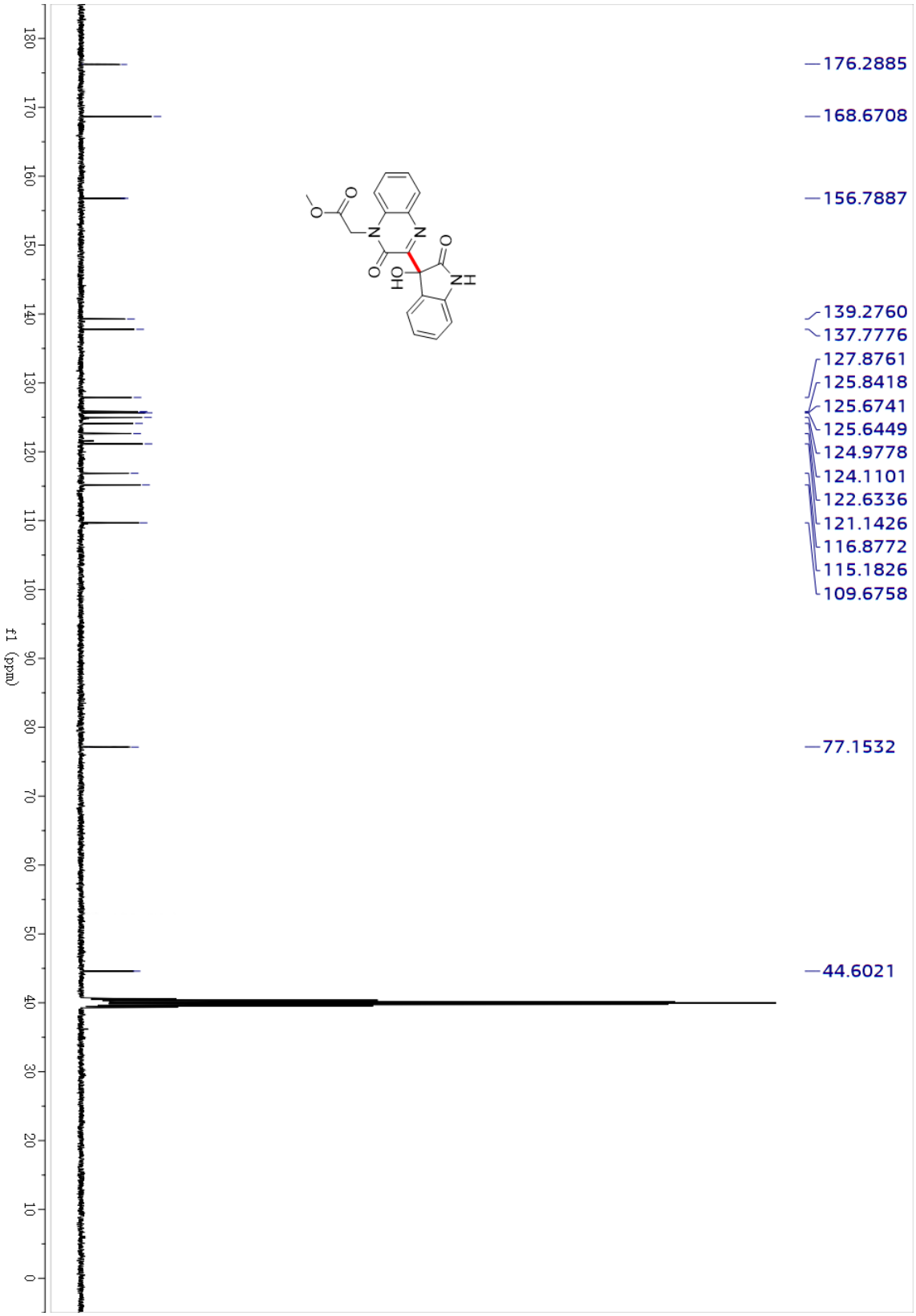


Figure S36. The ^{13}C NMR Spectrum of Compound **3af** in DMSO-d_6

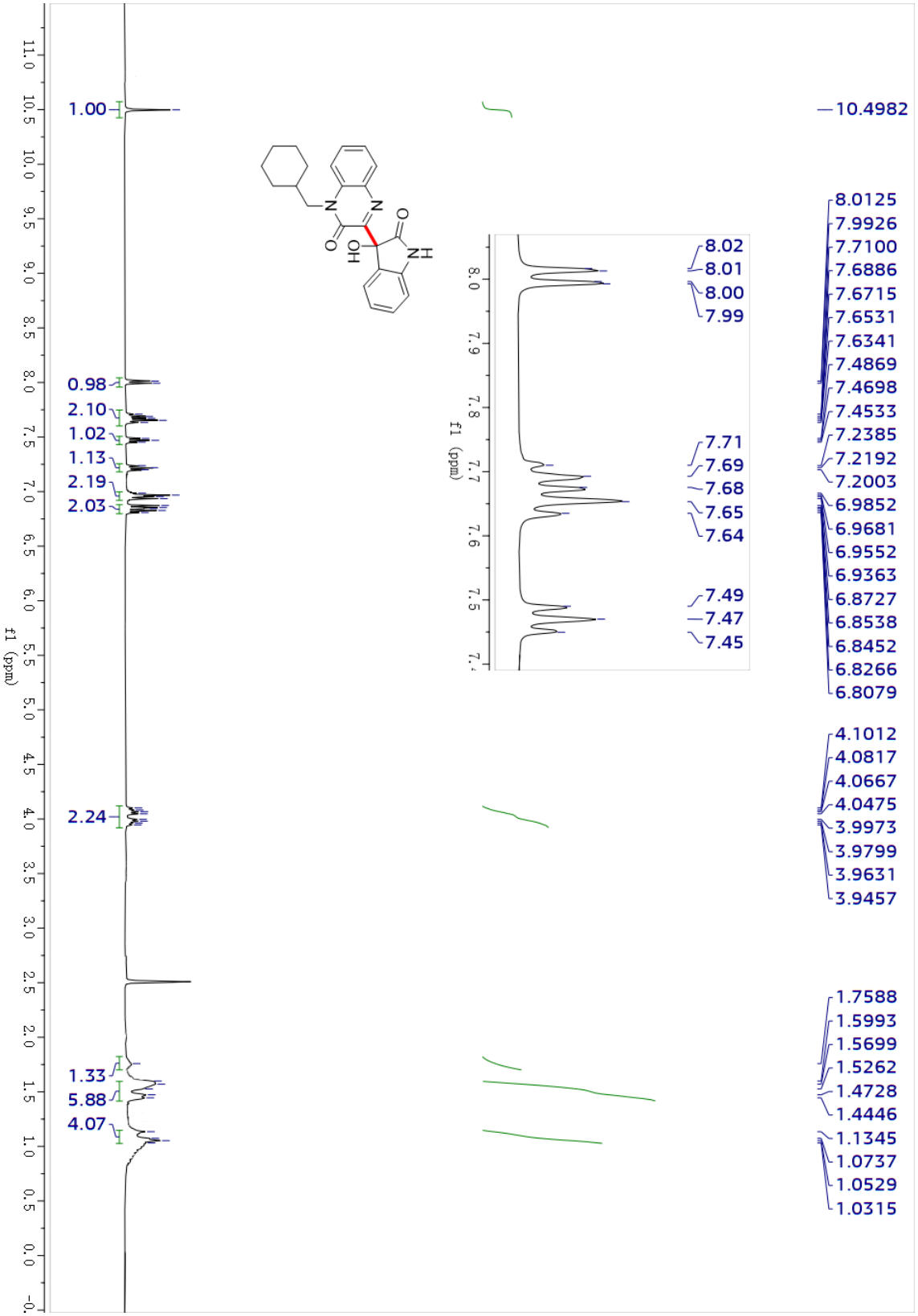


Figure S37. The ^{1}H NMR Spectrum of Compound **3ag** in DMSO-d_6

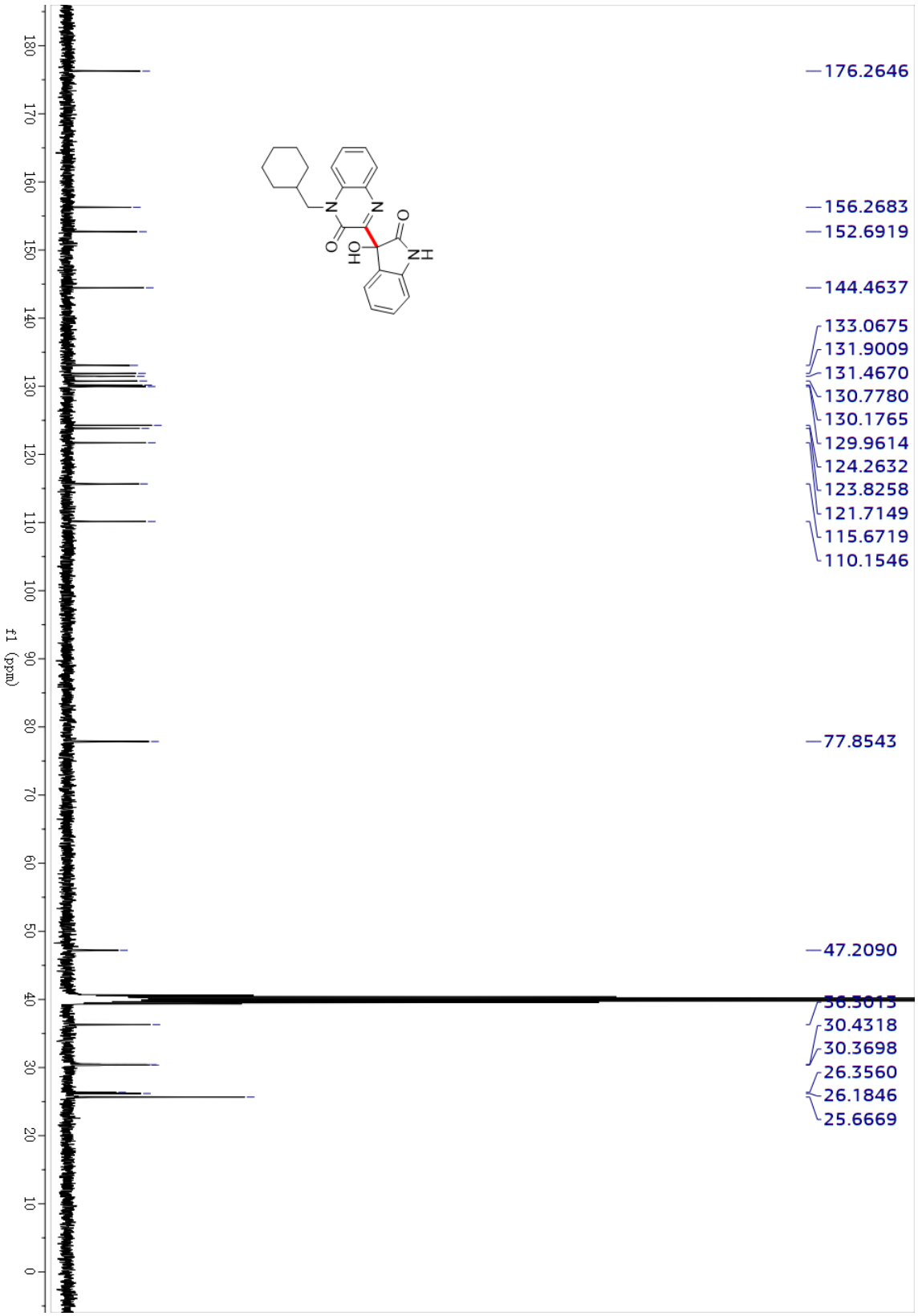


Figure S38. The ^{13}C NMR Spectrum of Compound **3ag** in DMSO-d_6

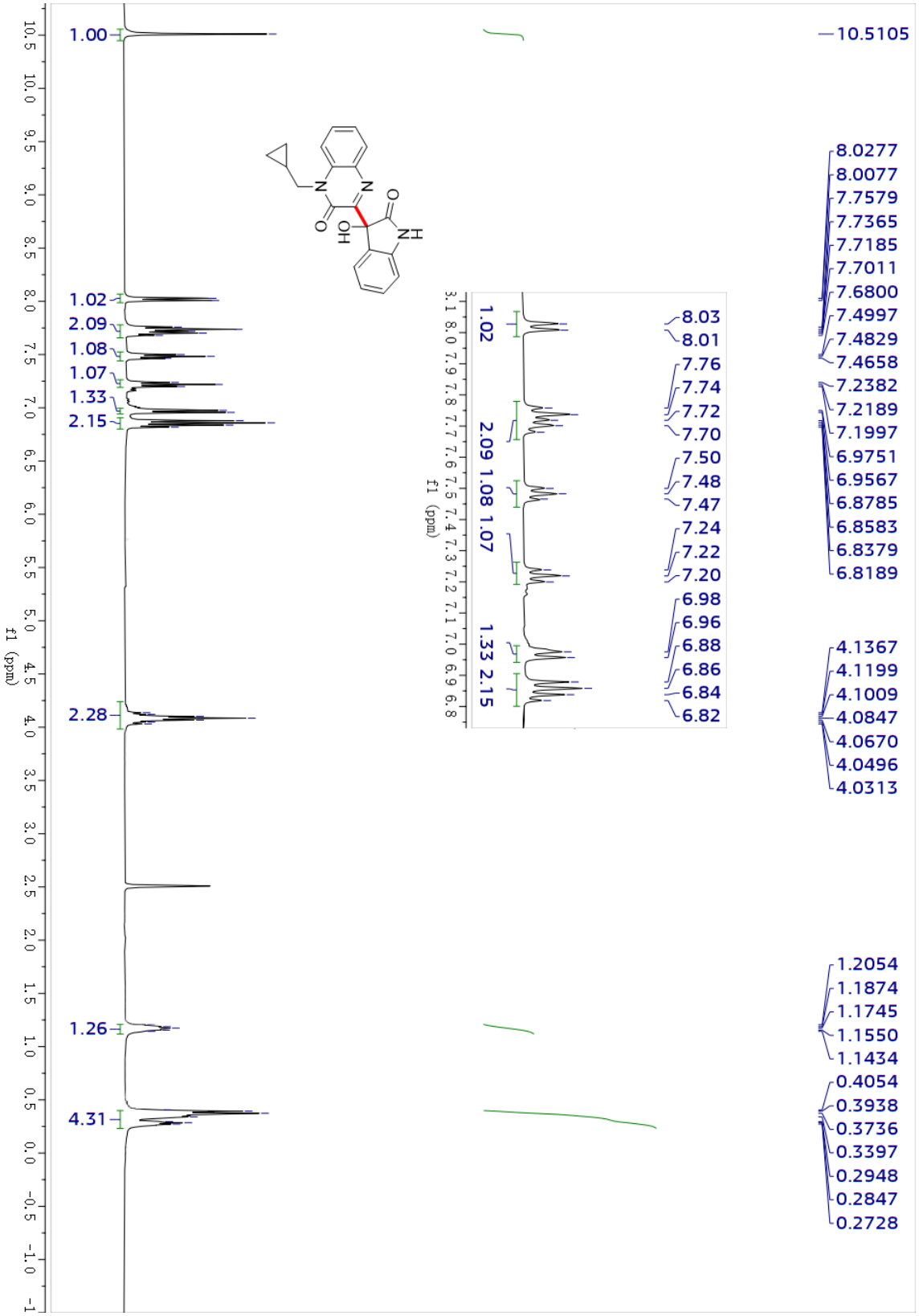


Figure S39. The ^{1}H NMR Spectrum of Compound **3ah** in DMSO-d_6

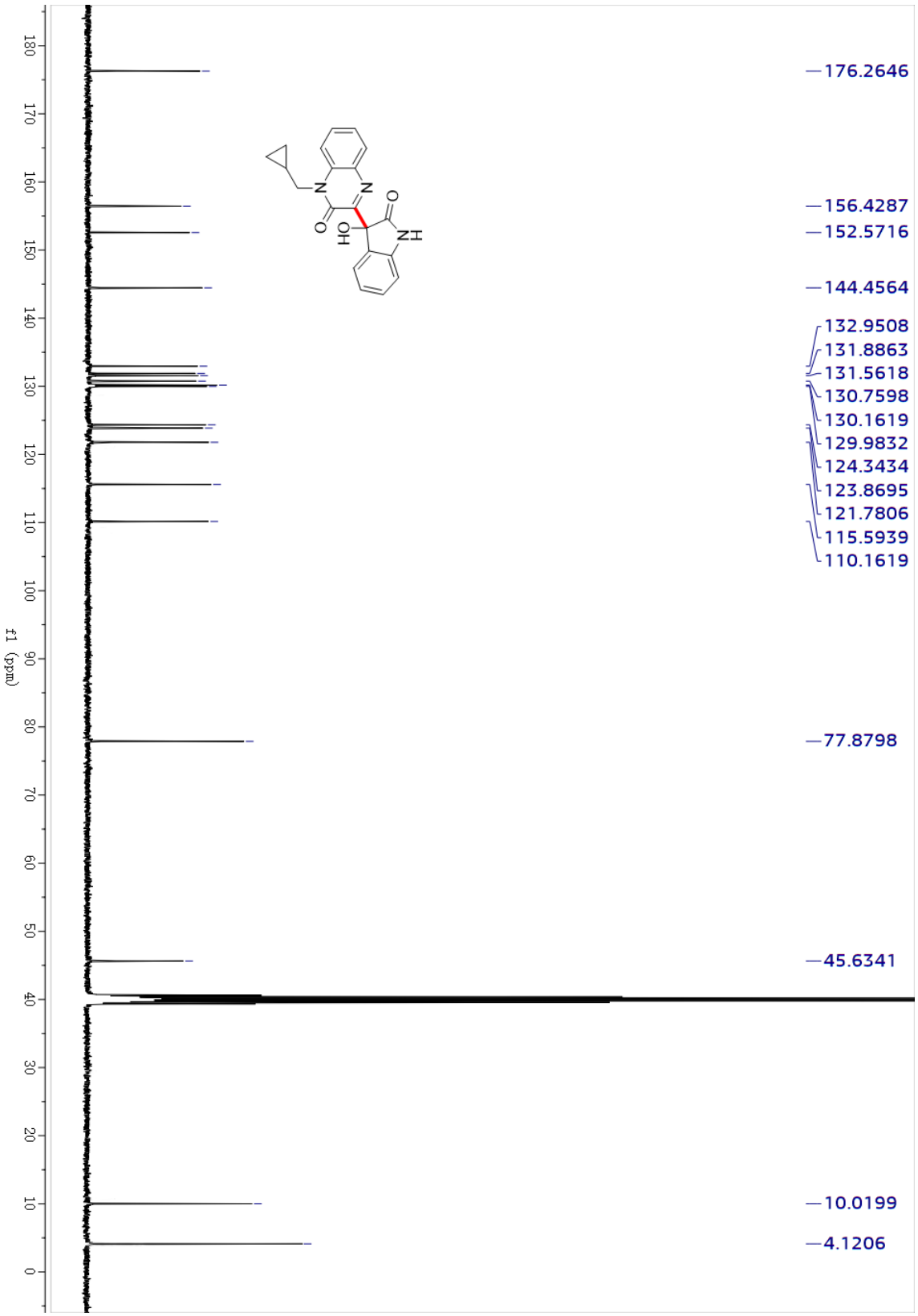


Figure S40. The ^{13}C NMR Spectrum of Compound **3ah** in DMSO-d_6

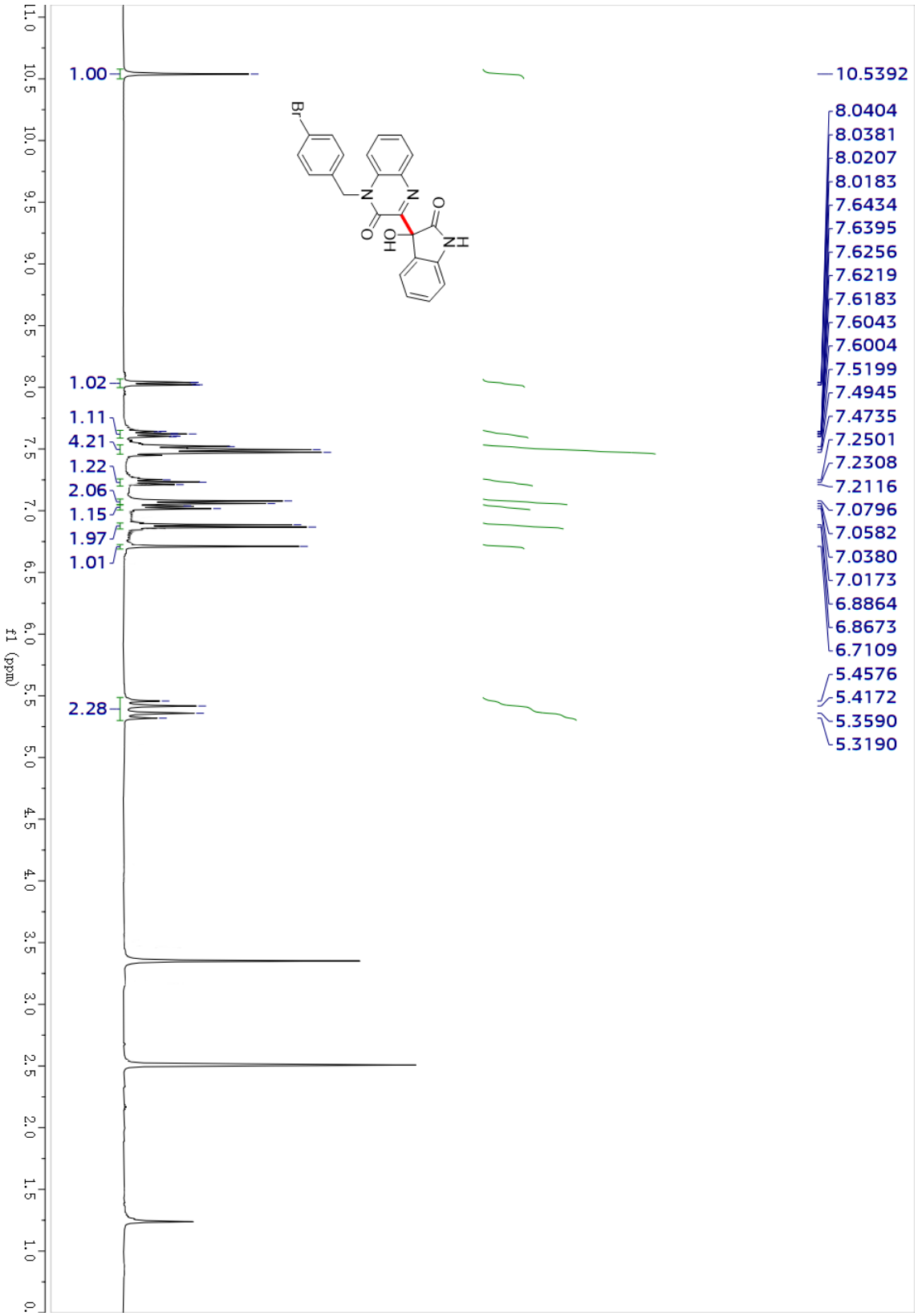


Figure S41. The ^{1}H NMR Spectrum of Compound **3ai** in DMSO-d_6

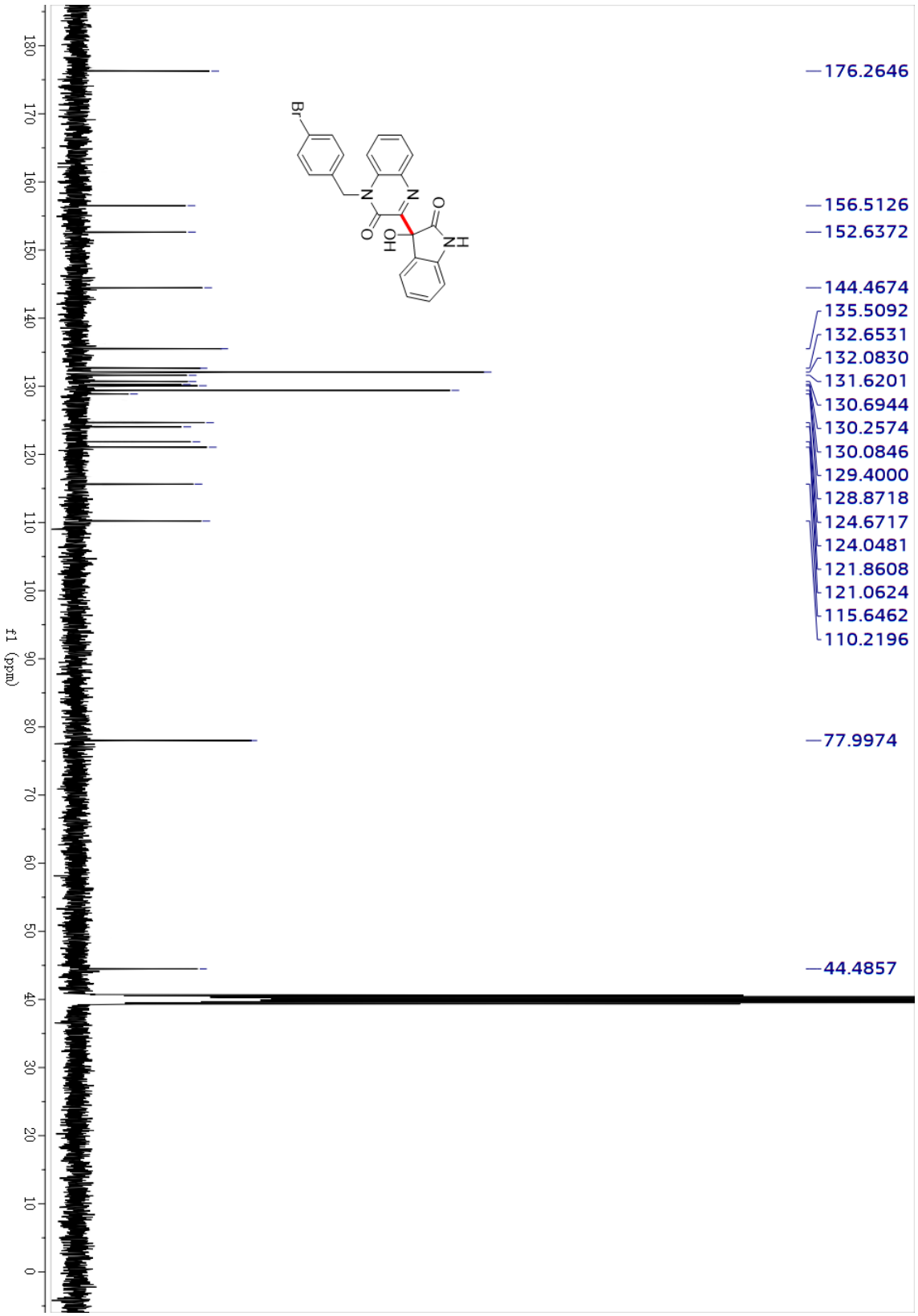


Figure S42. The ^{13}C NMR Spectrum of Compound **3ai** in DMSO-d_6

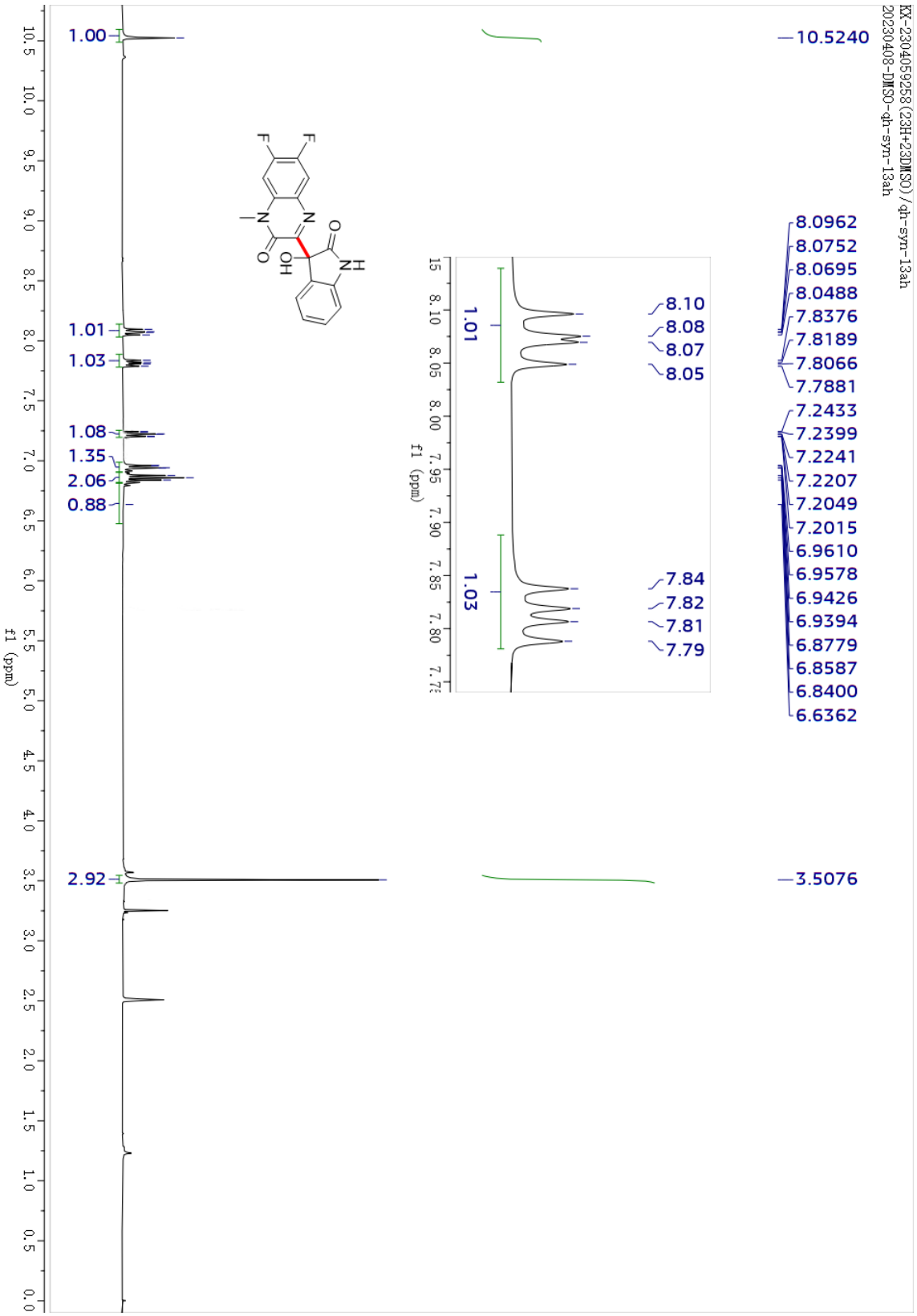


Figure S43. The ^{1}H NMR Spectrum of Compound **3aj** in DMSO-d_6

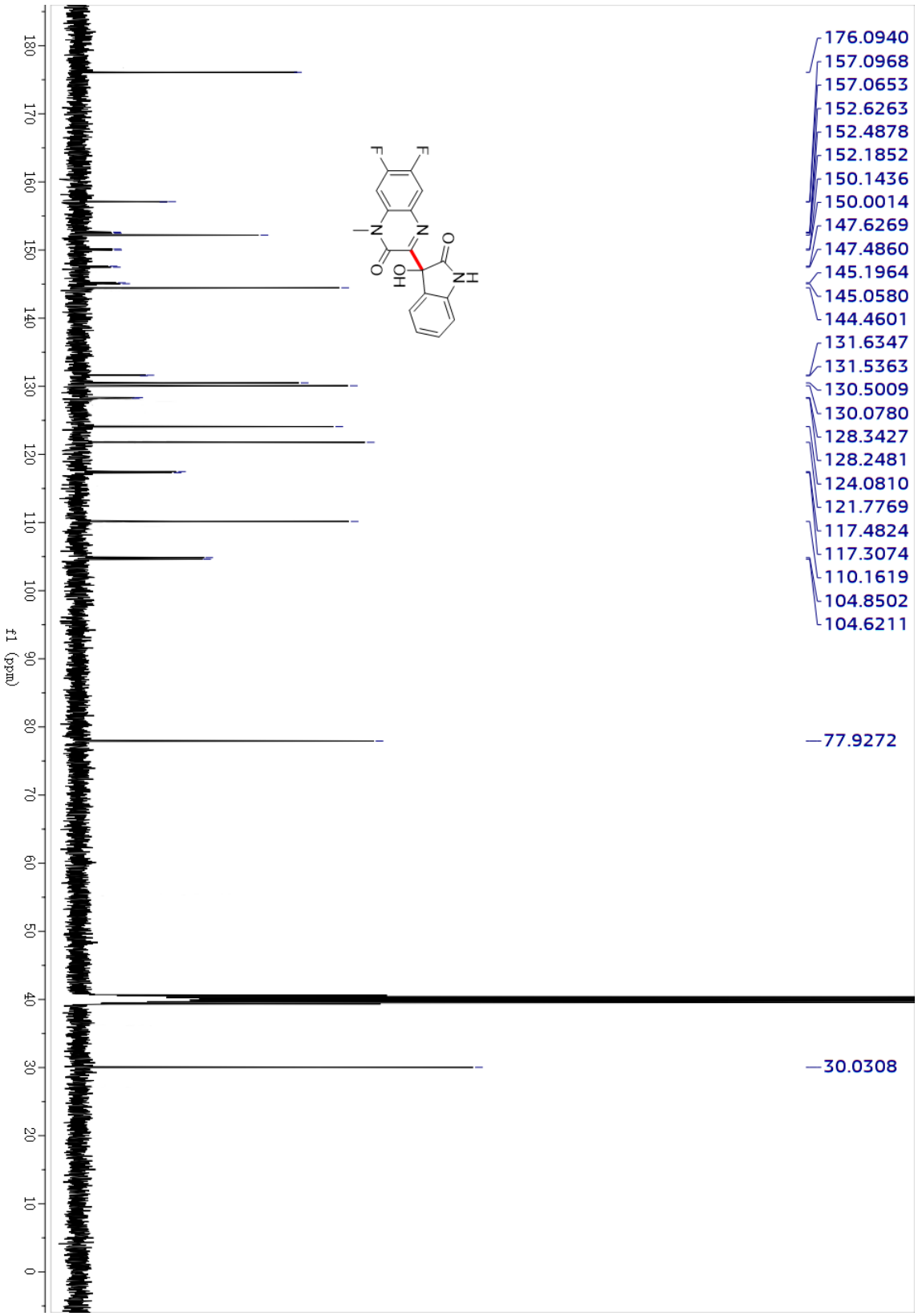


Figure S44. The ^{13}C NMR Spectrum of Compound **3aj** in DMSO-d_6

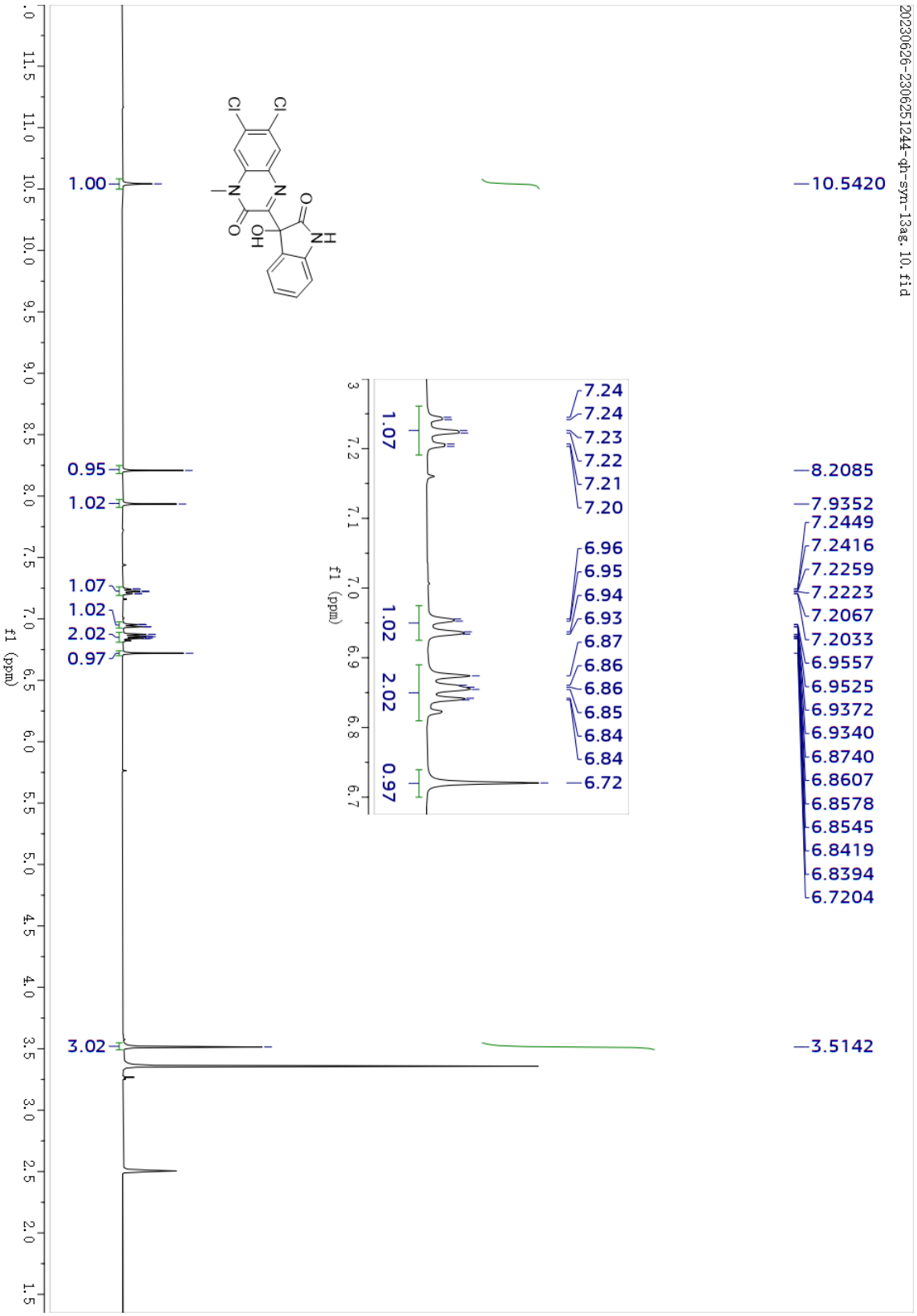


Figure S45. The ^{1}H NMR Spectrum of Compound **3ak** in DMSO-d_6

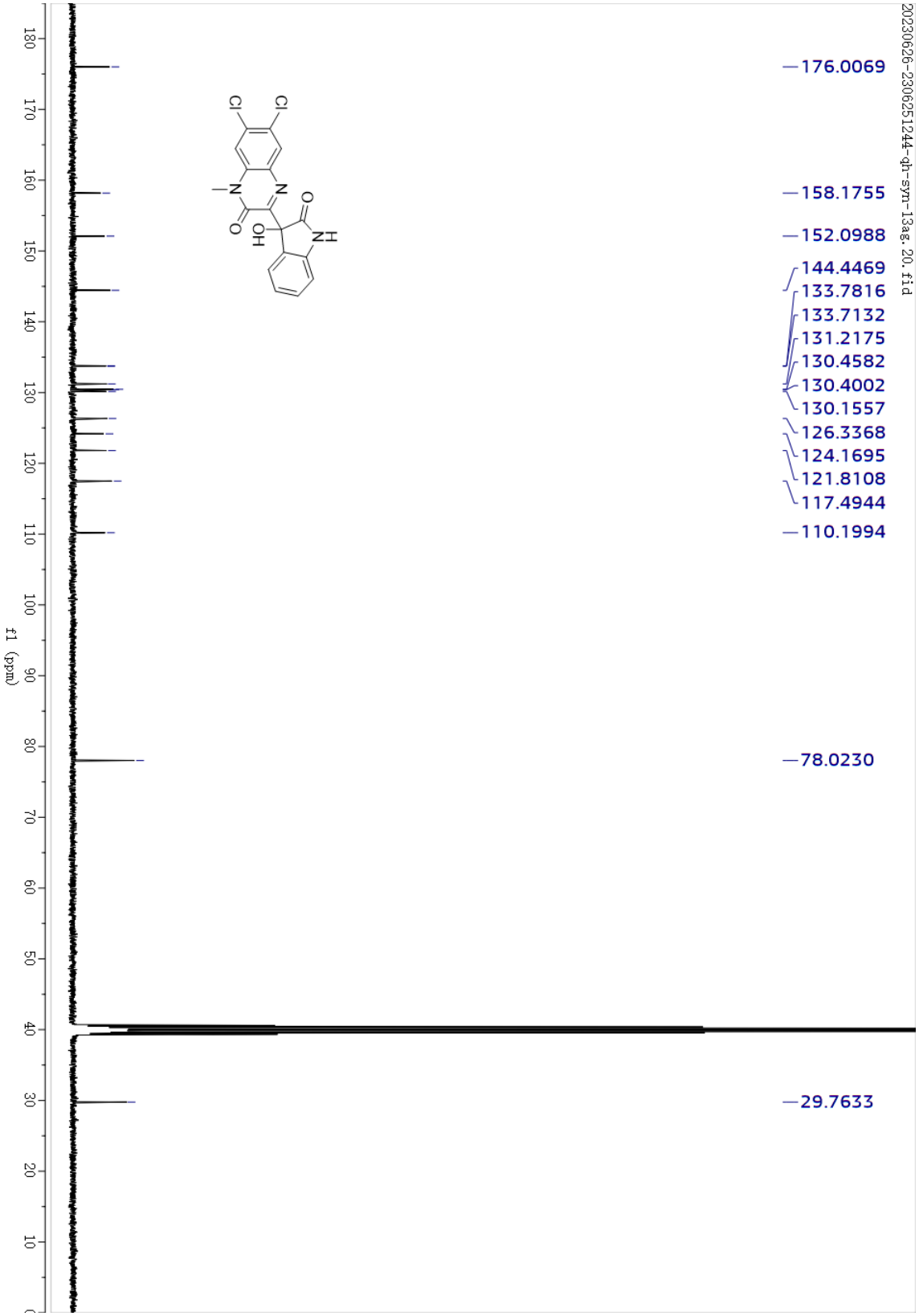


Figure S46. The ^{13}C NMR Spectrum of Compound **3ak** in DMSO-d_6

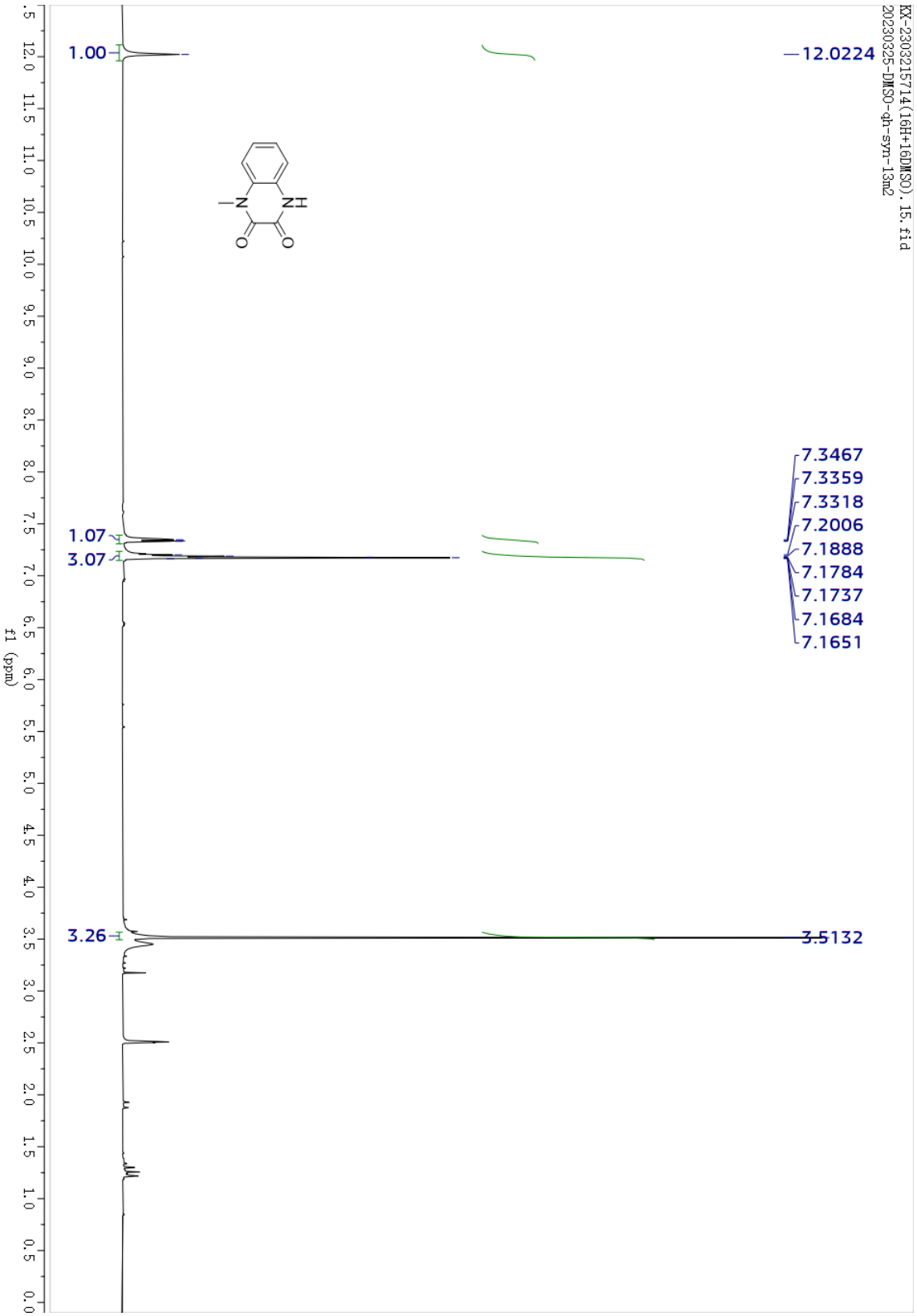


Figure S47. The ^{1}H NMR Spectrum of Compound **4** in DMSO-d_6