

# UV<sub>365</sub> light promoted catalyst-free synthesis of pyrimido[4,5-*b*]quinoline-2,4-diones in aqueous-glycerol medium.

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### **General procedure for preparation of 4a-x:**

In a 100 ml borosilicate tube, barbituric acid (1mmol), aromatic amine (1 mmol) and 30ml of Millipore water-glycerol (50:50) was irradiated by 8 lamps of UV<sub>365</sub> source for 15 minutes under continuous air-bubbling condition; then aryl aldehyde (1 mmol) was charged into the solution and further irradiated by 8 lamps of UV<sub>365</sub> for another 45-75 minutes. On completion of the reaction (indicated by appearance of thick solid precipitate), the precipitate was recovered by simple filtration followed by washing with warm Millipore water and drying.

### **Procedure for reaction of barbituric acid with aniline in the presence of hydroxyl radical inhibitor:**

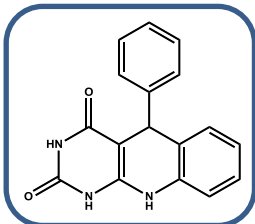
In a 100 ml borosilicate tube, barbituric acid (1mmol), aniline (1 mmol), H<sub>2</sub>O<sub>2</sub> (200mmol) and 50ml of Millipore water-glycerol (50:50) was irradiated by 8 lamps of UV<sub>365</sub> source for 15 minutes under continuous air-bubbling condition. The mixture was extracted with dichloromethane and the compounds purified by column chromatography.

### **Experimental**

All the chemicals involved in the synthesis were purchased from Alfa Aesar, Sigma-Aldrich & Merck and were used without further purification. The purity of the products was confirmed by infrared (FT-IR), <sup>1</sup>H-NMR, and <sup>13</sup>C-NMR. FT-IR spectra were recorded in KBr pellets on a Perkin Elmer Spectrum 400 FTIR instrument, and the frequencies are expressed in cm<sup>-1</sup>. <sup>1</sup>H-NMR and <sup>13</sup>C-NMR spectra were recorded on a BrukerAvance II-400 spectrometer in DMSO-d<sub>6</sub> (chemical shifts in δ). Elemental analyses were carried out on a Heraeus CHN-O-Rapid analyzer. The UV<sub>365</sub> irradiation was conducted in a UV reactor fitted with twelve lamps (8W each) of Herber Scientific make; model HML, Compact-LP-MP-812.

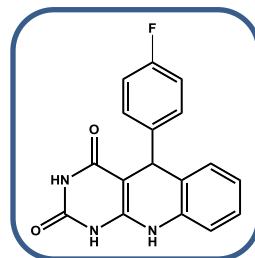
## Analytical data and Spectra

**5-phenyl-5,10-dihydropyrimido[4,5-*b*]quinoline-2,4(1*H*,3*H*)-dione (4a):** Yield: 98%; Melting point: 224-226 °C;



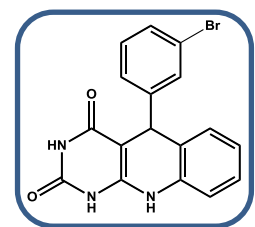
IR (KBr):  $\nu$  3335, 3025, 1690, 1619, 1495, 1409, 1123, 780, 556  $\text{cm}^{-1}$ ;  $^1\text{H-NMR}$  (400 MHz, DMSO- $\text{D}_6$ ):  $\delta$  11.15 (s, 1H), 10.17 (bs, 2H), 8.10 (d, 1H,  $J = 7.2\text{Hz}$ ), 7.47-7.56 (m, 1H), 7.33-7.35 (m, 2H), 7.04-7.18 (m, 5H), 5.93 (s, 1H);  $^{13}\text{C-NMR}$  (100 MHz, DMSO- $\text{D}_6$ ):  $\delta$  167.7, 161.5, 150.6, 144.2, 135.7, 133.0, 129.5, 128.8, 127.4, 126.6, 125.2, 124.4, 120.9, 91.6, 30.6. Anal. Calcd. for  $\text{C}_{17}\text{H}_{13}\text{N}_3\text{O}_2$ : C, 70.09; H, 4.50; N, 14.42%; Found: C, 70.25; H, 4.45; N, 14.29%.

**5-(4-fluorophenyl)-5,10-dihydropyrimido[4,5-*b*]quinoline-2,4(1*H*,3*H*)-dione (4b):** Yield: 95%; Melting point:



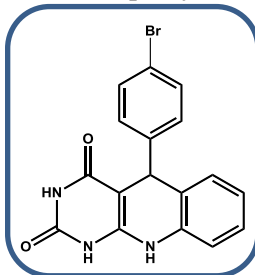
196-198 °C; IR (KBr):  $\nu$  3375, 3033, 1687, 1622, 1505, 1402, 1124, 776, 557  $\text{cm}^{-1}$ ;  $^1\text{H-NMR}$  (400 MHz, DMSO- $\text{D}_6$ ):  $\delta$  11.25 (s, 1H), 10.11 (bs, 2H), 7.30-7.23 (m, 3H), 7.03-6.99 (m, 4H), 6.95-6.91 (m, 1H), 5.88 (s, 1H);  $^{13}\text{C-NMR}$  (100 MHz, DMSO- $\text{D}_6$ ):  $\delta$  165.1, 160.8, 158.7, 150.8, 140.3, 136.9, 132.6, 129.4, 128.2, 128.1, 124.2, 120.2, 113.7, 91.9, 30.1. Anal. Calcd. for  $\text{C}_{17}\text{H}_{12}\text{FN}_3\text{O}_2$ : C, 66.02; H, 3.91; N, 13.59%; Found: C, 66.19; H, 3.84; N, 13.66%.

**5-(3-bromophenyl)-5,10-dihydropyrimido[4,5-*b*]quinoline-2,4(1*H*,3*H*)-dione (4c):** Yield: 93%; Melting point:



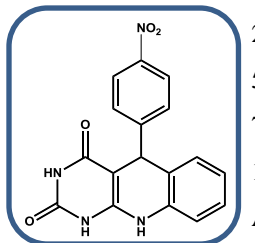
200-202 °C; IR (KBr):  $\nu$  3356, 3032, 1690, 1615, 1487, 1389, 1125, 780, 557  $\text{cm}^{-1}$ ;  $^1\text{H-NMR}$  (400 MHz, DMSO- $\text{D}_6$ ):  $\delta$  11.11 (s, 1H), 10.16 (s, 2H), 7.42-7.34 (m, 2H), 7.23-7.09 (m, 5H), 7.01 (d, 1H,  $J = 7.6\text{Hz}$ ), 5.91 (s, 1H);  $^{13}\text{C-NMR}$  (100 MHz, DMSO- $\text{D}_6$ ):  $\delta$  167.7, 159.8, 150.5, 147.7, 142.2, 134.8, 129.6, 129.5, 129.2, 127.3, 125.8, 123.0, 121.1, 109.1, 91.1, 30.6. Anal. Calcd. for  $\text{C}_{17}\text{H}_{12}\text{BrN}_3\text{O}_2$ : C, 55.15; H, 3.27; N, 11.35%; Found: C, 55.28; H, 3.34; N, 11.19%.

**5-(4-bromophenyl)-5,10-dihydropyrimido[4,5-*b*]quinoline-2,4(1*H*,3*H*)-dione (4d):** Yield: 94%; Melting point:



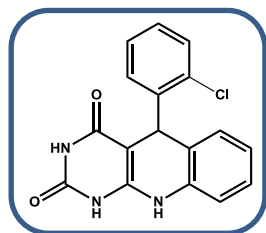
218-220 °C; IR (KBr):  $\nu$  3376, 3021, 1691, 1614, 1478, 1405, 1126, 778, 555  $\text{cm}^{-1}$ ;  $^1\text{H-NMR}$  (400 MHz, DMSO- $\text{D}_6$ ):  $\delta$  11.26 (s, 1H), 10.12 (bs, 2H), 7.65 (d, 2H,  $J = 8.8\text{Hz}$ ), 7.37-7.25 (m, 3H), 7.13-7.08 (m, 2H), 6.95 (d, 1H,  $J = 8.4\text{Hz}$ ), 5.86 (s, 1H);  $^{13}\text{C-NMR}$  (100 MHz, DMSO- $\text{D}_6$ ):  $\delta$  163.2, 159.6, 150.5, 150.1, 144.0, 134.6, 131.8, 130.9, 130.1, 129.5, 129.0, 126.2, 125.2, 120.9, 117.3, 91.3, 30.4. Anal. Calcd. for  $\text{C}_{17}\text{H}_{12}\text{BrN}_3\text{O}_2$ : C, 55.15; H, 3.27; N, 11.35%; Found: C, 54.96; H, 3.25; N, 11.43%.

**5-(4-nitrophenyl)-5,10-dihydropyrimido[4,5-*b*]quinoline-2,4(1*H*,3*H*)-dione (4e):** Yield: 90%; Melting point:



231-233 °C; IR (KBr):  $\nu$  3387, 2999, 1692, 1622, 1496, 1412, 1346, 1227, 1111, 849, 779, 556  $\text{cm}^{-1}$ ;  $^1\text{H-NMR}$  (400 MHz, DMSO- $\text{D}_6$ ):  $\delta$  11.12 (s, 1H), 10.20 (s, 2H), 8.03-8.05 (m, 2H), 7.39-7.43 (m, 2H), 7.20-7.27 (m, 4H), 6.03 (s, 1H);  $^{13}\text{C-NMR}$  (100 MHz, DMSO- $\text{D}_6$ ):  $\delta$  168.7, 160.0, 154.0, 150.5, 144.9, 134.0, 129.6, 127.8, 126.4, 123.9, 122.8, 121.8, 90.2, 31.3. Anal. Calcd. for  $\text{C}_{17}\text{H}_{12}\text{N}_4\text{O}_4$ : C, 60.71; H, 3.60; N, 16.66%; Found: C, 60.58; H, 3.63; N, 16.72%.

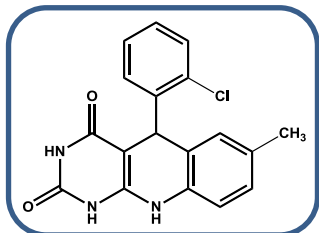
**5-(2-chlorophenyl)-5,10-dihydropyrimido[4,5-*b*]quinoline-2,4(1*H*,3*H*)-dione (4f):** Yield: 90%; Melting point:



204-206 °C; IR (KBr):  $\nu$  3345, 3019, 1697, 1617, 1405, 1121, 780, 558  $\text{cm}^{-1}$ ;  $^1\text{H-NMR}$  (400 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  11.12 (s, 1H), 10.01 (bs, 2H), 7.74 (d, 1H,  $J = 7.2\text{Hz}$ ), 7.29-7.25 (m, 3H), 7.08-6.97 (m, 4H), 5.78 (s, 1H);  $^{13}\text{C-NMR}$  (100 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  168.2, 164.8, 151.1, 150.6, 142.6, 137.3, 133.1, 132.3, 130.6, 129.9, 129.5, 126.9, 126.0, 124.8, 120.8, 80.0, 31.4. Anal. Calcd. for  $\text{C}_{17}\text{H}_{12}\text{ClN}_3\text{O}_2$ : C, 62.68; H, 3.71; N, 12.90%; Found:

C, 62.79; H, 3.67; N, 12.82%.

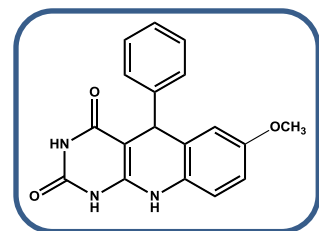
**5-(2-chlorophenyl)-7-methyl-5,10-dihydropyrimido[4,5-*b*]quinoline-2,4(1*H*,3*H*)-dione (4g):** Yield: 87%;



Melting point: 184-186 °C; IR (KBr):  $\nu$  3363, 3022, 1689, 1624, 1467, 1384, 1124, 781, 559  $\text{cm}^{-1}$ ;  $^1\text{H-NMR}$  (400 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  11.12 (s, 1H), 9.99 (bs, 2H), 7.74 (d, 1H,  $J = 7.6\text{Hz}$ ), 7.27-7.16 (m, 3H), 7.14-7.10 (m, 1H), 7.07-7.03 (m, 2H), 5.80 (s, 1H), 2.26 (s, 3H);  $^{13}\text{C-NMR}$  (100 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  168.2, 164.9, 151.1, 150.7, 142.6, 136.0, 133.6, 133.1, 130.0, 130.6, 130.4, 129.5, 126.9, 126.0, 122.1, 90.2,

31.3, 20.9. Anal. Calcd. for  $\text{C}_{18}\text{H}_{14}\text{ClN}_3\text{O}_2$ : C, 63.63; H, 4.15; N, 12.37%; Found: C, 63.77; H, 4.09; N, 12.44%.

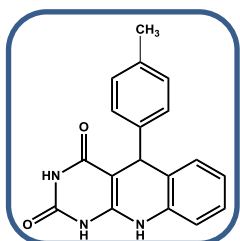
**7-methoxy-5-phenyl-5,10-dihydropyrimido[4,5-*b*]quinoline-2,4(1*H*,3*H*)-dione (4h):** Yield: 97%; Melting point:



190-192 °C; IR (KBr):  $\nu$  3310, 3133, 2960, 1693, 1606, 1493, 1404, 1251, 778, 555  $\text{cm}^{-1}$ ;  $^1\text{H-NMR}$  (400 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  11.13 (s, 1H), 10.06 (bs, 2H), 7.18-7.10 (m, 4H), 7.01-6.95 (m, 4H), 5.94 (s, 1H), 3.73 (s, 3H);  $^{13}\text{C-NMR}$  (100 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  167.8, 158.3, 158.0, 157.9, 150.6, 136.2, 131.0, 128.7, 128.3, 127.3, 126.6, 125.5, 122.3, 114.7, 114.3, 90.9, 55.2, 30.4. Anal. Calcd. for  $\text{C}_{18}\text{H}_{15}\text{N}_3\text{O}_3$ : C, 67.28; H, 4.71;

N, 13.08%; Found: C, 67.36; H, 4.68; N, 13.15%.

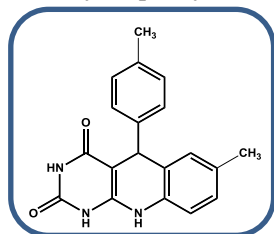
**5-(*p*-tolyl)-5,10-dihydropyrimido[4,5-*b*]quinoline-2,4(1*H*,3*H*)-dione (4i):** Yield: 91%; Melting point: 180-182



°C; IR (KBr):  $\nu$  3350, 3120, 2960, 1667, 1408, 1231, 778, 557  $\text{cm}^{-1}$ ;  $^1\text{H-NMR}$  (400 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  11.34 (s, 1H), 10.04 (bs, 2H), 7.28 (d, 2H,  $J = 8.4\text{Hz}$ ), 7.22-7.18 (m, 2H), 6.93-6.87 (m, 4H), 5.84 (s, 1H), 2.36 (s, 3H);  $^{13}\text{C-NMR}$  (100 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  163.5, 161.7, 150.5, 143.4, 141.1, 137.8, 133.9, 133.0, 129.8, 129.3, 128.8, 127.9, 126.5, 123.5, 119.7, 91.0, 30.3, 21.3. Anal. Calcd. for  $\text{C}_{18}\text{H}_{15}\text{N}_3\text{O}_2$ : C, 70.81; H, 4.95; N, 13.76%; Found:

C, 70.90; H, 5.01; N, 13.68%.

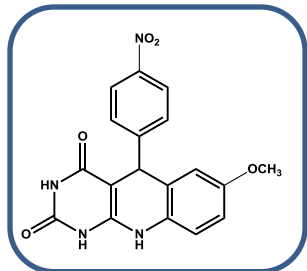
**7-methyl-5-(*p*-tolyl)-5,10-dihydropyrimido[4,5-*b*]quinoline-2,4(1*H*,3*H*)-dione (4j):** Yield: 88%; Melting point:



200-201 °C; IR (KBr):  $\nu$  3345, 3048, 2957, 1676, 1411, 1225, 780, 556  $\text{cm}^{-1}$ ;  $^1\text{H-NMR}$  (400 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  11.11 (s, 1H), 10.00 (bs, 2H), 7.1 (d, 2H,  $J = 8\text{Hz}$ ), 6.93-6.86 (m, 5H), 5.87 (s, 1H), 2.22 (s, 3H), 2.18 (s, 3H);  $^{13}\text{C-NMR}$  (100 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  163.6, 161.8, 150.6, 150.2, 141.2, 134.9, 132.9, 132.3, 129.9, 129.3, 128.8, 128.5, 127.9, 126.5, 121.2, 90.9, 30.1, 21.3, 20.4. Anal. Calcd. for  $\text{C}_{19}\text{H}_{17}\text{N}_3\text{O}_2$ : C, 71.46; H, 5.37; N,

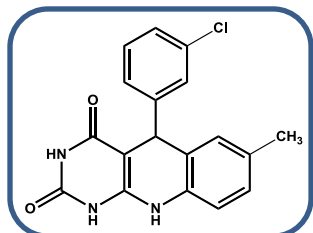
13.16%; Found: C, 71.55; H, 5.43; N, 13.08%.

**7-methoxy-5-(4-nitrophenyl)-5,10-dihydropyrimido[4,5-*b*]quinoline-2,4(1*H*,3*H*)-dione (4k):** Yield: 95%;



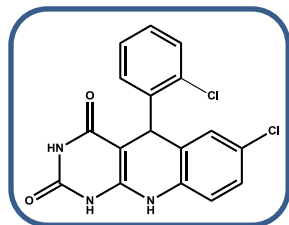
Melting point: 231-233 °C; IR (KBr):  $\nu$  3413, 3037, 2965, 1699, 1619, 1398, 1254, 780, 554  $\text{cm}^{-1}$ ;  $^1\text{H-NMR}$  (400 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  11.13 (s, 1H), 10.16 (bs, 2H), 8.05 (d, 2H,  $J = 8.4\text{Hz}$ ), 7.24-7.26 (m, 3H), 7.02 (d, 2H,  $J = 8.8\text{Hz}$ ), 6.04 (s, 1H), 3.75 (s, 3H);  $^{13}\text{C-NMR}$  (100 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  167.4, 161.2, 158.5, 154.0, 150.6, 144.9, 135.4, 131.2, 127.7, 124.2, 122.8, 114.7, 90.4, 55.3, 31.2. Anal. Calcd. for  $\text{C}_{18}\text{H}_{14}\text{N}_4\text{O}_5$ : C, 59.02; H, 3.85; N, 15.29%; Found: C, 58.91; H, 3.86; N, 15.35%.

**5-(3-chlorophenyl)-7-methyl-5,10-dihydropyrimido[4,5-*b*]quinoline-2,4(1*H*,3*H*)-dione (4l):** Yield: 89%;



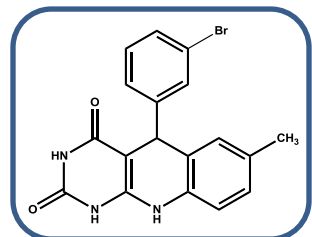
Melting point: 270-272 °C; IR (KBr):  $\nu$  3401, 3031, 2950, 1687, 1623, 1406, 1122, 789, 552  $\text{cm}^{-1}$ ;  $^1\text{H-NMR}$  (400 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  11.11 (s, 1H), 10.09 (bs, 2H), 7.21-7.15 (m, 3H), 7.10-7.06 (m, 3H), 6.95 (d, 1H,  $J = 7.6\text{Hz}$ ), 5.92 (s, 1H), 2.27 (s, 3H);  $^{13}\text{C-NMR}$  (100 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  163.5, 161.5, 150.5, 147.5, 136.5, 132.2, 130.2, 130.0, 129.3, 126.2, 125.4, 124.4, 122.2, 117.0, 90.2, 30.5, 20.4. Anal. Calcd. for  $\text{C}_{18}\text{H}_{14}\text{ClN}_3\text{O}_2$ : C, 63.63; H, 4.15; N, 12.37%; Found: C, 63.72; H, 4.11; N, 12.29%.

**7-chloro-5-(2-chlorophenyl)-5,10-dihydropyrimido[4,5-*b*]quinoline-2,4(1*H*,3*H*)-dione (4m):** Yield: 85%;



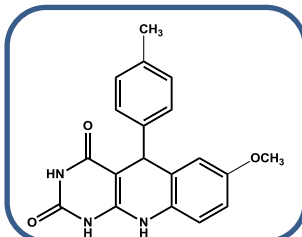
Melting point: 186-188 °C; IR (KBr):  $\nu$  3334, 3021, 1691, 1405, 1122, 778, 554  $\text{cm}^{-1}$ ;  $^1\text{H-NMR}$  (400 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  11.11 (s, 1H), 10.19 (bs, 2H), 7.73 (d, 1H,  $J = 7.2\text{Hz}$ ), 7.45 (t, 1H,  $J = 7.2\text{Hz}$ ), 7.35 (t, 1H,  $J = 7.4\text{Hz}$ ), 7.26-7.19 (m, 1H), 7.15-7.04 (m, 2H), 6.74 (d, 1H,  $J = 8.8\text{Hz}$ ), 5.72 (s, 1H);  $^{13}\text{C-NMR}$  (100 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  163.1, 161.3, 151.0, 150.1, 140.9, 132.3, 130.7, 129.4, 129.3, 127.1, 126.7, 126.1, 125.1, 122.2, 119.9, 91.5, 31.8. Anal. Calcd. for  $\text{C}_{17}\text{H}_{11}\text{Cl}_2\text{N}_3\text{O}_2$ : C, 56.69; H, 3.08; N, 11.67%; Found: C, 56.49; H, 3.12; N, 11.74%.

**5-(3-bromophenyl)-7-methyl-5,10-dihydropyrimido[4,5-*b*]quinoline-2,4(1*H*,3*H*)-dione (4n):** Yield: 90%;



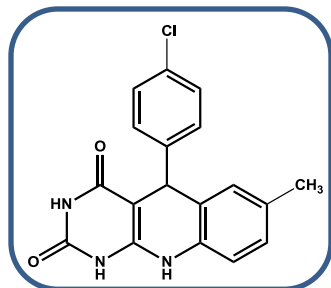
Melting point: >300 °C; IR (KBr):  $\nu$  3352, 3043, 1688, 1621, 1396, 1121, 851, 780, 557  $\text{cm}^{-1}$ ;  $^1\text{H-NMR}$  (400 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  11.11 (s, 1H), 10.12 (bs, 2H), 7.43-7.37 (m, 1H), 7.23-7.21 (m, 2H), 7.14-7.09 (m, 3H), 7.00 (d, 1H,  $J = 8\text{Hz}$ ), 5.92 (s, 1H), 2.27 (s, 1H);  $^{13}\text{C-NMR}$  (100 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  163.2, 161.5, 150.5, 147.8, 136.6, 130.1, 130.0, 129.6, 129.1, 127.3, 125.8, 122.3, 121.1, 90.3, 30.5, 20.4. Anal. Calcd. for  $\text{C}_{18}\text{H}_{14}\text{BrN}_3\text{O}_2$ : C, 56.27; H, 3.67; N, 10.94%; Found: C, 56.00; H, 3.58; N, 11.17%.

**7-methoxy-5-(*p*-tolyl)-5,10-dihydropyrimido[4,5-*b*]quinoline-2,4(1*H*,3*H*)-dione (4o):** Yield: 93%; Melting point:



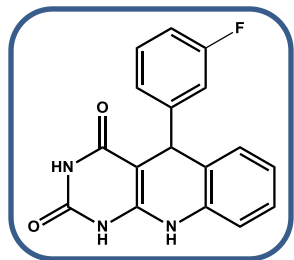
197-199 °C; IR (KBr):  $\nu$  3339, 3027, 1698, 1618, 1408, 1225, 780, 554  $\text{cm}^{-1}$ ;  $^1\text{H-NMR}$  (400 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  11.11 (s, 1H), 9.99 (s, 2H), 7.09 (d, 2H,  $J = 8.8\text{Hz}$ ), 6.97-6.86 (m, 5H), 5.88 (s, 1H), 3.71 (s, 3H), 2.18 (s, 3H);  $^{13}\text{C-NMR}$  (100 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  158.6, 158.1, 151.1, 144.5, 141.9, 133.4, 129.8, 128.4, 127.0, 123.7, 122.7, 115.2, 91.5, 55.7, 30.5, 20.9. Anal. Calcd. for  $\text{C}_{19}\text{H}_{17}\text{N}_3\text{O}_3$ : C, 68.05; H, 5.11; N, 12.53%; Found: C, 67.88; H, 5.03; N, 12.70%.

**5-(4-chlorophenyl)-7-methyl-5,10-dihydropyrimido[4,5-*b*]quinoline-2,4(1*H*,3*H*)-dione (4p):** Yield: 87%;



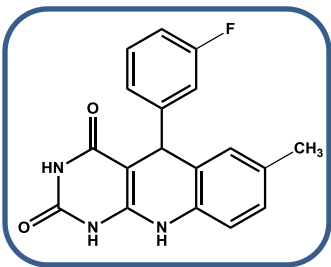
Melting point: 218-220 °C; IR (KBr):  $\nu$  3329, 3017, 2945, 1697, 1398, 1225, 780, 557  $\text{cm}^{-1}$ ;  $^1\text{H-NMR}$  (400 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  11.11 (s, 1H), 10.07 (bs, 2H), 7.20-7.16 (m, 3H), 7.07 (d, 2H,  $J = 8\text{Hz}$ ), 6.99 (d, 2H,  $J = 8.4\text{Hz}$ ), 5.89 (s, 1H), 2.26 (s, 3H);  $^{13}\text{C-NMR}$  (100 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  164.9, 160.7, 150.6, 143.6, 136.1, 130.7, 130.0, 128.8, 128.5, 128.0, 127.2, 122.0, 90.5, 30.2, 20.4. Anal. Calcd. for  $\text{C}_{18}\text{H}_{14}\text{ClN}_3\text{O}_2$ : C, 66.63; H, 4.15; N, 12.37%; Found: C, 63.83; H, 4.07; N, 12.12%.

**5-(3-fluorophenyl)-5,10-dihydropyrimido[4,5-*b*]quinoline-2,4(1*H*,3*H*)-dione (4q):** Yield: 93%; Melting point:



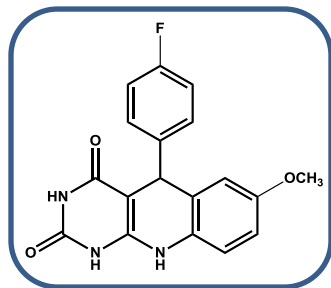
198-200 °C; IR (KBr):  $\nu$  3367, 3024, 1686, 1619, 1398, 1122, 778, 554  $\text{cm}^{-1}$ ;  $^1\text{H-NMR}$  (400 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  11.11 (s, 1H), 10.16 (bs, 2H), 7.37-7.33 (m, 2H), 7.19-7.13 (m, 3H), 6.85-6.70 (m, 3H), 5.90 (s, 1H);  $^{13}\text{C-NMR}$  (100 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  164.4, 163.3, 160.9, 150.5, 147.9, 134.8, 129.5, 129.1, 129.0, 125.8, 122.7, 121.4, 118.3, 113.0, 111.2, 90.3, 30.7. Anal. Calcd. for  $\text{C}_{17}\text{H}_{12}\text{FN}_3\text{O}_2$ : C, 66.02; H, 3.91; N, 13.59%; Found: C, 66.23; H, 4.02; N, 13.38%.

**5-(3-fluorophenyl)-7-methyl-5,10-dihydropyrimido[4,5-*b*]quinoline-2,4(1*H*,3*H*)-dione (4r):** Yield: 91%;



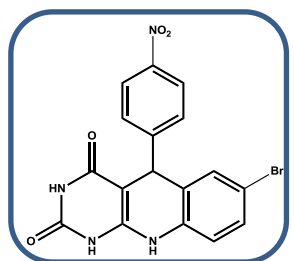
Melting point: >300 °C; IR (KBr):  $\nu$  3365, 3057, 2957, 1698, 1614, 1412, 1125, 779, 553  $\text{cm}^{-1}$ ;  $^1\text{H-NMR}$  (400 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  11.11 (s, 1H), 10.09 (bs, 2H), 7.22-7.08 (m, 4H), 6.84-6.82 (m, 2H), 6.71-6.68 (m, 1H), 5.92 (s, 1H), 2.27 (s, 3H);  $^{13}\text{C-NMR}$  (100 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  168.2, 163.8, 161.4, 151.0, 148.6, 137.0, 130.8, 130.5, 129.6, 129.5, 123.2, 122.7, 113.7, 111.5, 91.0, 31.1, 20.9. Anal. Calcd. for  $\text{C}_{18}\text{H}_{14}\text{FN}_3\text{O}_2$ : C, 66.87; H, 4.36; N, 13.00%; Found: C, 66.68; H, 4.27; N, 13.20%.

**5-(4-fluorophenyl)-7-methoxy-5,10-dihydropyrimido[4,5-*b*]quinoline-2,4(1*H*,3*H*)-dione (4s):** Yield: 96%;



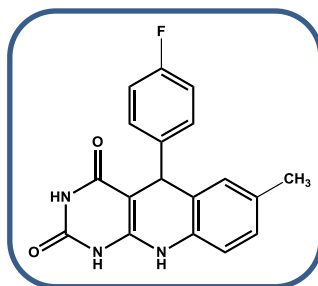
Melting point: 194-196 °C; IR (KBr):  $\nu$  3387, 3032, 1695, 1617, 1397, 1123, 780, 558  $\text{cm}^{-1}$ ;  $^1\text{H-NMR}$  (400 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  11.12 (s, 1H), 10.06 (bs, 2H), 7.18 (d, 2H,  $J = 8.8\text{Hz}$ ), 7.00-6.90 (m, 5H), 5.90 (s, 1H), 3.73 (s, 3H);  $^{13}\text{C-NMR}$  (100 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  168.2, 161.5, 159.1, 158.6, 151.1, 141.0, 133.4, 128.7, 125.8, 124.1, 122.8, 115.2, 114.4, 91.3, 55.8, 30.4. Anal. Calcd. for  $\text{C}_{18}\text{H}_{14}\text{FN}_3\text{O}_3$ : C, 63.71; H, 4.16; N, 12.38%; Found: C, 63.56; H, 4.06; N, 12.45%.

**7-bromo-5-(4-nitrophenyl)-5,10-dihydropyrimido[4,5-*b*]quinoline-2,4(1*H*,3*H*)-dione (4t):** Yield: 91%; Melting



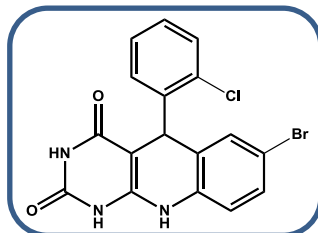
point: 238-240 °C; IR (KBr):  $\nu$  3398, 3038, 1682, 1621, 1514, 1346, 1110, 851, 780, 554  $\text{cm}^{-1}$ ;  $^1\text{H-NMR}$  (400 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  11.32 (s, 1H), 10.30 (bs, 2H), 8.06 (d, 2H,  $J = 8\text{Hz}$ ), 7.40 (d, 2H,  $J = 16\text{Hz}$ ), 7.26-7.32 (m, 1H), 6.90 (d, 2H,  $J = 8\text{Hz}$ ), 5.98 (s, 1H);  $^{13}\text{C-NMR}$  (100 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  168.7, 161.0, 153.4, 150.5, 145.0, 137.9, 132.0, 129.7, 127.8, 123.9, 122.8, 121.5, 114.9, 91.9, 31.5. Anal. Calcd. for  $\text{C}_{17}\text{H}_{11}\text{BrN}_4\text{O}_4$ : C, 49.18; H, 2.67; N, 13.49%; Found: C, 42.28; H, 2.71; N, 13.30%.

**5-(4-fluorophenyl)-7-methyl-5,10-dihydropyrimido[4,5-*b*]quinoline-2,4(1*H*,3*H*)-dione (4u):** Yield:87%; Melting



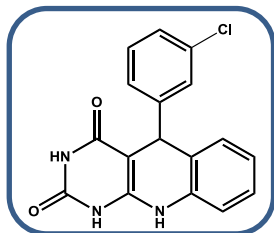
point: 204-206 °C; IR (KBr):  $\nu$  3375, 3018, 1689, 1614, 1409, 1124, 778, 553  $\text{cm}^{-1}$ ;  $^1\text{H-NMR}$  (400 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  11.11 (s, 1H), 10.08 (bs, 2H), 7.18 (d, 2H,  $J = 8\text{Hz}$ ), 7.07 (d, 2H,  $J = 8\text{Hz}$ ), 7.01-6.90 (m, 3H), 5.89 (s, 1H), 2.26 (s, 3H);  $^{13}\text{C-NMR}$  (100 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  167.7, 161.0, 158.6, 150.6, 140.4, 135.7, 131.3, 129.9, 128.1, 126.5, 125.7, 121.7, 113.7, 90.8, 30.0, 20.7. Anal. Calcd. for  $\text{C}_{18}\text{H}_{14}\text{FN}_3\text{O}_2$ : C, 66.87; H, 4.36; N, 13.00%; Found: C, 67.02; H, 4.44; N, 12.88%.

**7-bromo-5-(2-chlorophenyl)-5,10-dihydropyrimido[4,5-*b*]quinoline-2,4(1*H*,3*H*)-dione (4v):** Yield: 88%;



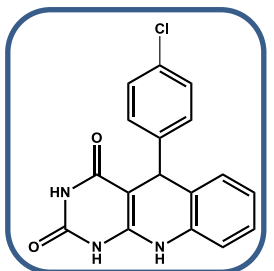
Melting point: 193-195 °C; IR (KBr):  $\nu$  3374, 3017, 1689, 1618, 1406, 1125, 780, 556  $\text{cm}^{-1}$ ;  $^1\text{H-NMR}$  (400 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  11.26 (s, 1H), 10.10 (bs, 2H), 7.74 (d, 1H,  $J = 7.6\text{Hz}$ ), 7.55 (d, 1H,  $J = 7.6\text{Hz}$ ), 7.47 (t, 1H,  $J = 7.4\text{Hz}$ ), 7.36 (t, 1H,  $J = 7.4\text{Hz}$ ), 7.27-7.21 (m, 2H), 6.64 (d, 1H,  $J = 8.4\text{Hz}$ ), 5.74 (s, 1H);  $^{13}\text{C-NMR}$  (100 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  163.1, 161.3, 150.6, 150.1, 143.4, 133.6, 132.7, 132.1, 130.7, 129.3, 127.0, 126.7, 126.1, 119.1, 110.9, 88.3, 31.8. Anal. Calcd. for  $\text{C}_{17}\text{H}_{11}\text{BrClN}_3\text{O}_2$ : C, 50.46; H, 2.74; N, 10.38%; Found: C, 50.58; H, 2.69; N, 10.27%.

**5-(3-chlorophenyl)-5,10-dihydropyrimido[4,5-*b*]quinoline-2,4(1*H*,3*H*)-dione (4w):** Yield: 85%; Melting point:



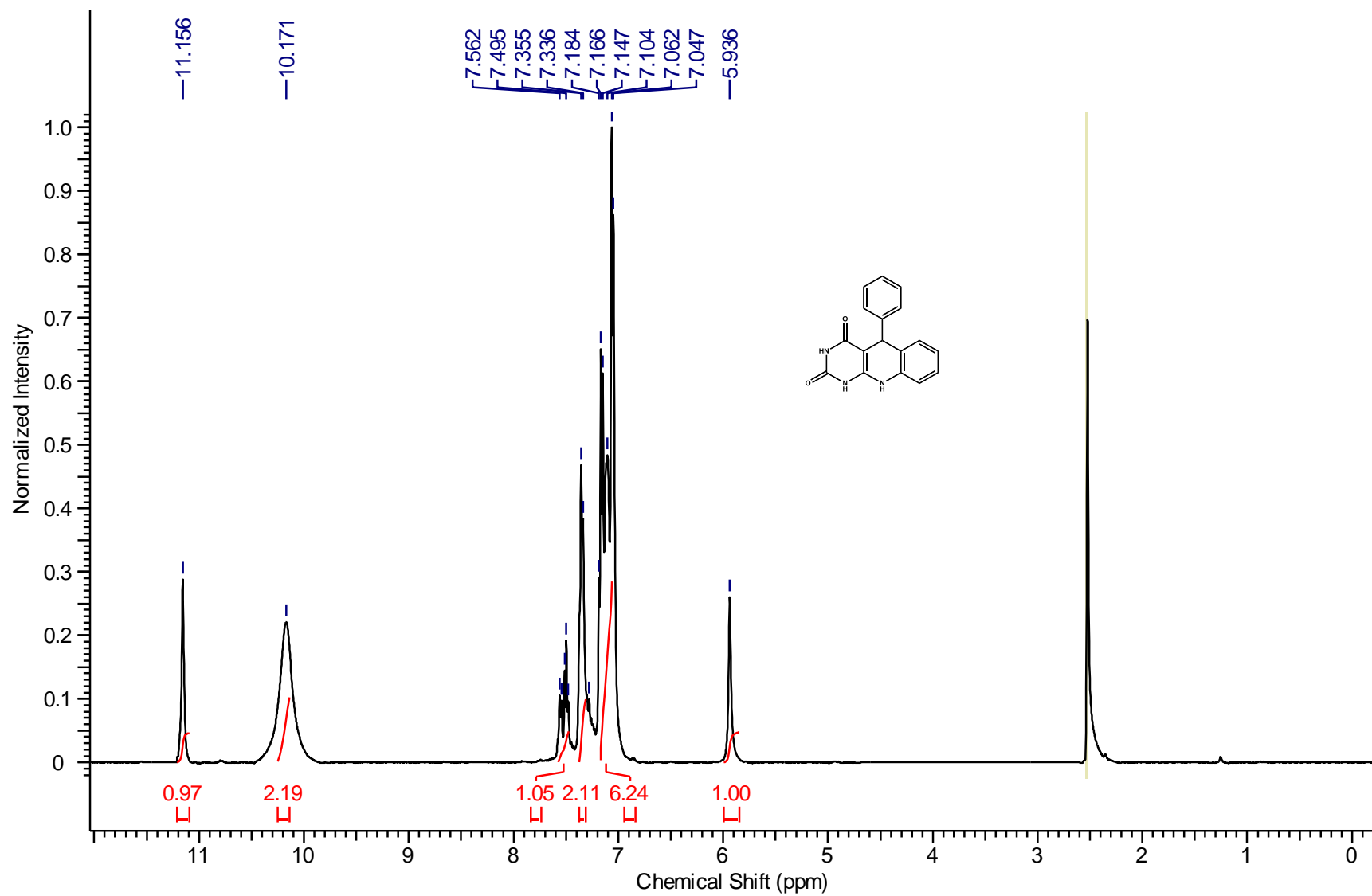
202-204°C; IR (KBr):  $\nu$  3353, 3032, 1689, 1625, 1399, 1121, 780, 557  $\text{cm}^{-1}$ ;  $^1\text{H-NMR}$  (400 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  11.11 (s, 1H), 10.12 (bs, 2H), 7.34-7.30 (m, 2H), 7.19-7.06 (m, 5H), 6.96 (d, 1H,  $J = 7.6\text{Hz}$ ), 5.91 (s, 1H);  $^{13}\text{C-NMR}$  (100 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  163.6, 161.2, 150.5, 147.5, 135.1, 132.2, 129.5, 129.3, 127.9, 126.3, 125.5, 125.4, 124.4, 121.2, 117.9, 90.2, 30.6. Anal. Calcd. for  $\text{C}_{17}\text{H}_{12}\text{ClN}_3\text{O}_2$ : C, 62.68; H, 3.71; N, 12.90%; Found: C, 62.47; H, 3.76; N, 13.11%.

**5-(4-chlorophenyl)-5,10-dihydropyrimido[4,5-*b*]quinoline-2,4(1*H*,3*H*)-dione (4x):** Yield: 93%; Melting point:



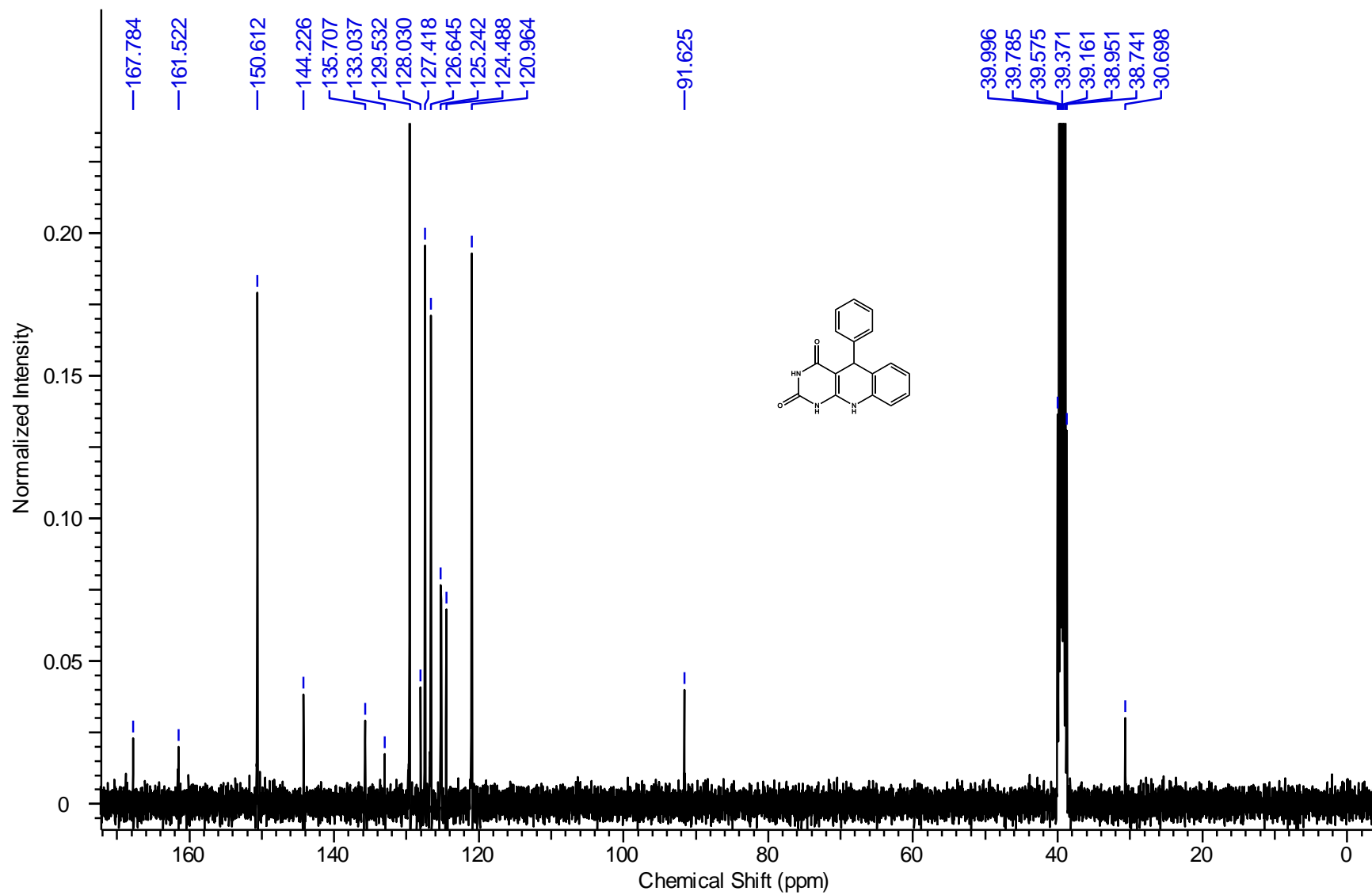
194-196 °C; IR (KBr):  $\nu$  3342, 3024, 1699, 1621, 1394, 1124, 779, 554  $\text{cm}^{-1}$ ;  $^1\text{H-NMR}$  (400 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  11.26 (s, 1H), 10.10 (bs, 2H), 7.32-7.25 (m, 3H), 7.17 (d, 2H,  $J = 8.4\text{Hz}$ ), 7.08-6.99 (m, 3H), 5.88 (s, 1H);  $^{13}\text{C-NMR}$  (100 MHz,  $\text{DMSO-D}_6$ ):  $\delta$  164.1, 161.6, 150.5, 143.6, 135.7, 130.2, 129.5, 128.9, 128.5, 128.0, 127.2, 125.1, 120.8, 90.4, 30.3. Anal. Calcd. for  $\text{C}_{17}\text{H}_{12}\text{ClN}_3\text{O}_2$ : C, 62.68; H, 3.71; N, 12.90%; Found: C, 62.81; H, 3.69; N, 12.76%.

<sup>1</sup>H-NMR of 4a

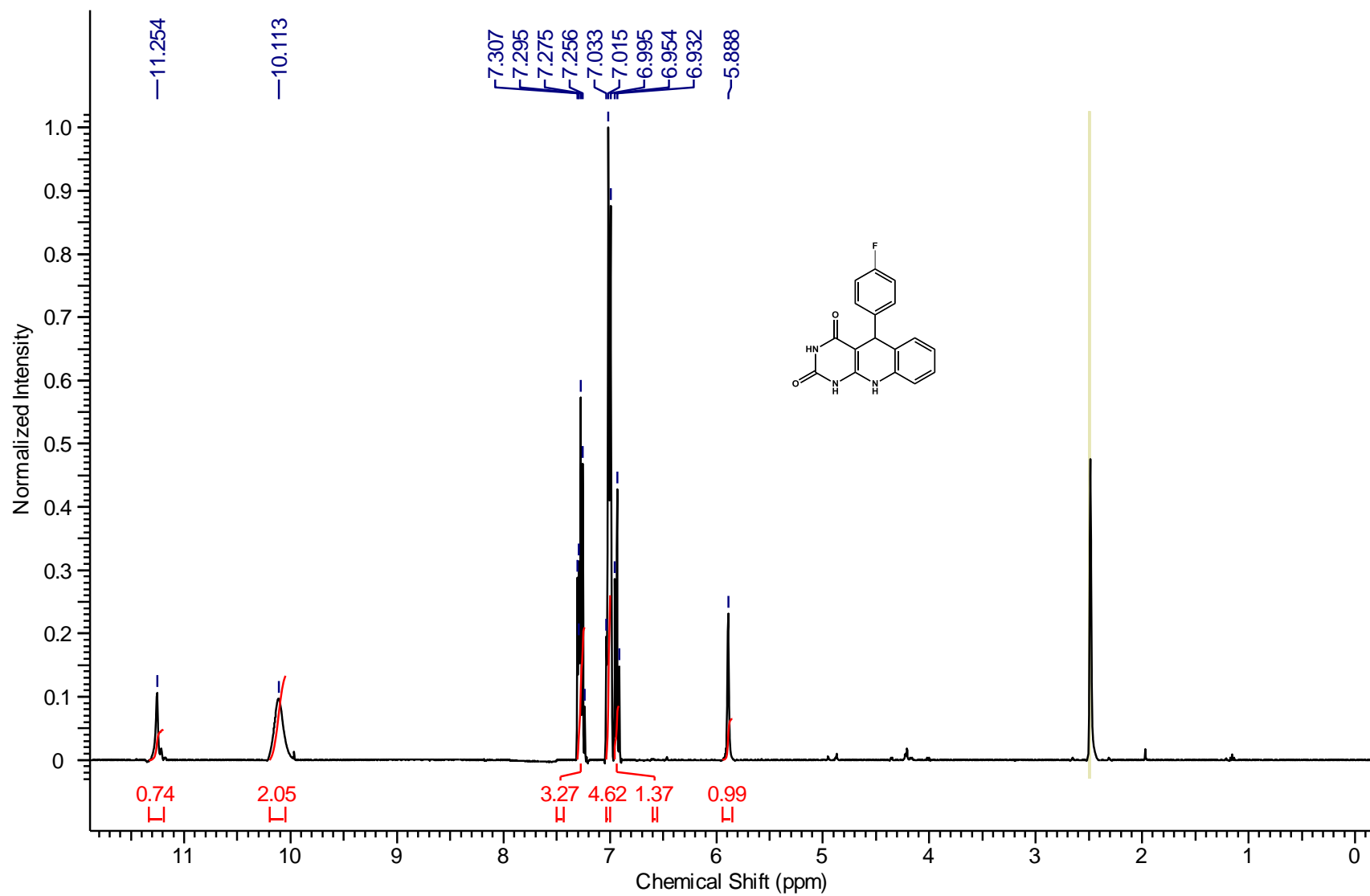




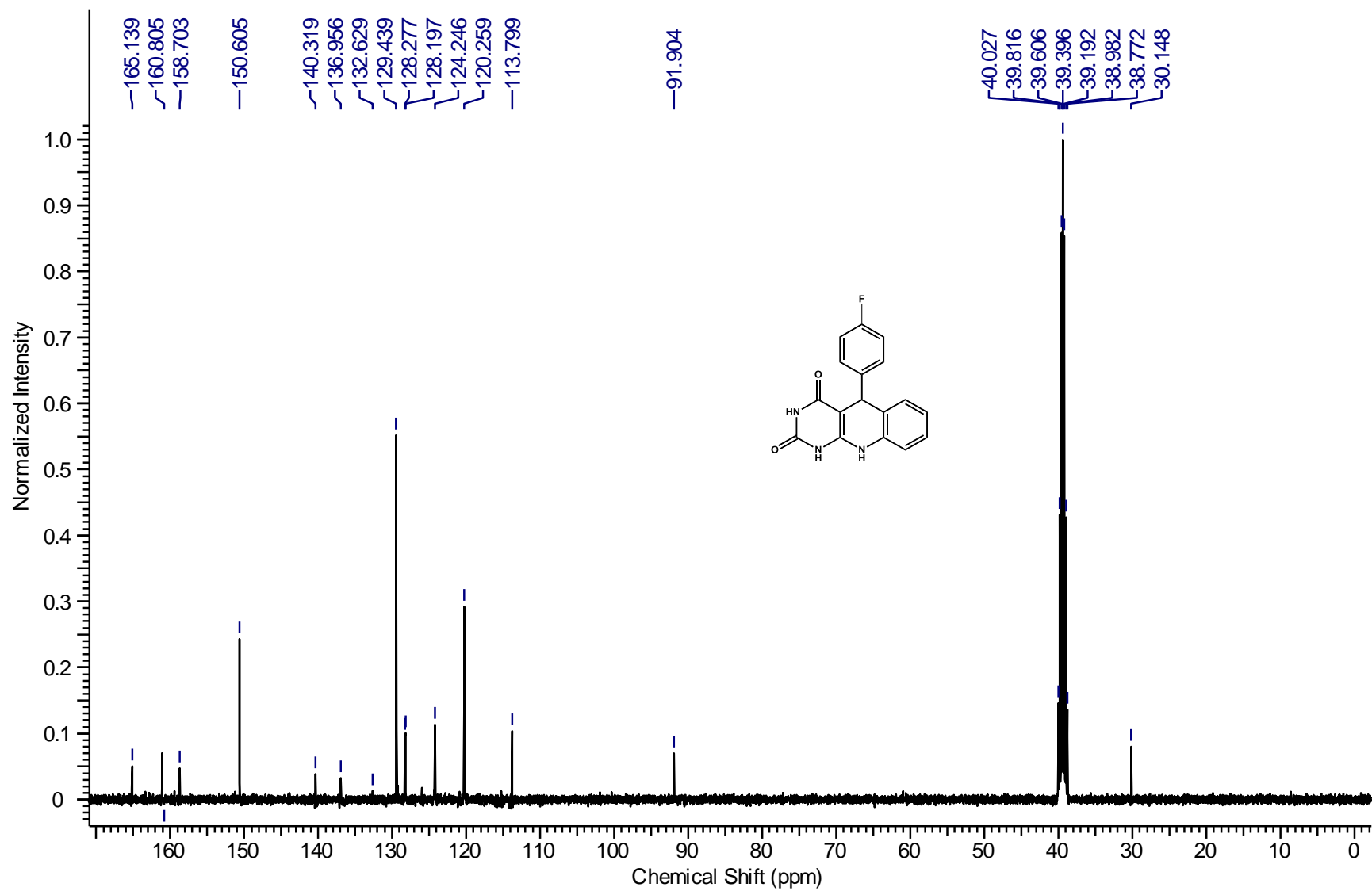
$^{13}\text{C}$ -NMR of 4a



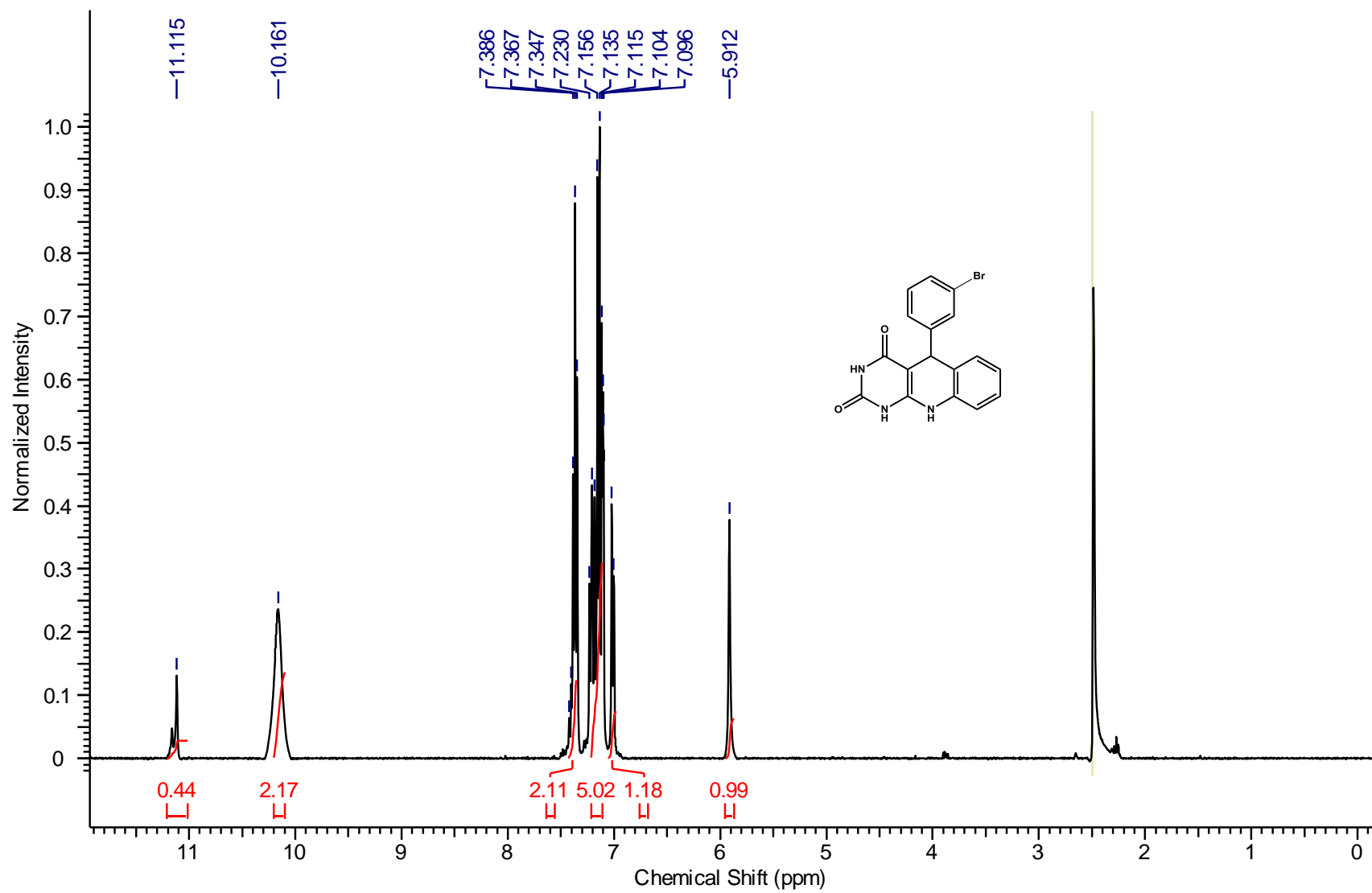
<sup>1</sup>H-NMR of 4b



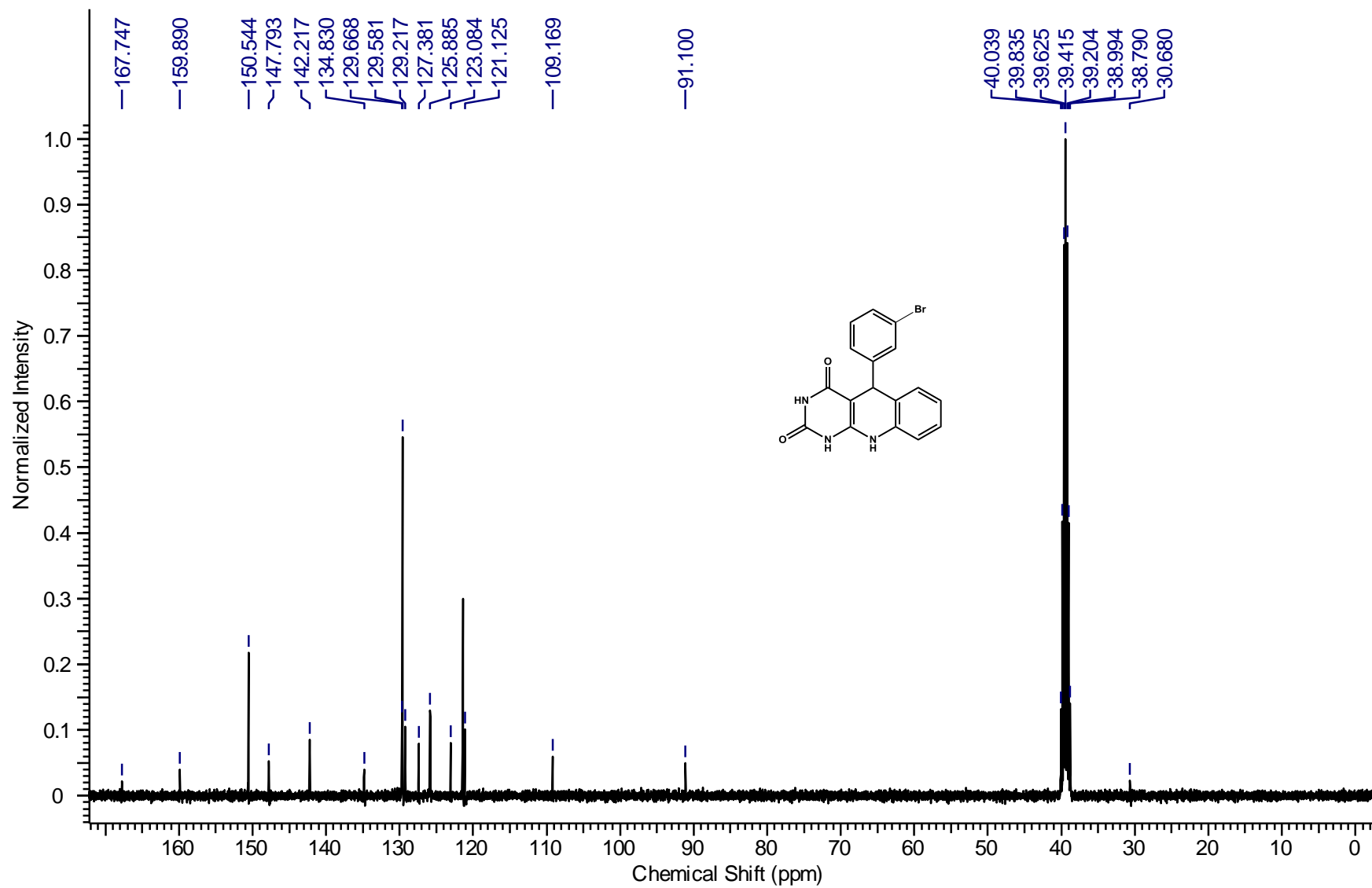
$^{13}\text{C}$ -NMR of 4b



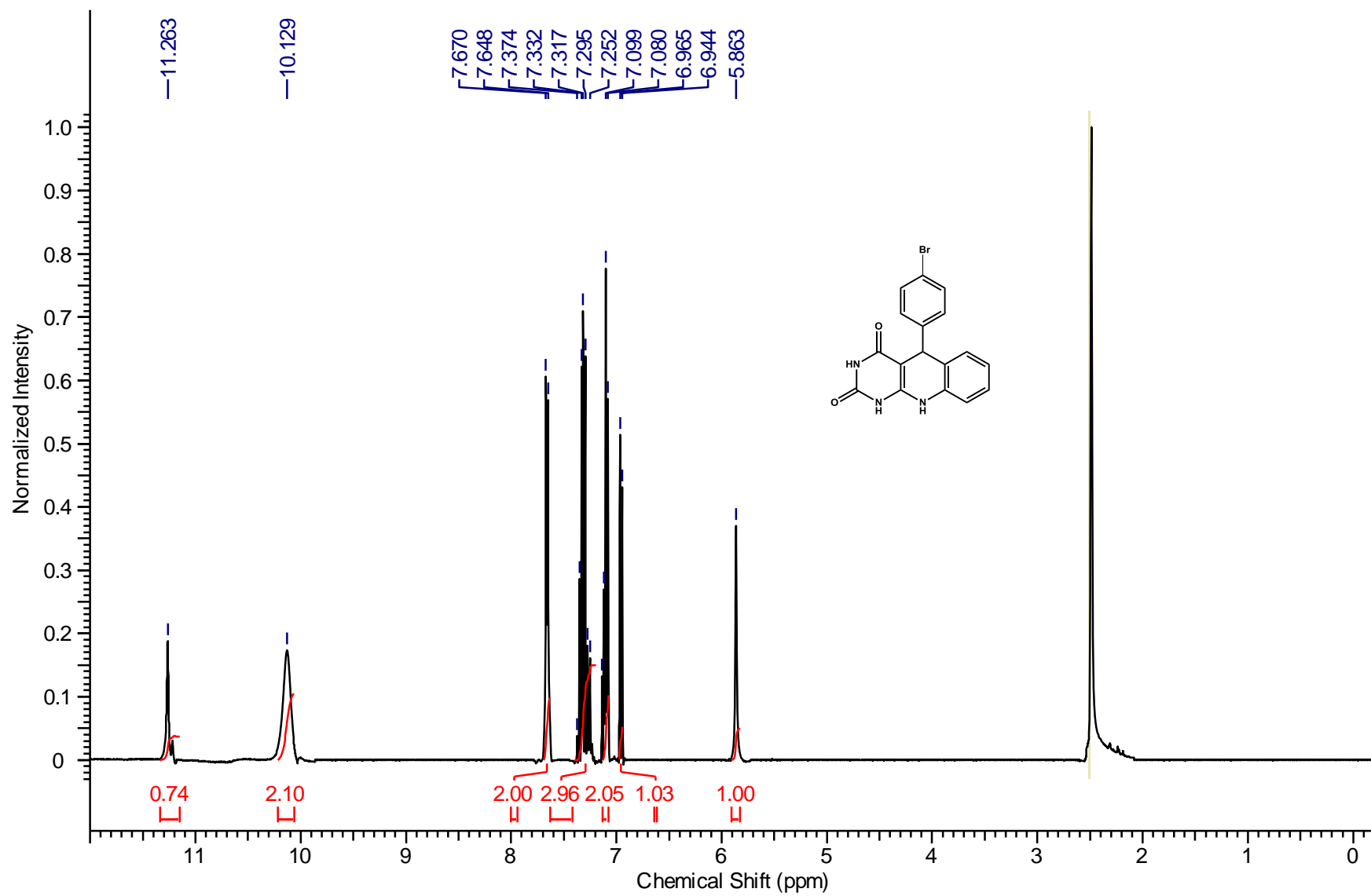
$^1\text{H-NMR}$  of 4c



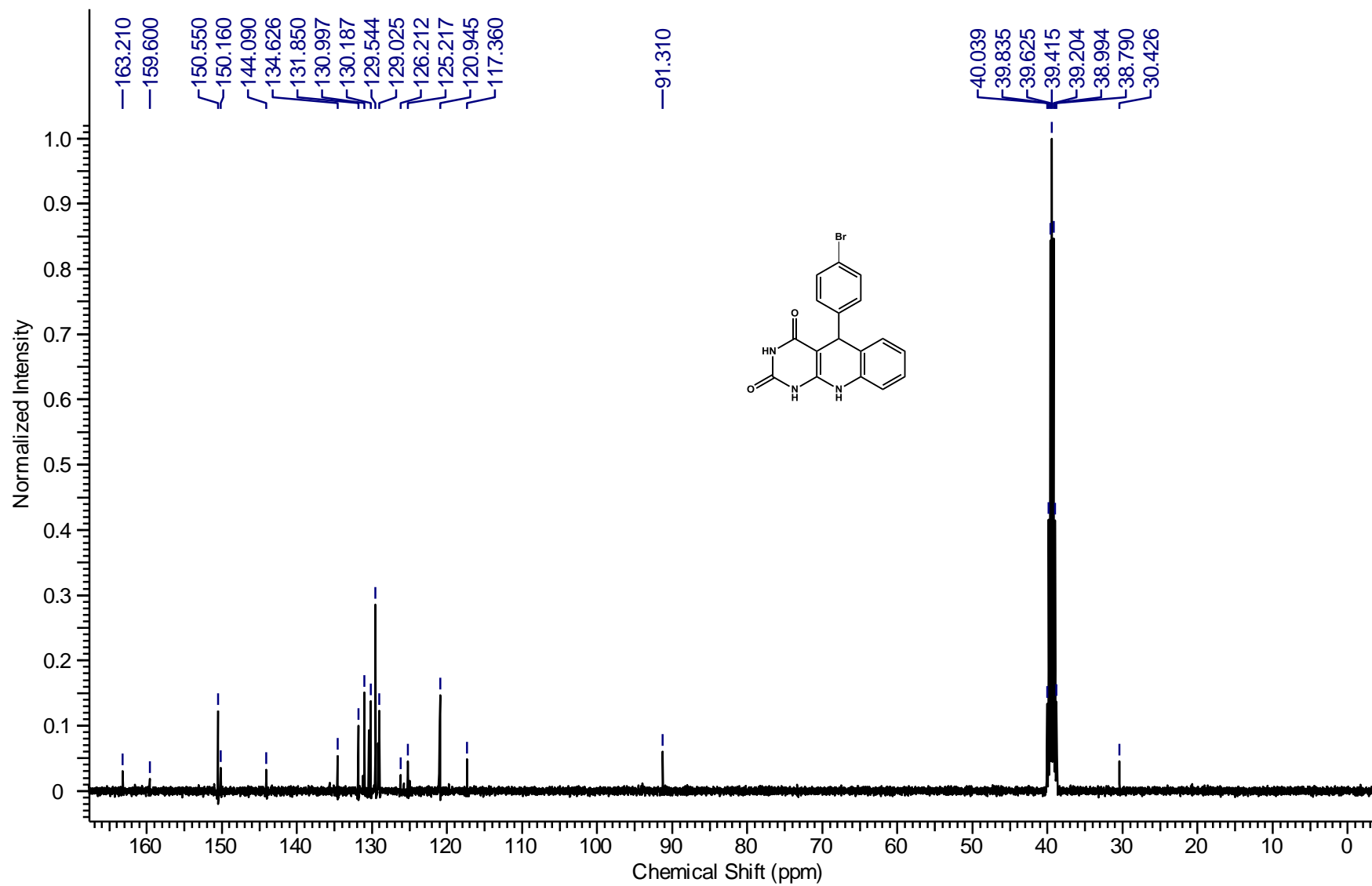
$^{13}\text{C}$ -NMR of 4c



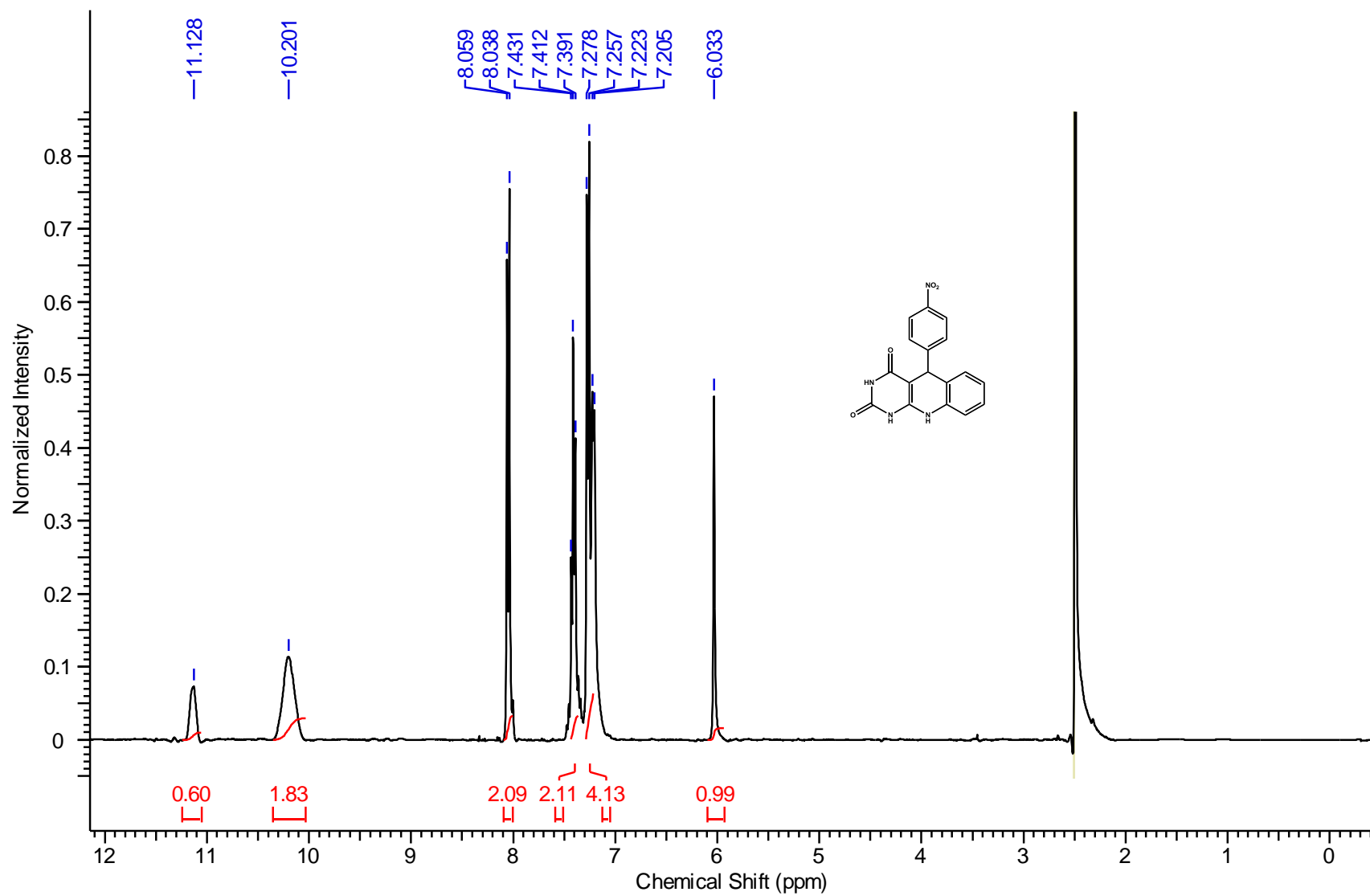
$^1\text{H-NMR}$  of 4d



$^{13}\text{C}$ -NMR of 4d

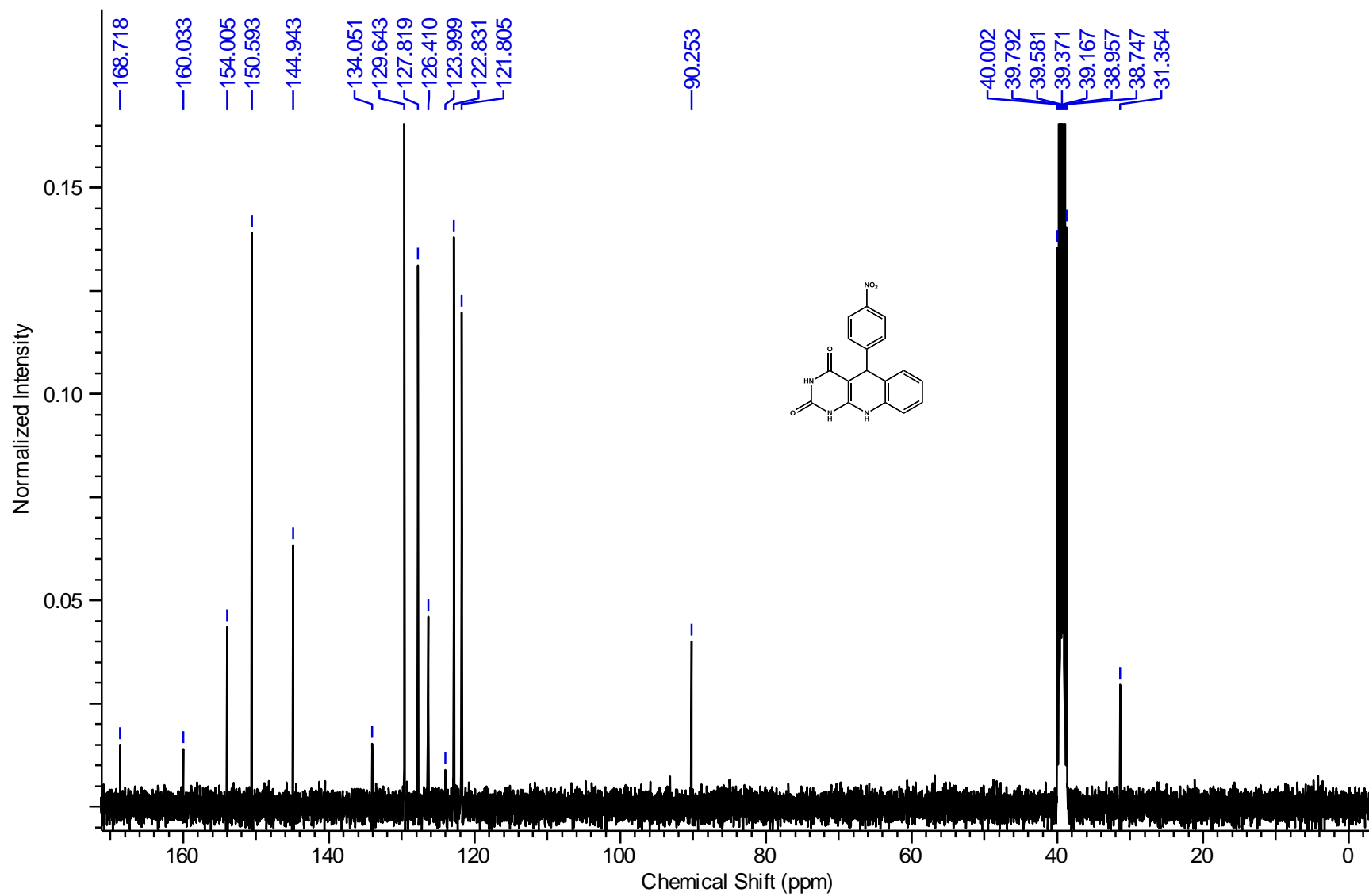


$^1\text{H-NMR}$  of 4e

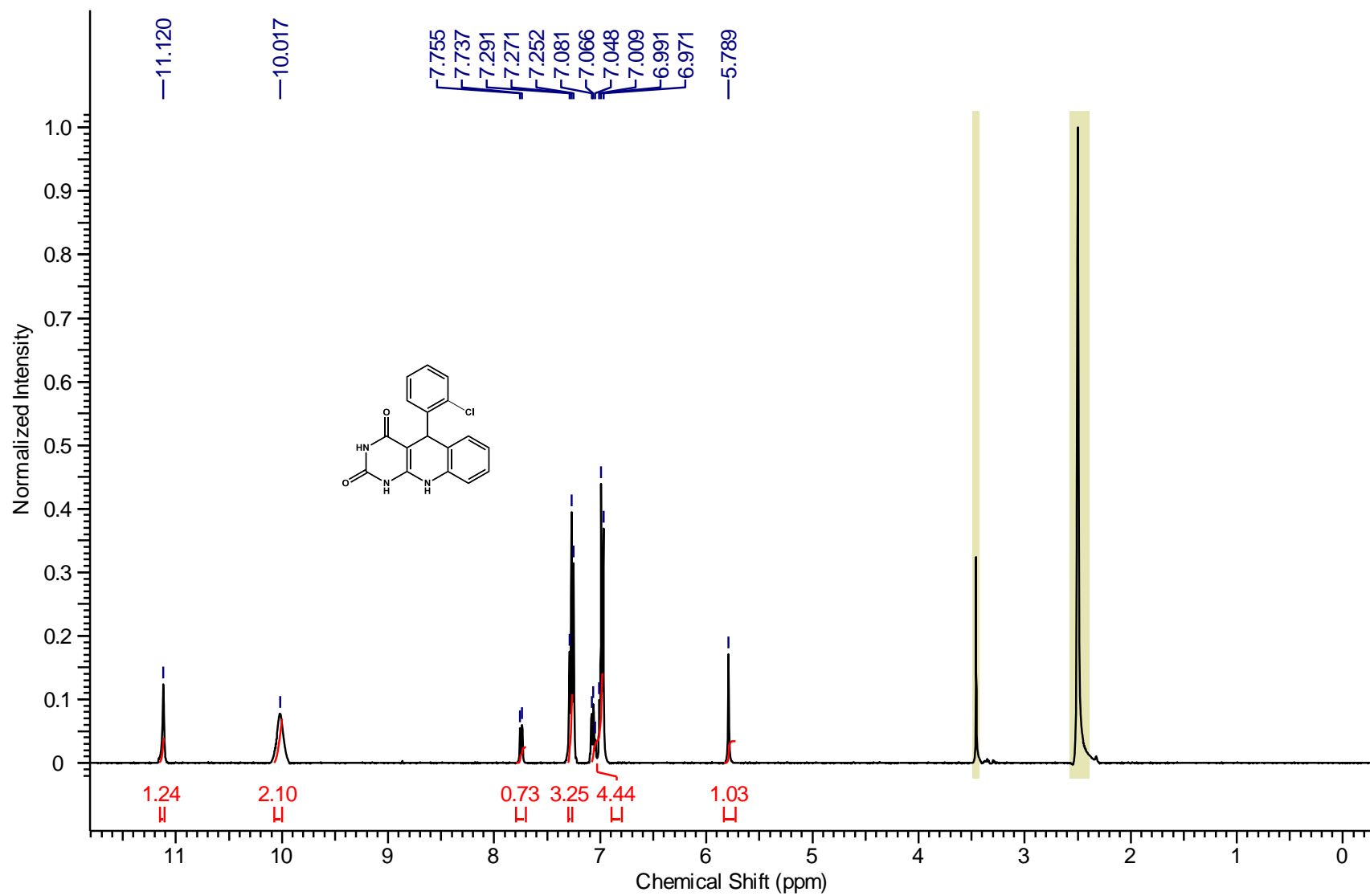




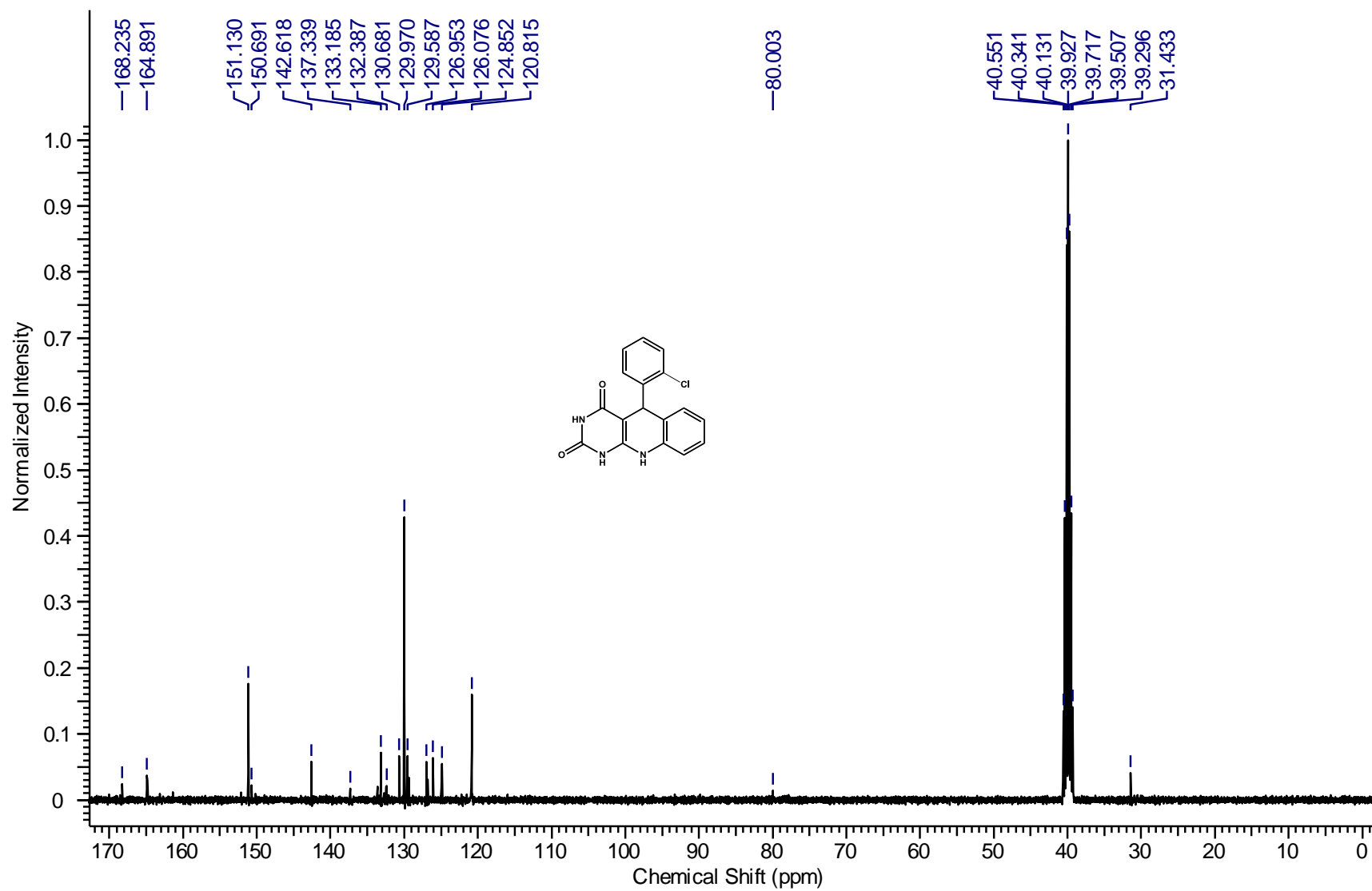
$^{13}\text{C}$ -NMR of 4e



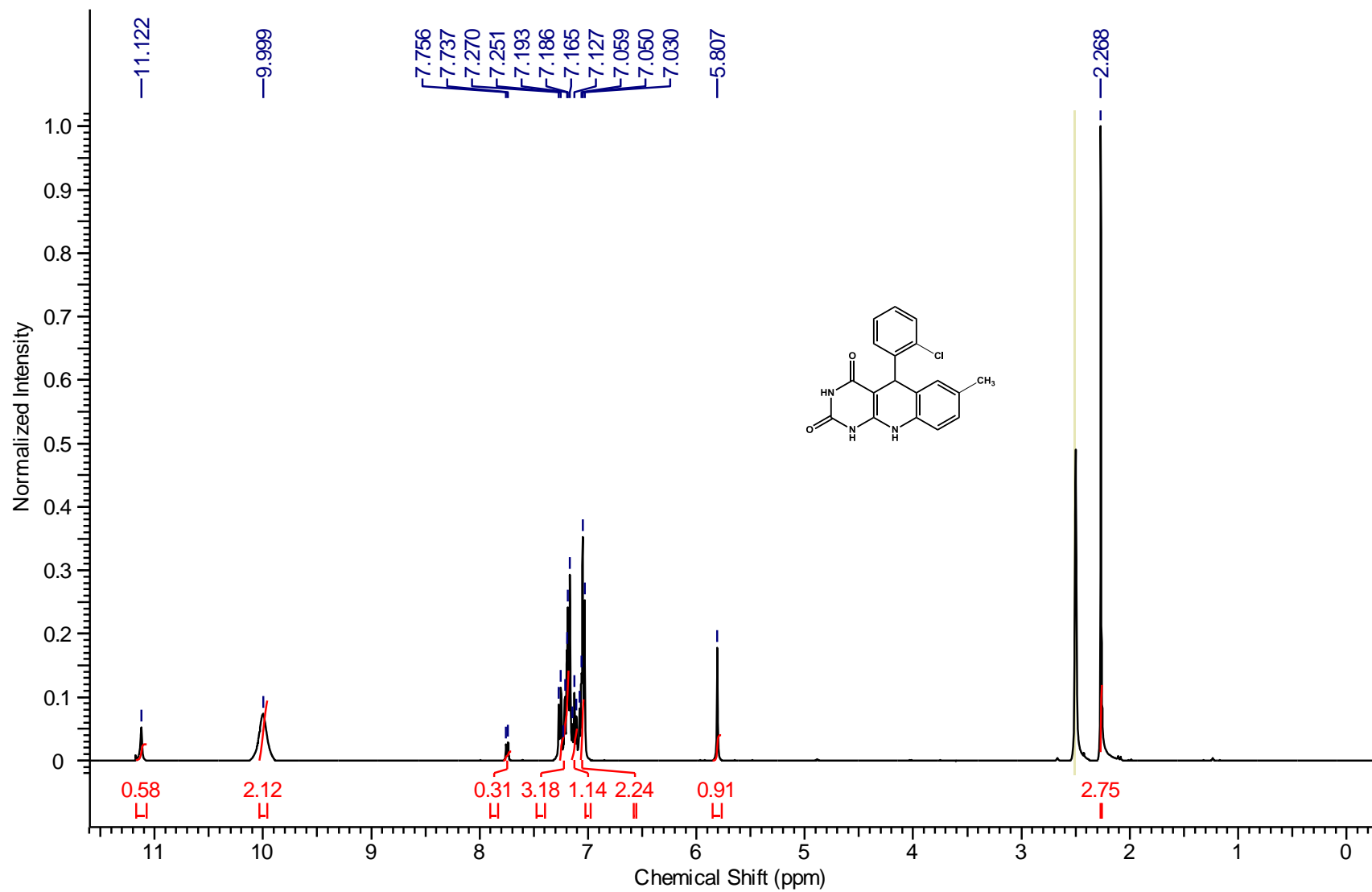
<sup>1</sup>H-NMR of 4f



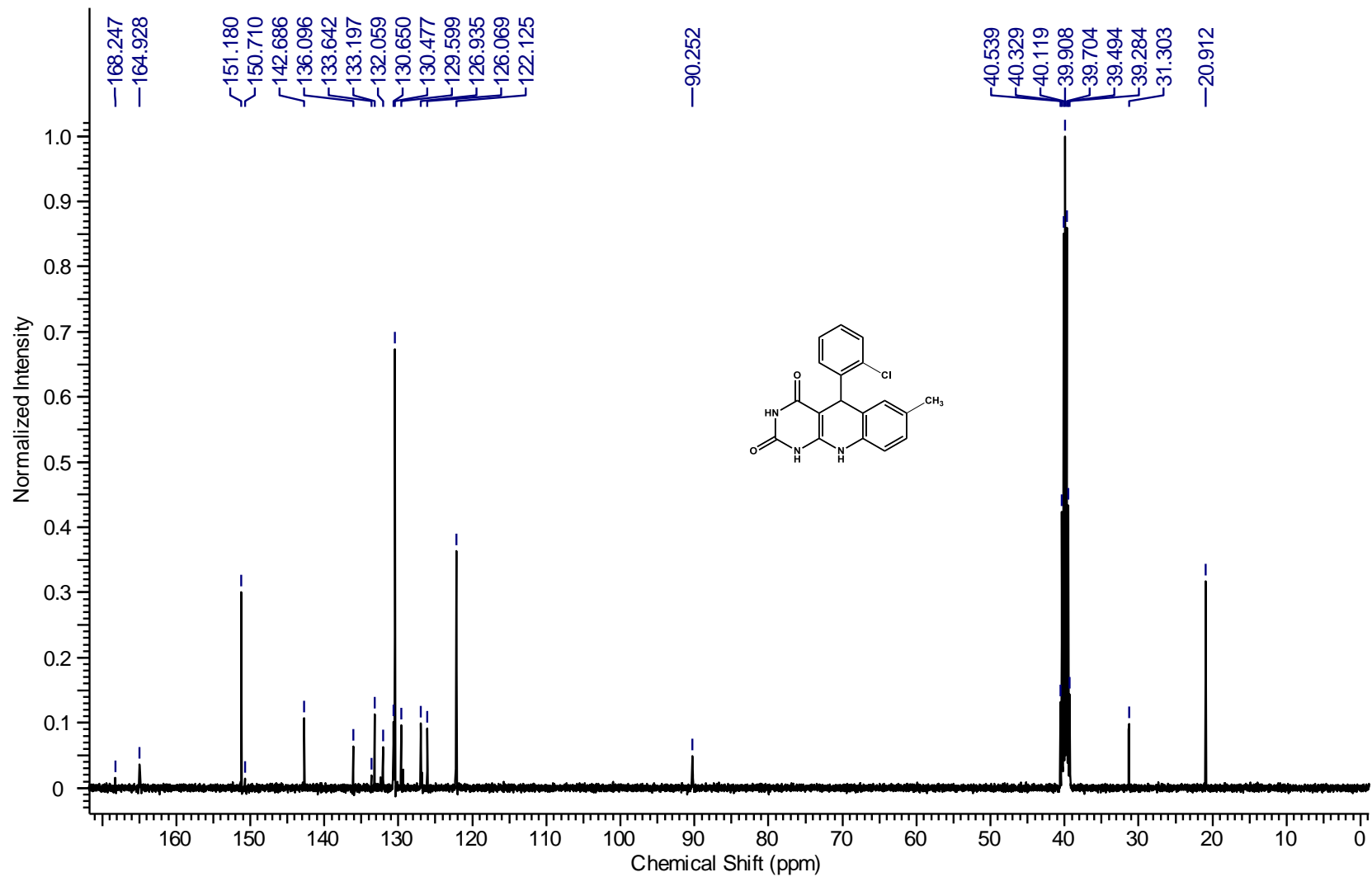
$^{13}\text{C}$ -NMR of 4f



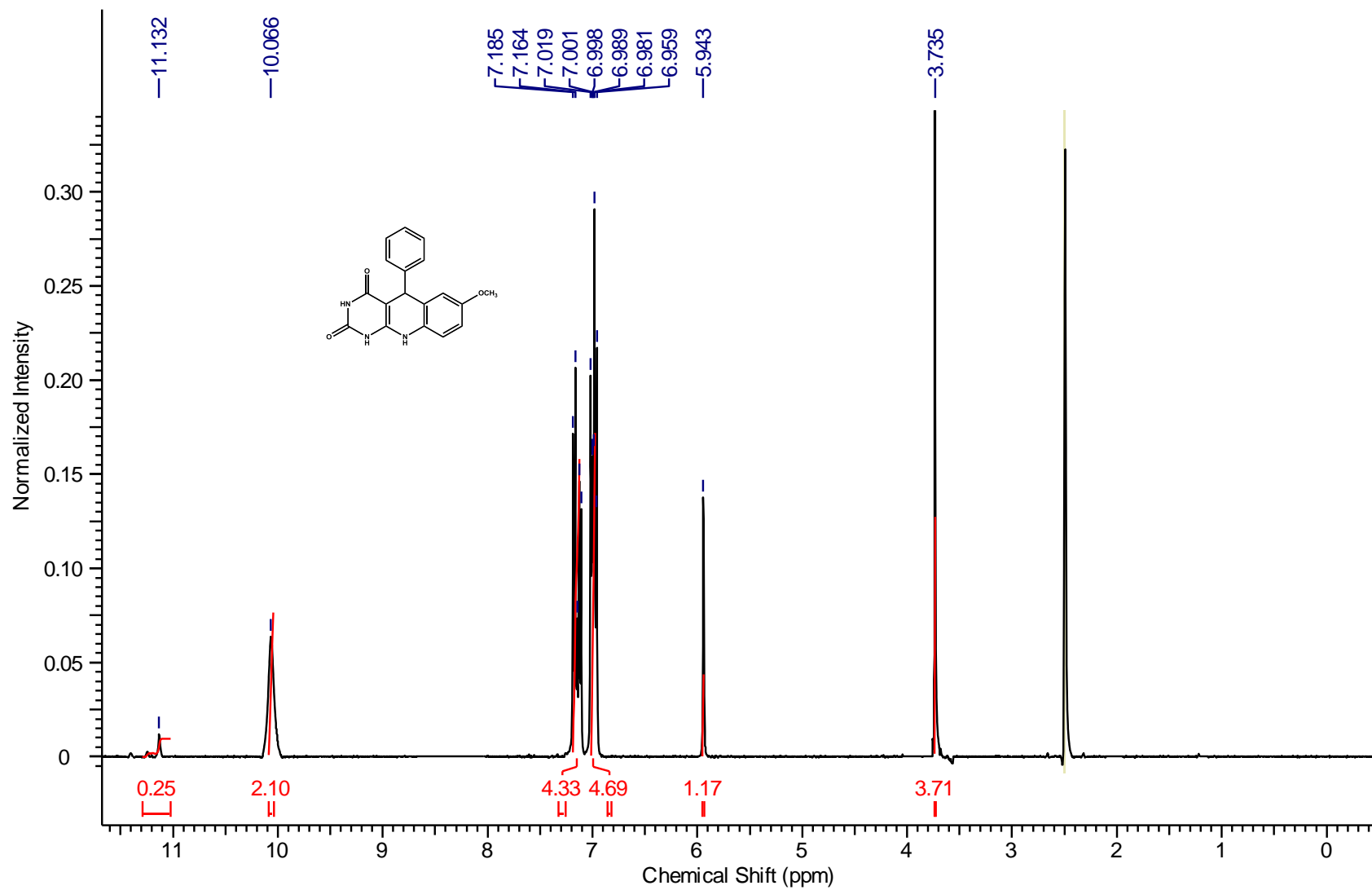
<sup>1</sup>H-NMR of 4g



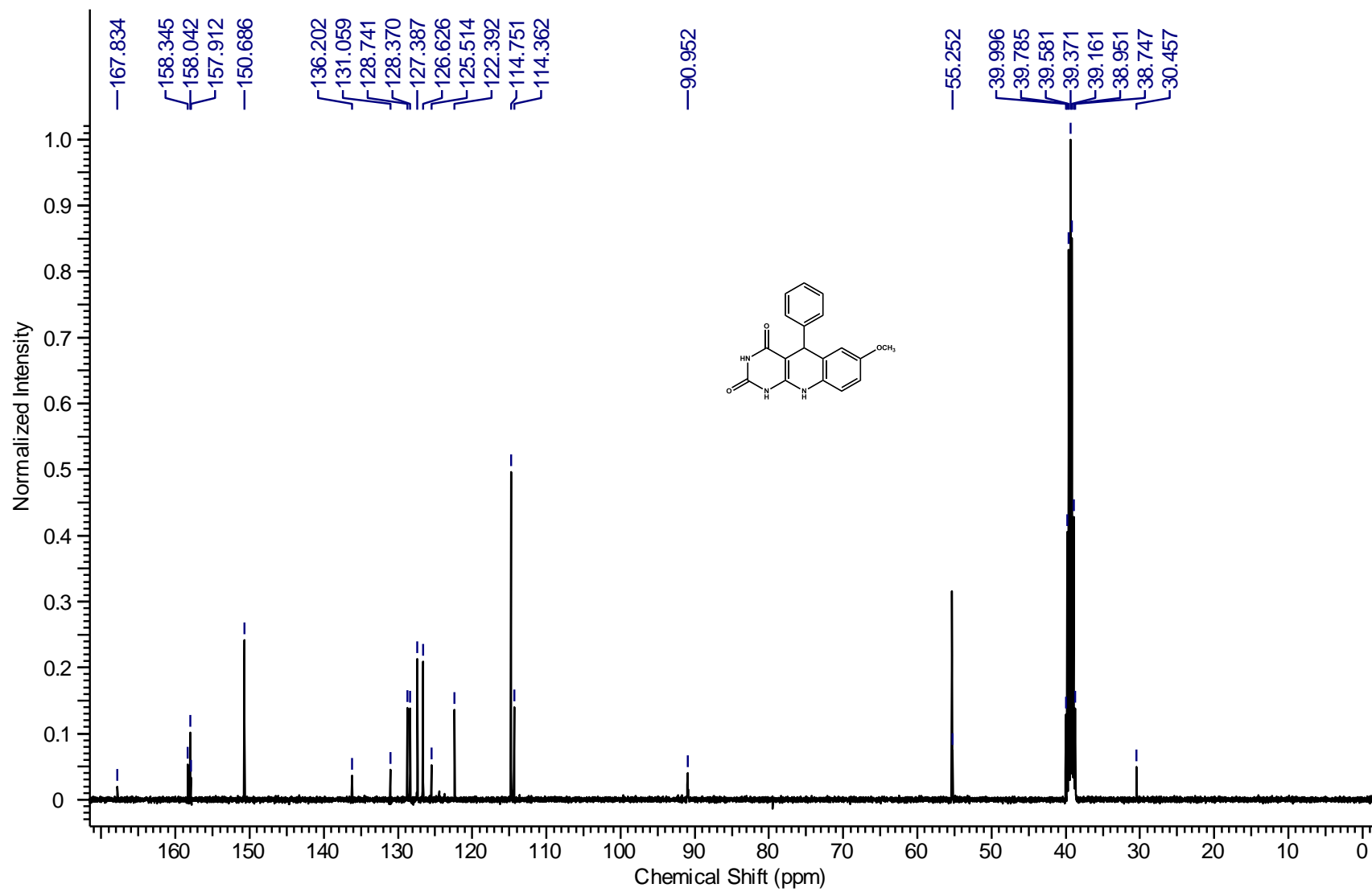
$^{13}\text{C}$ -NMR of 4g



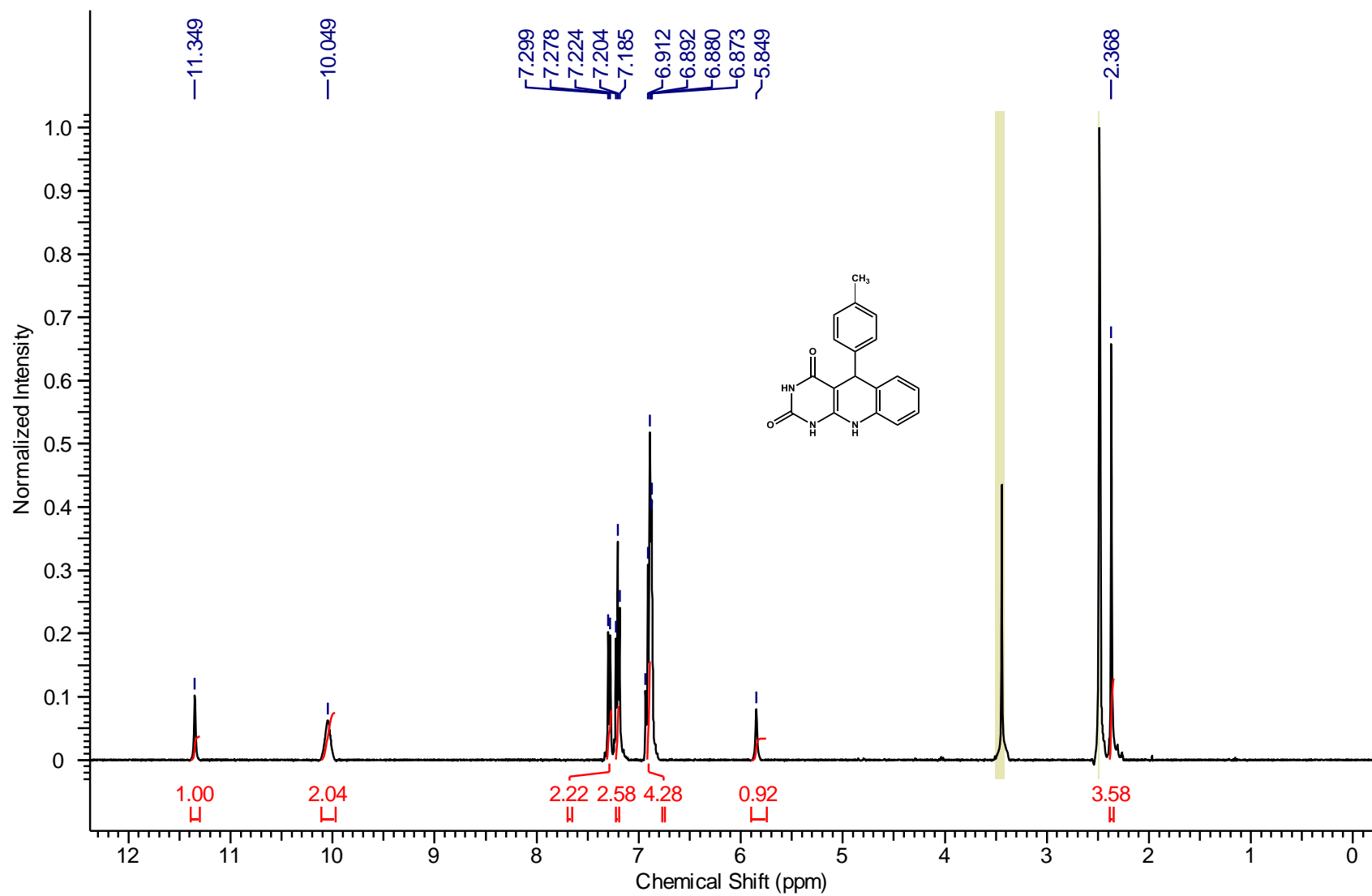
<sup>1</sup>H-NMR of 4h



$^{13}\text{C}$ -NMR of 4h

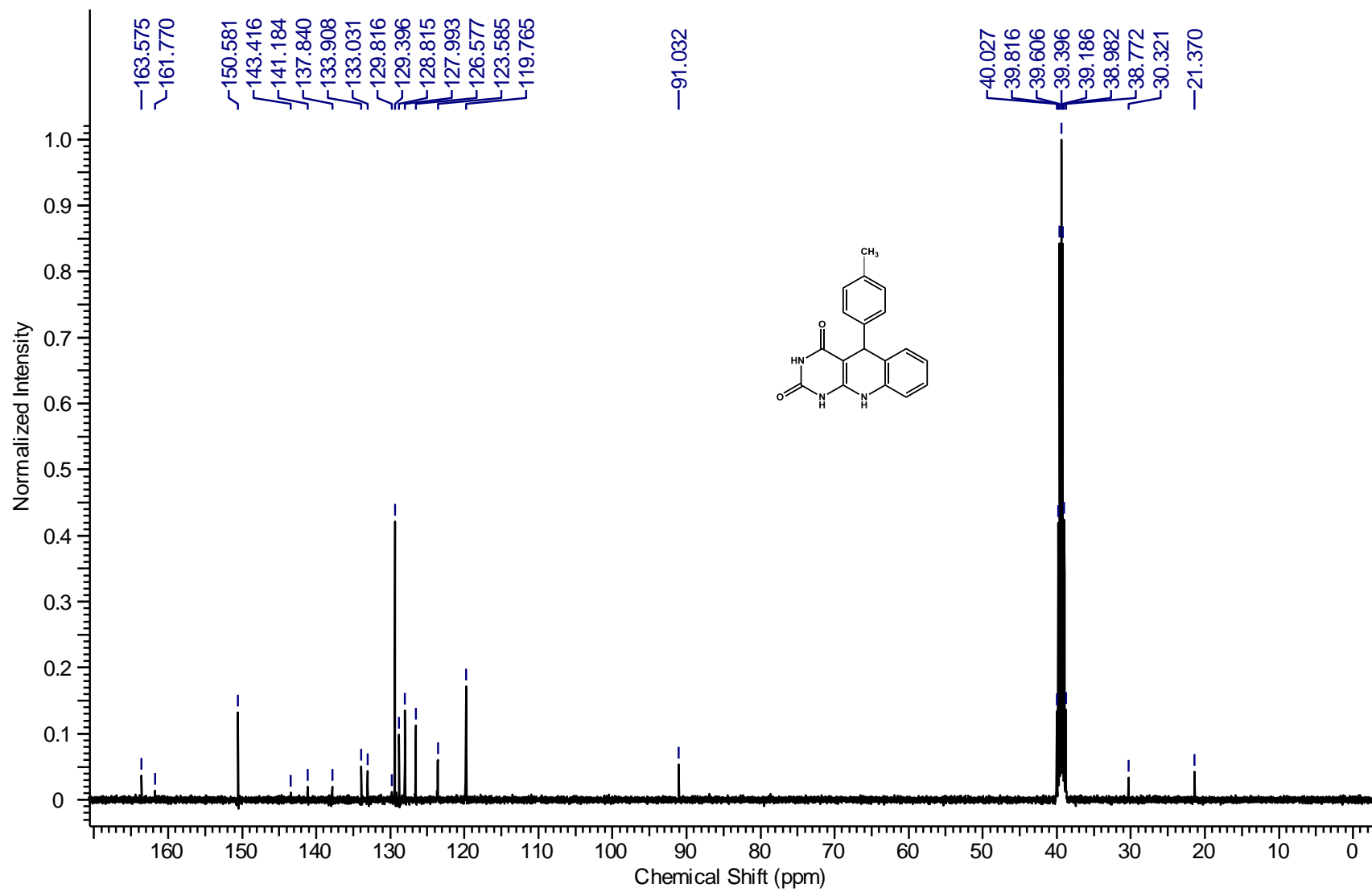


$^1\text{H-NMR}$  of 4i

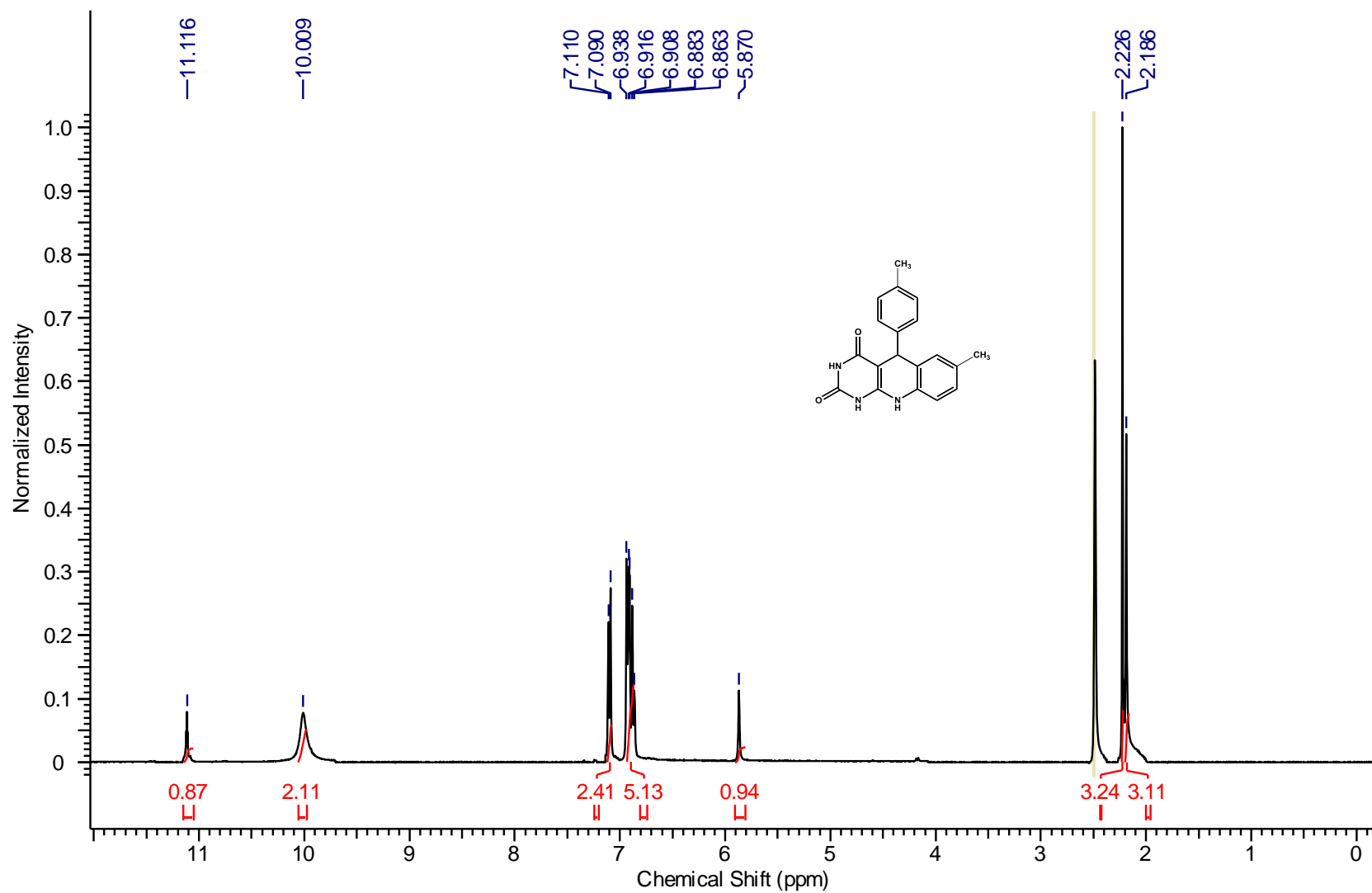




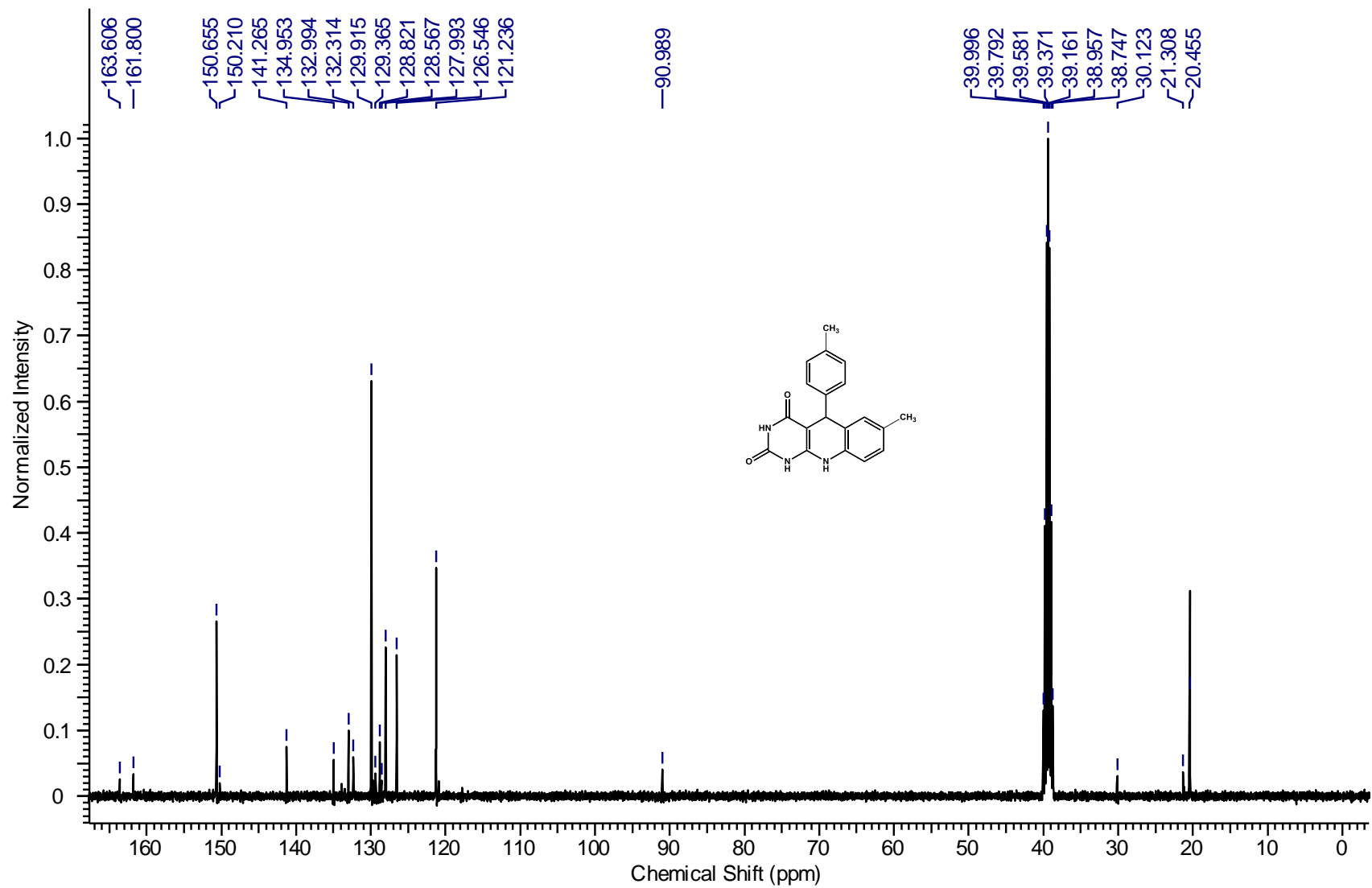
$^{13}\text{C}$ -NMR of 4i



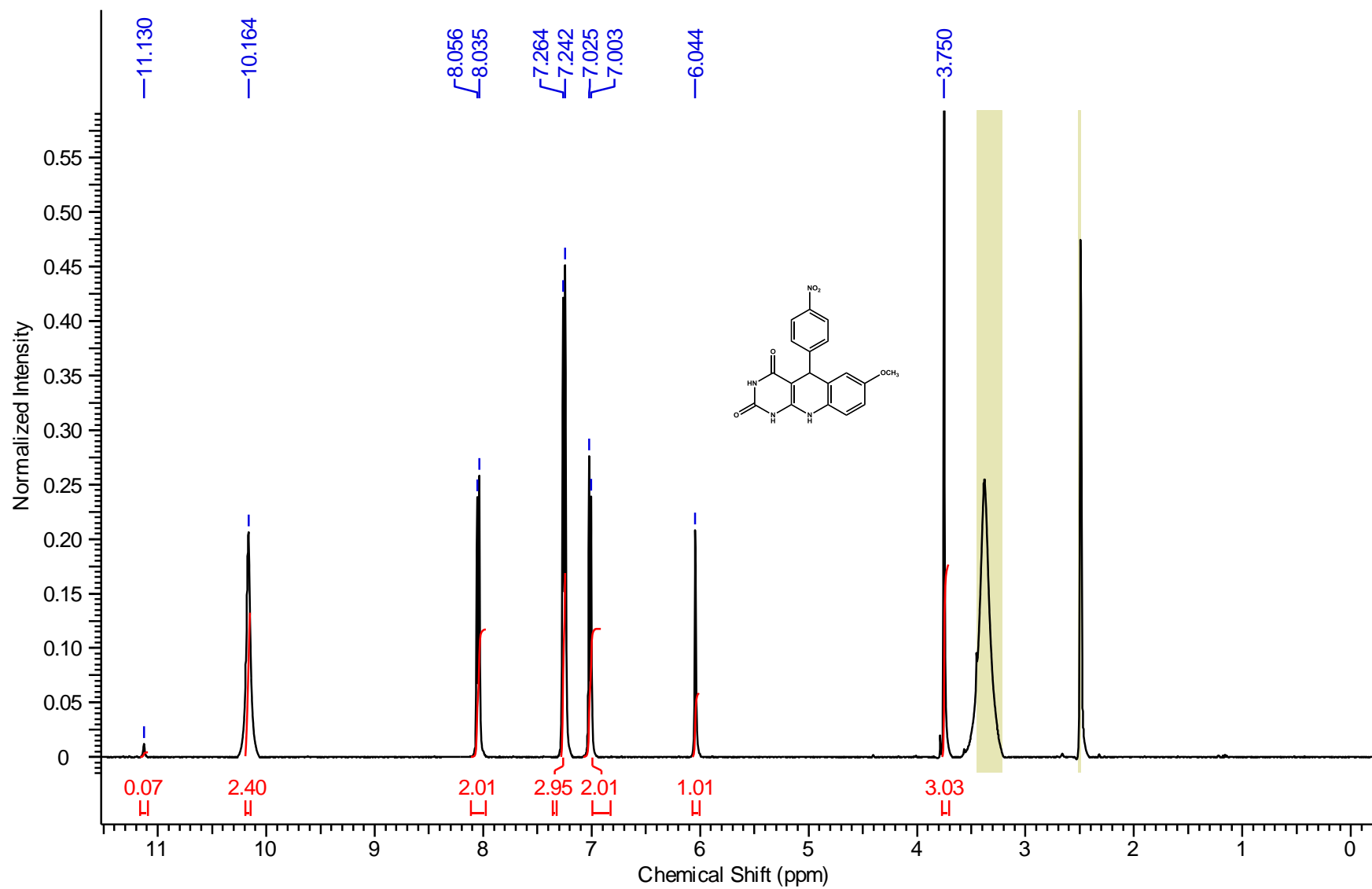
<sup>1</sup>H-NMR of 4j



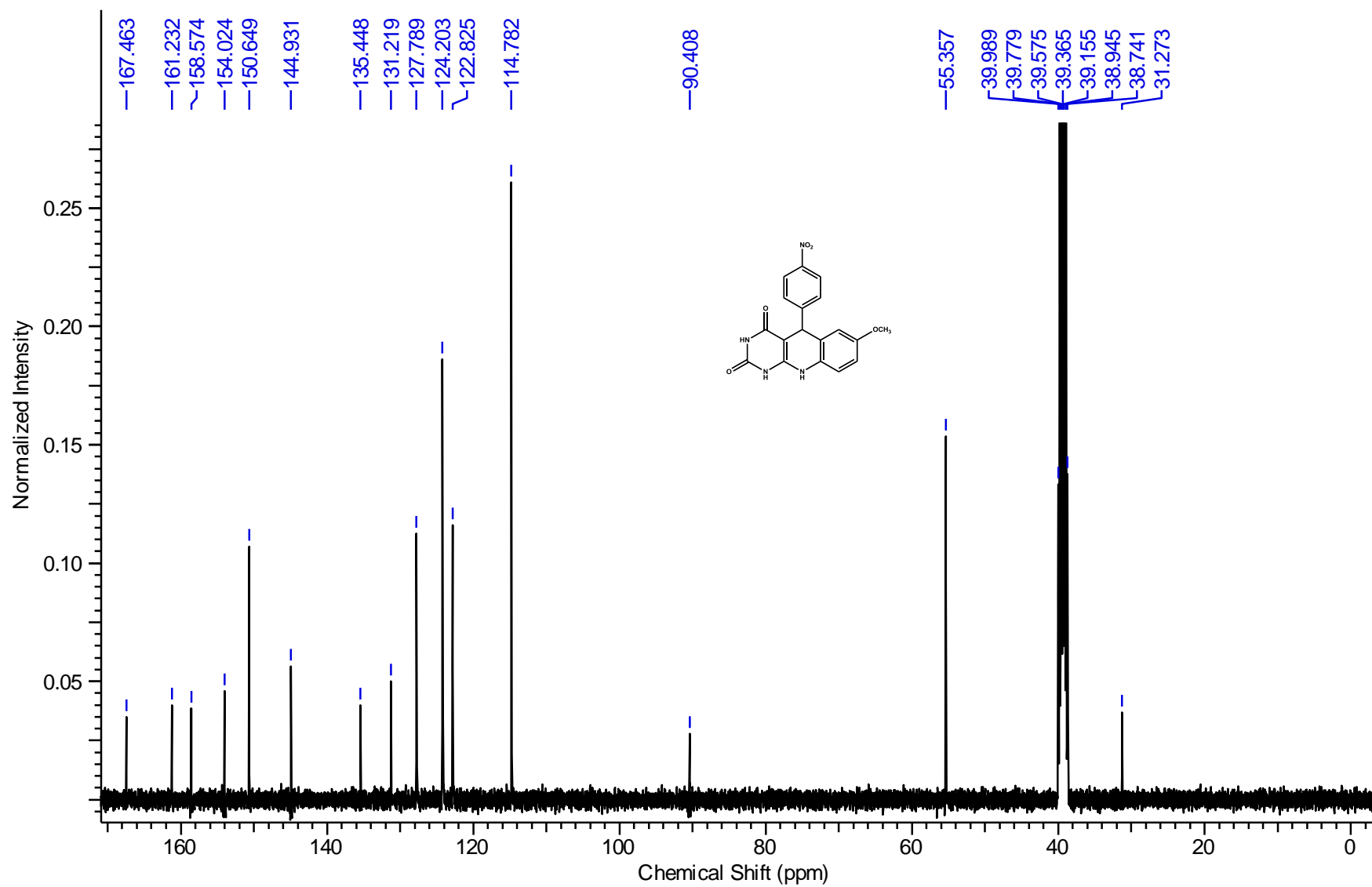
$^{13}\text{C}$ -NMR of 4j



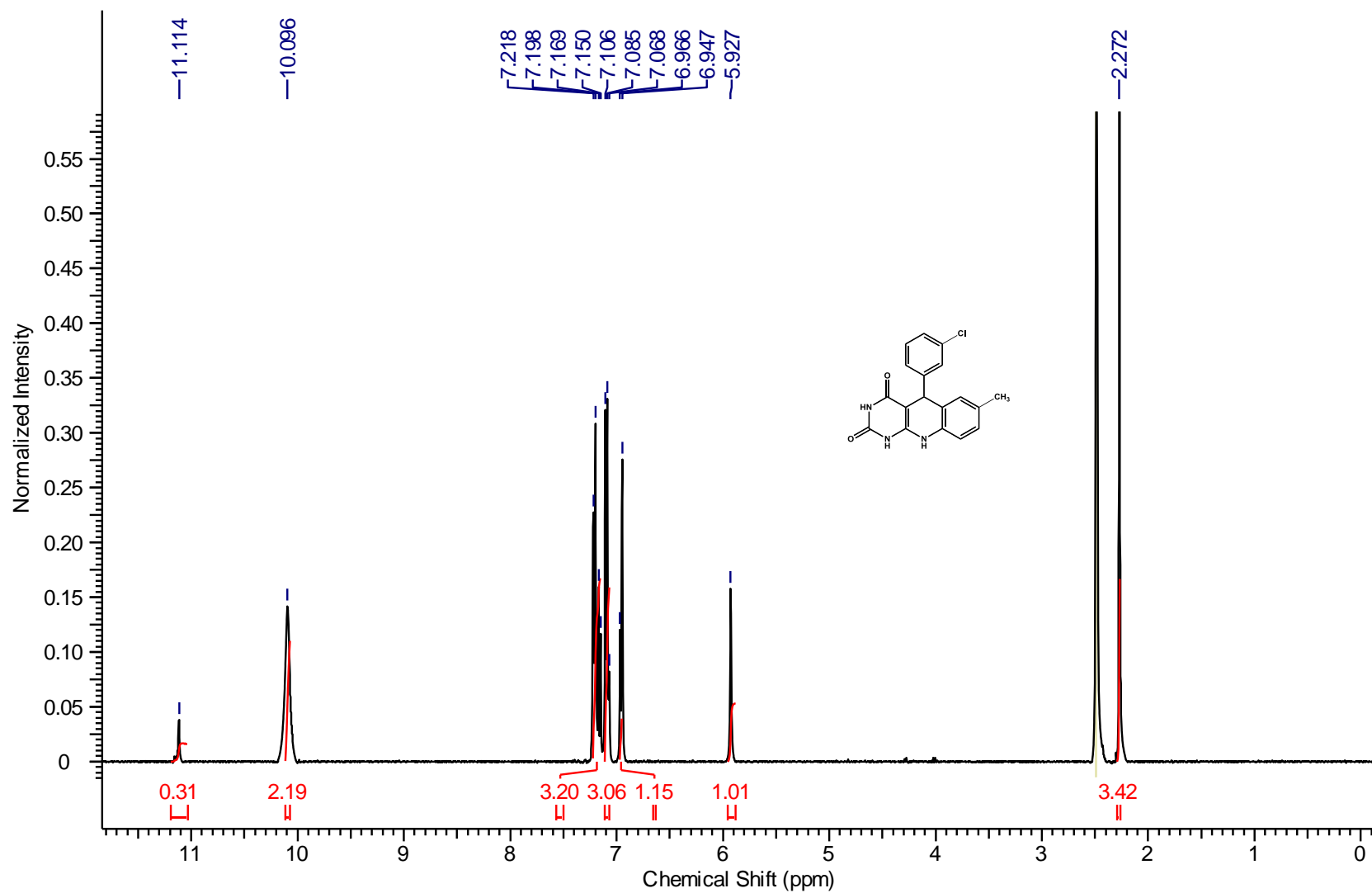
<sup>1</sup>H-NMR of 4k



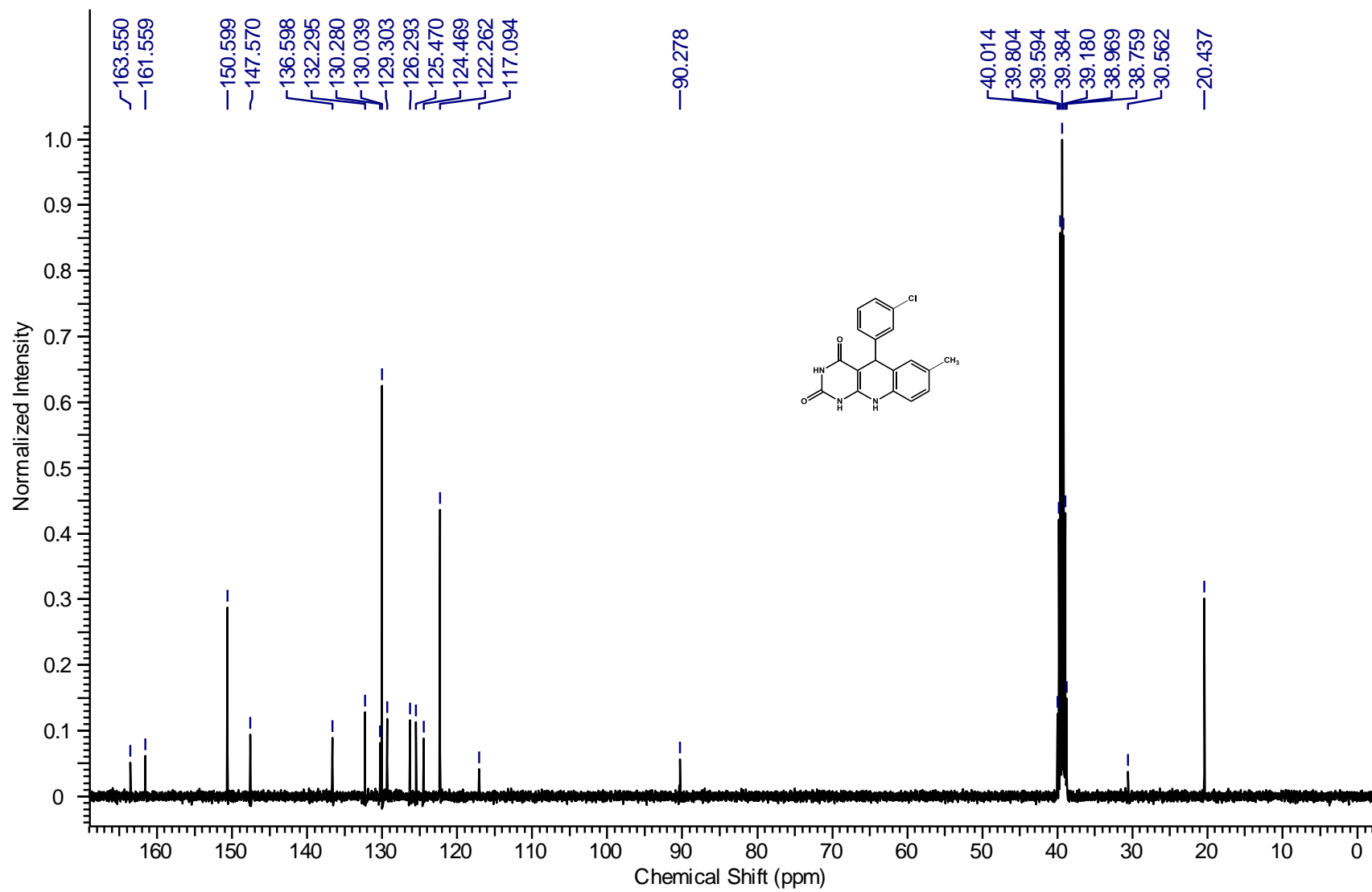
$^{13}\text{C}$ -NMR of 4k



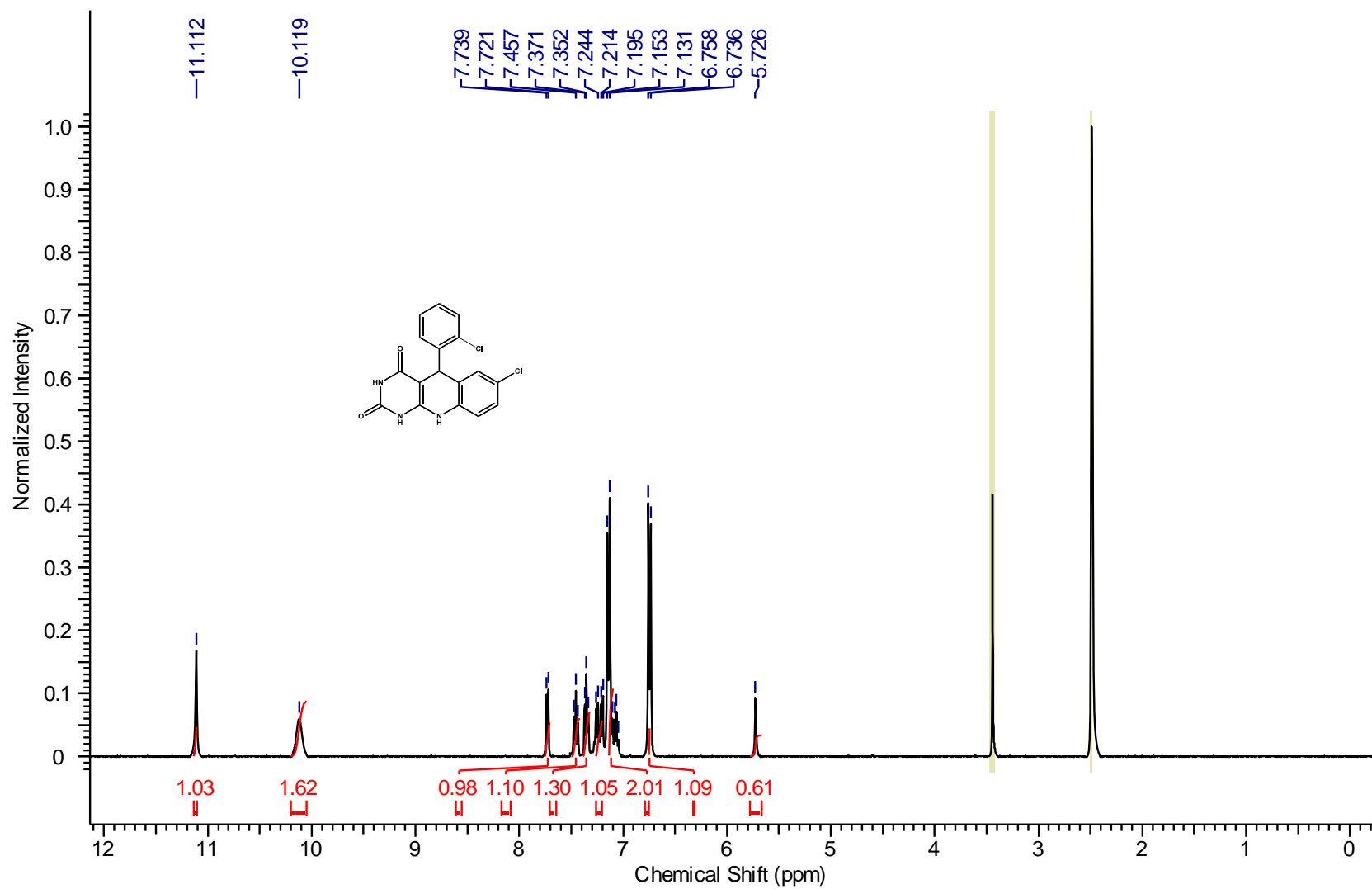
<sup>1</sup>H-NMR of 4l



$^{13}\text{C}$ -NMR of 4l

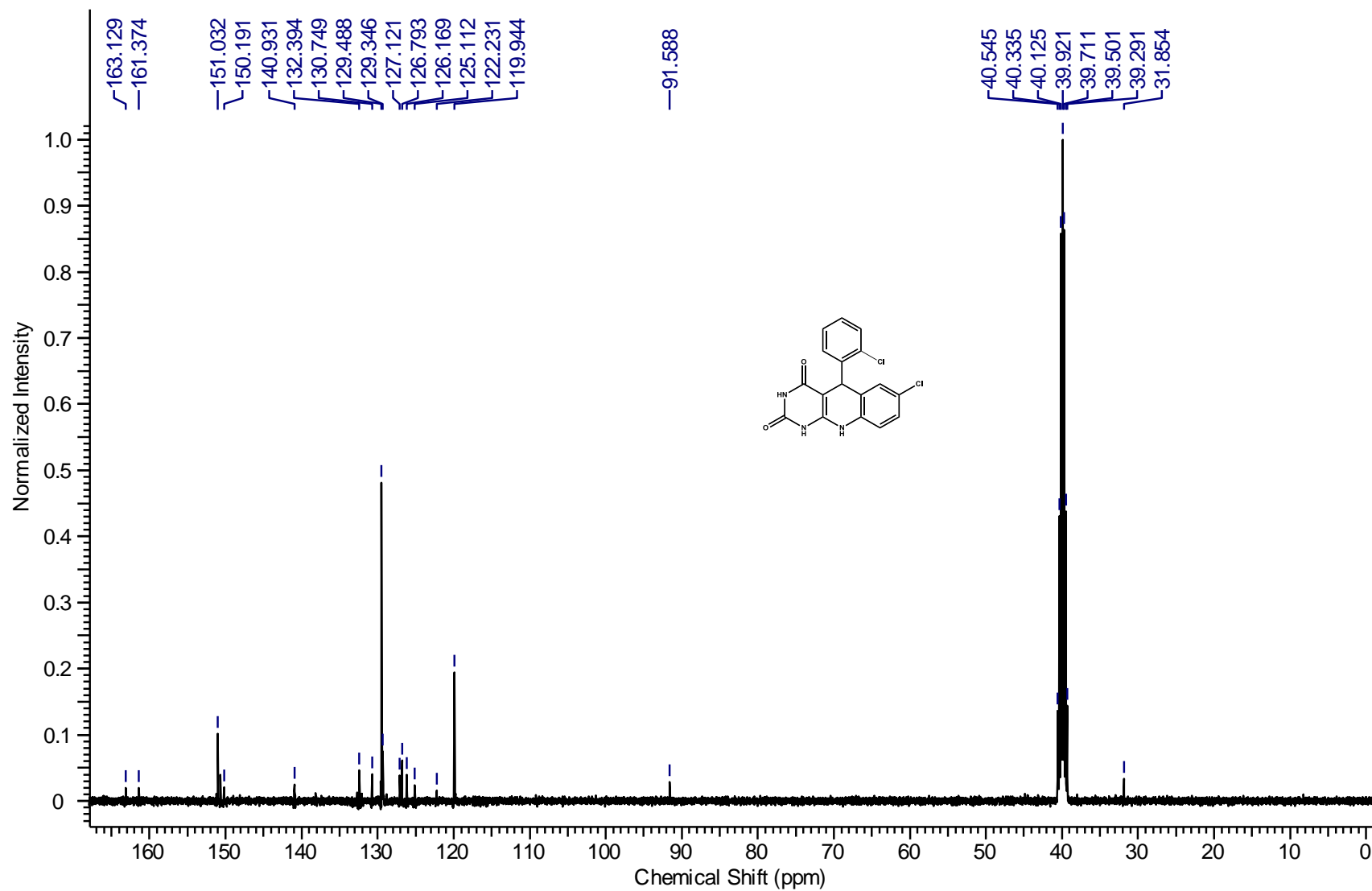


$^1\text{H-NMR}$  of 4m

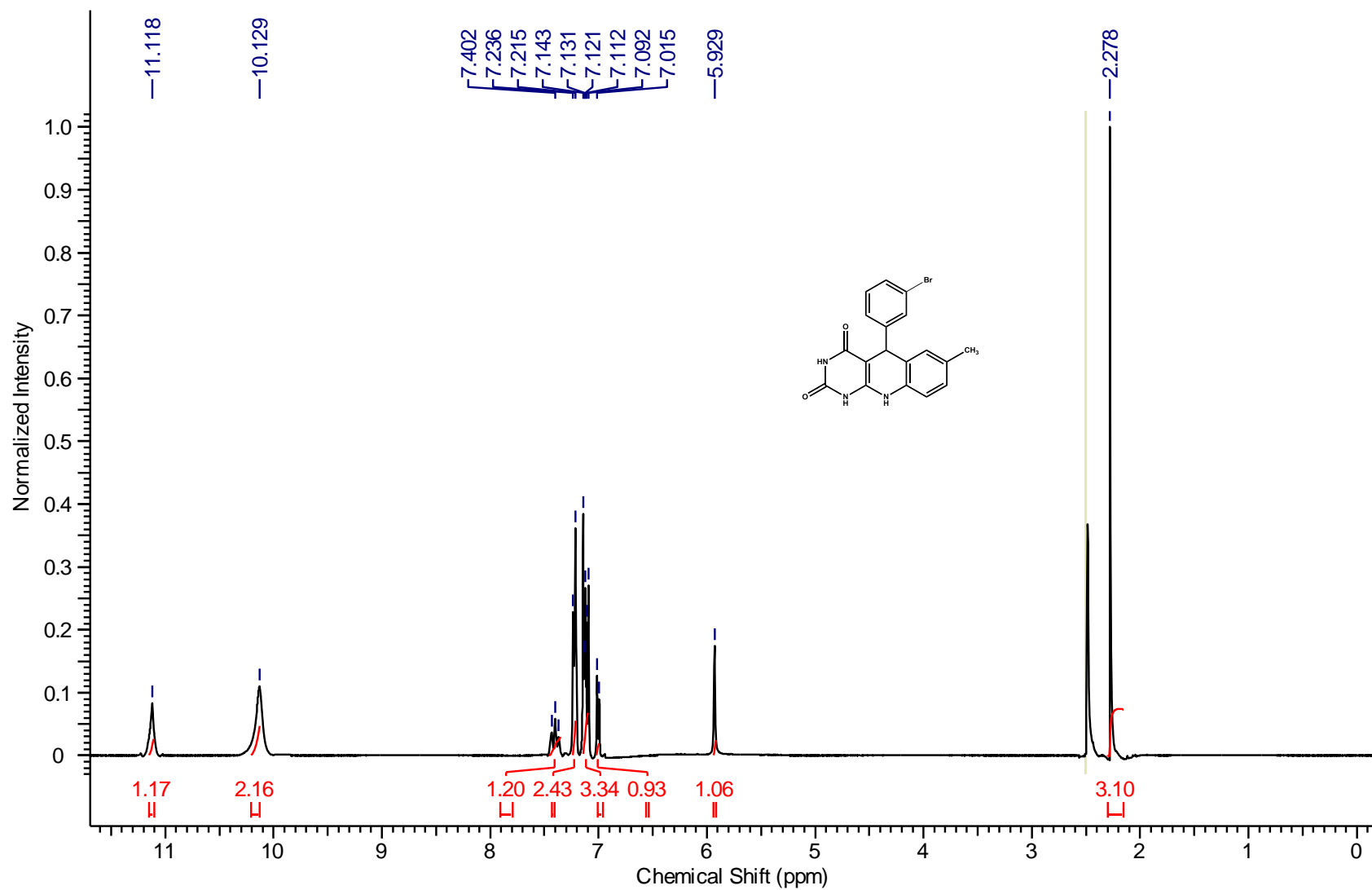




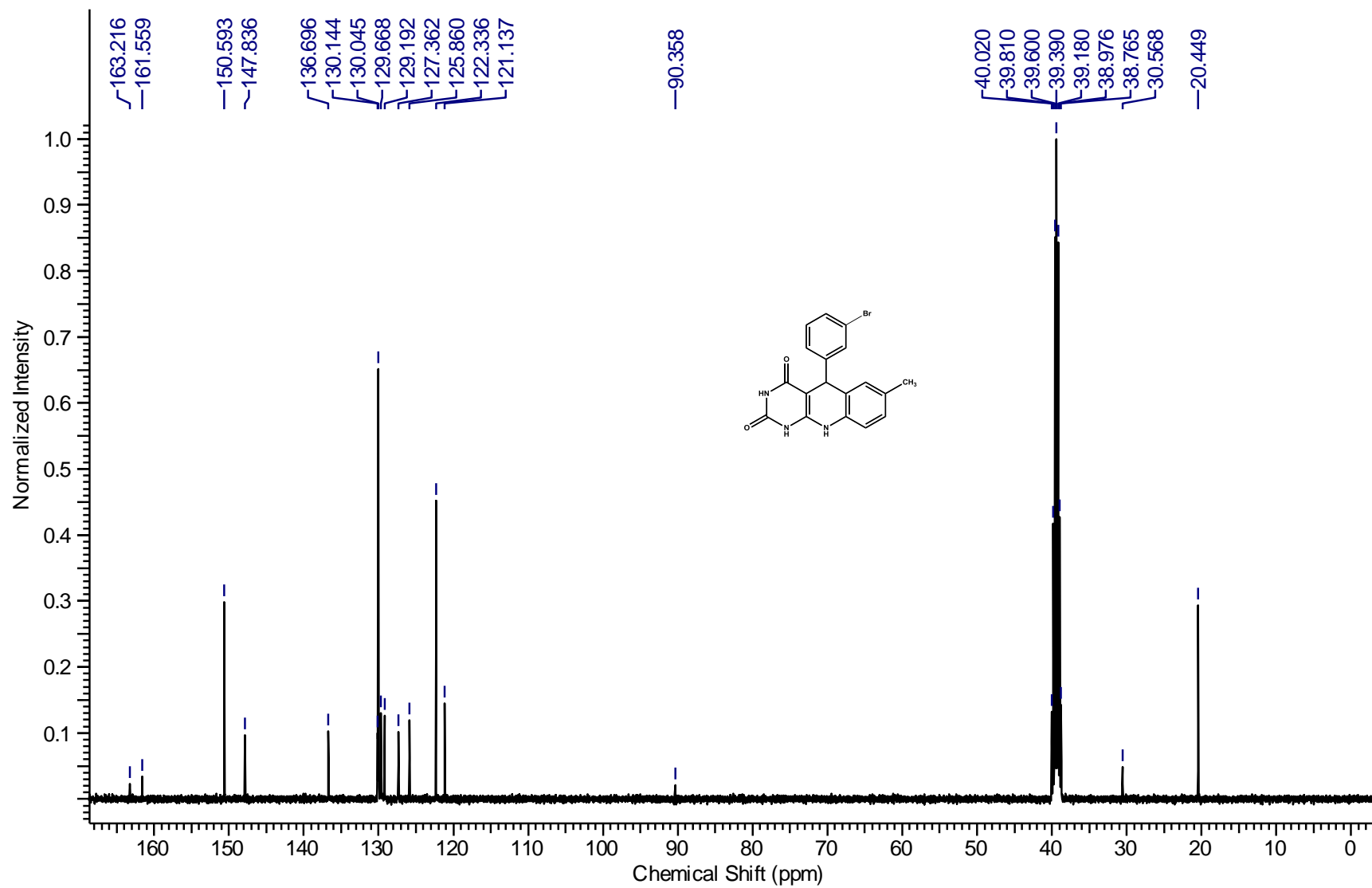
$^{13}\text{C}$ -NMR of 4m



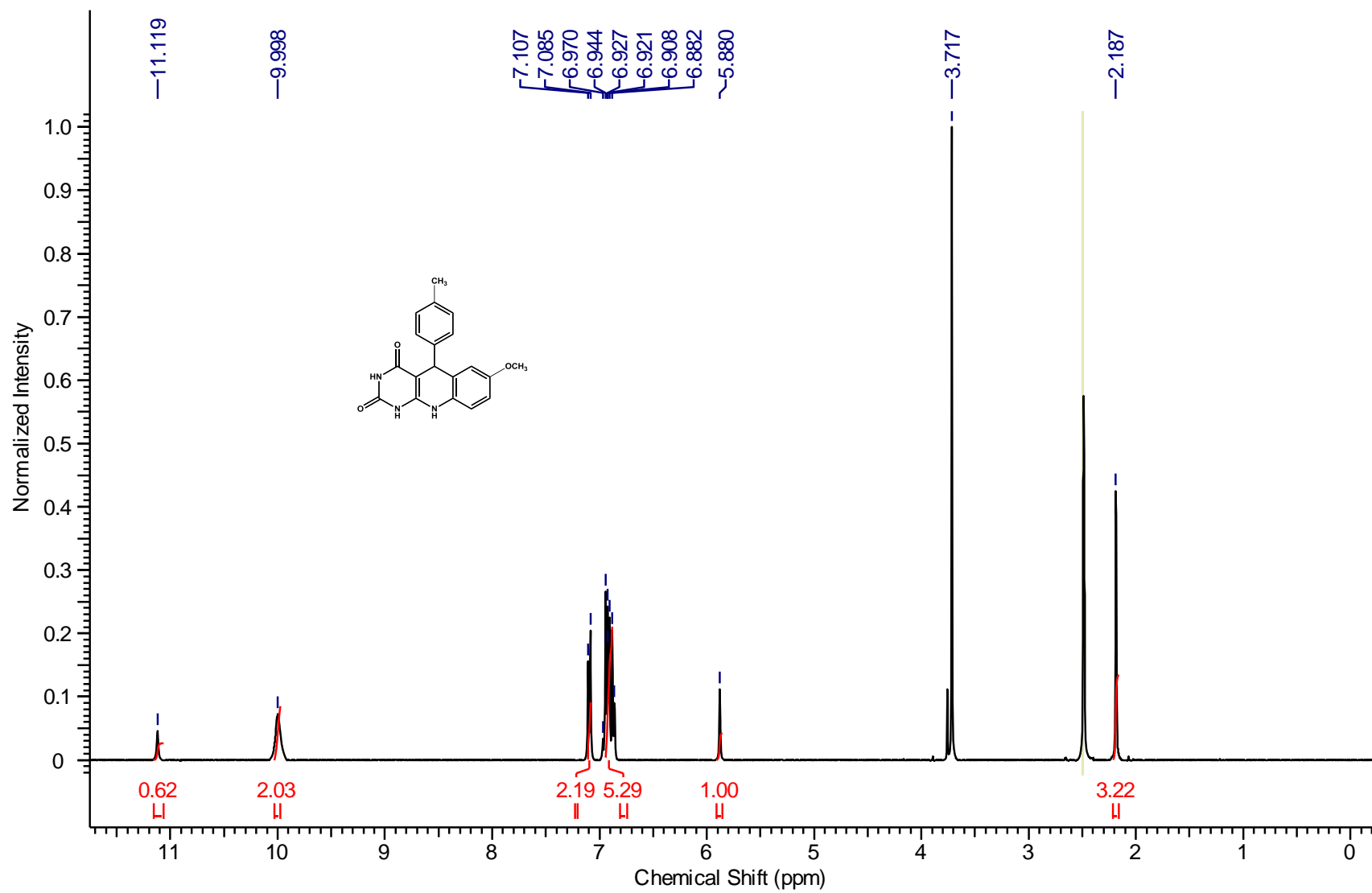
<sup>1</sup>H-NMR of 4n



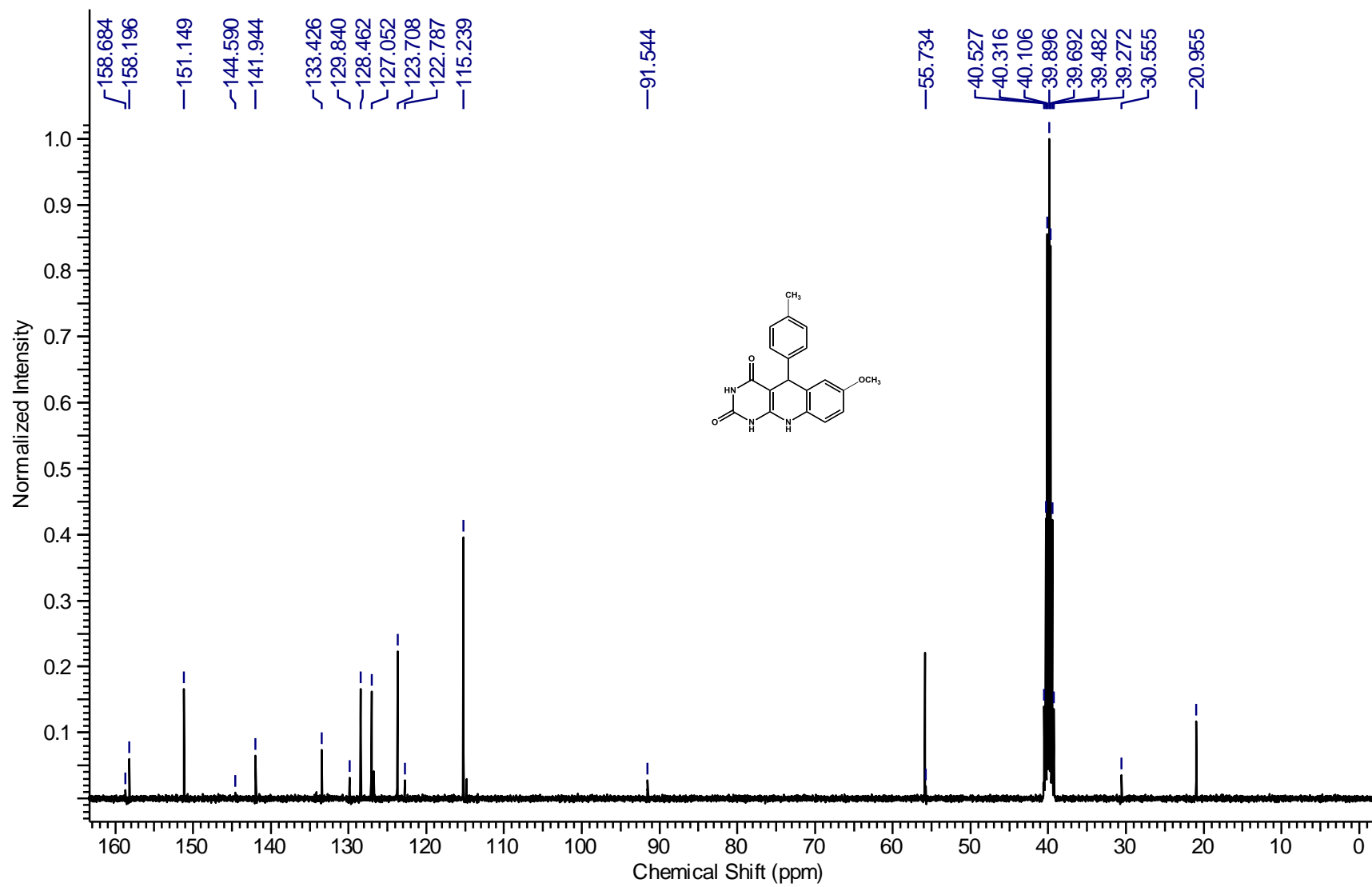
$^{13}\text{C}$ -NMR of 4n



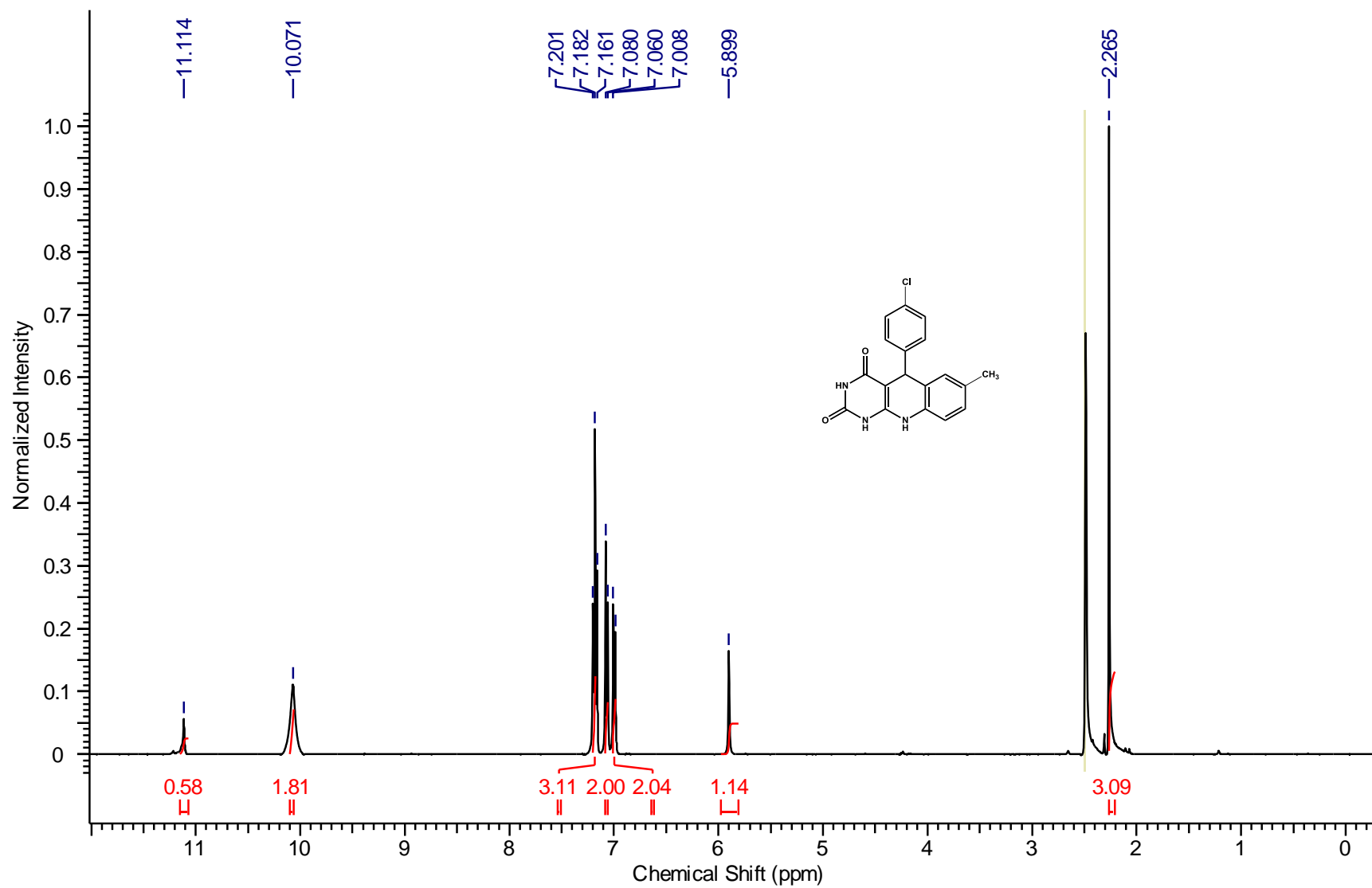
<sup>1</sup>H-NMR of 4o



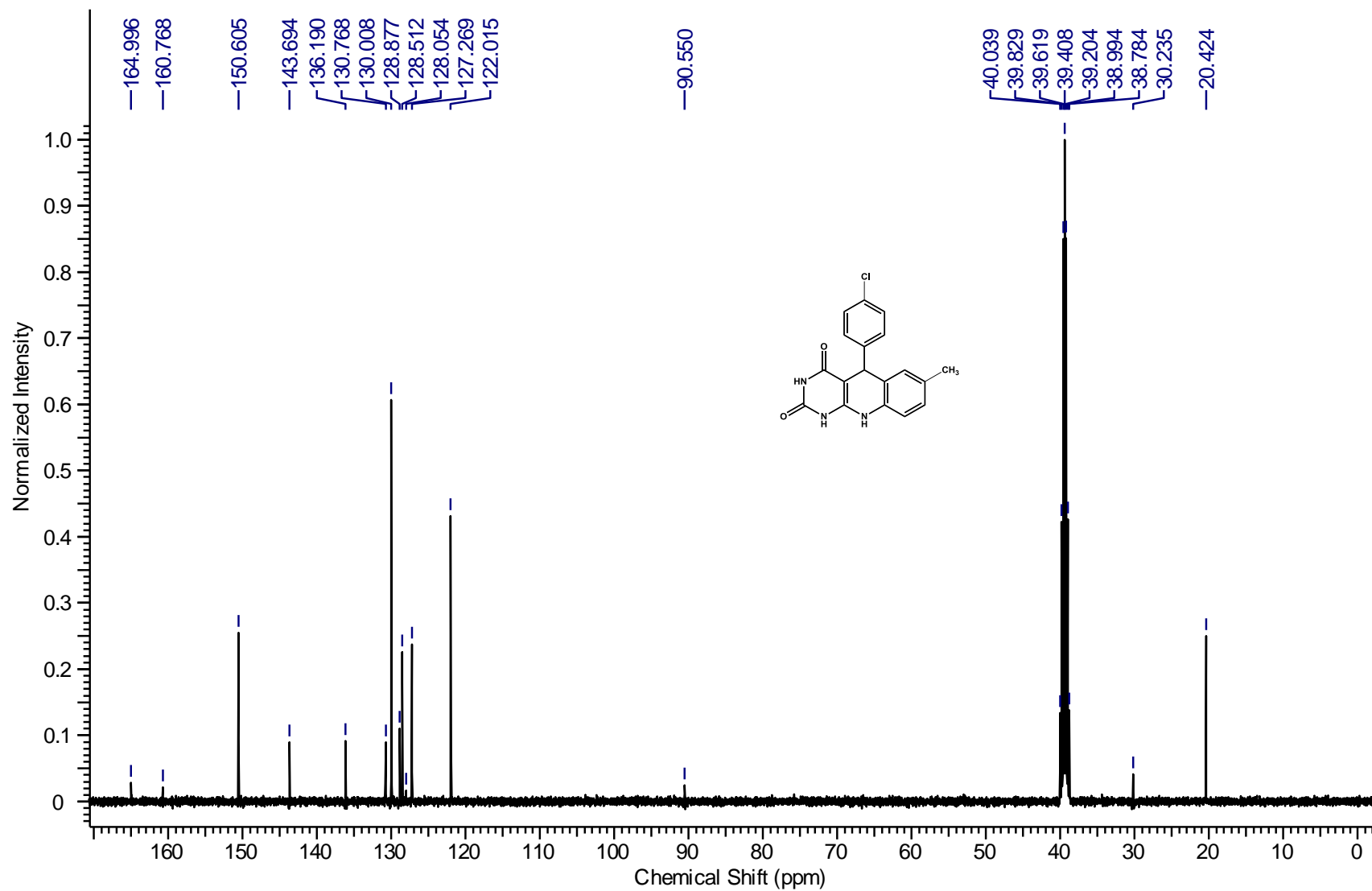
$^{13}\text{C}$ -NMR of 4o



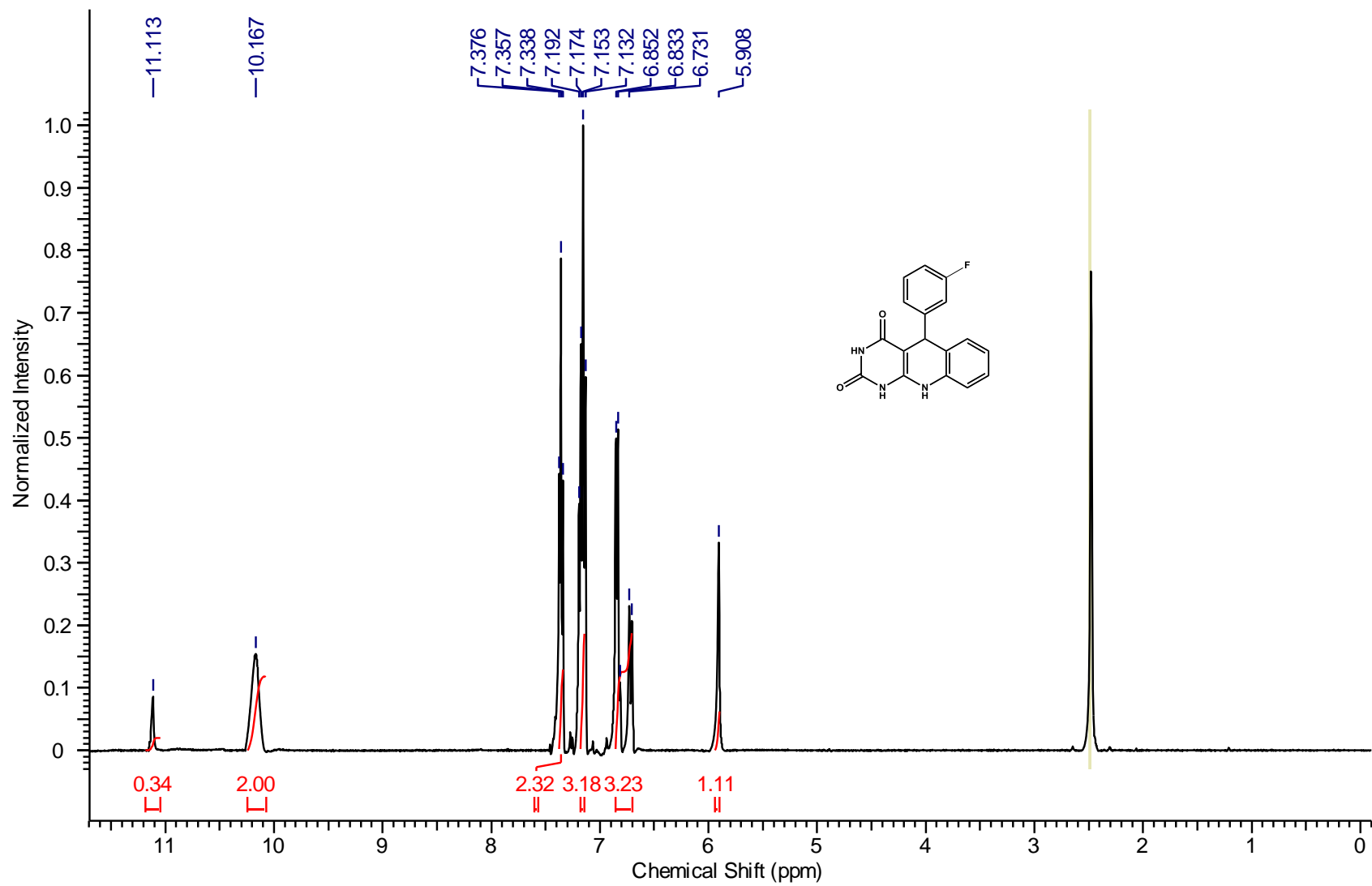
$^1\text{H-NMR}$  of 4p



$^{13}\text{C}$ -NMR of 4p

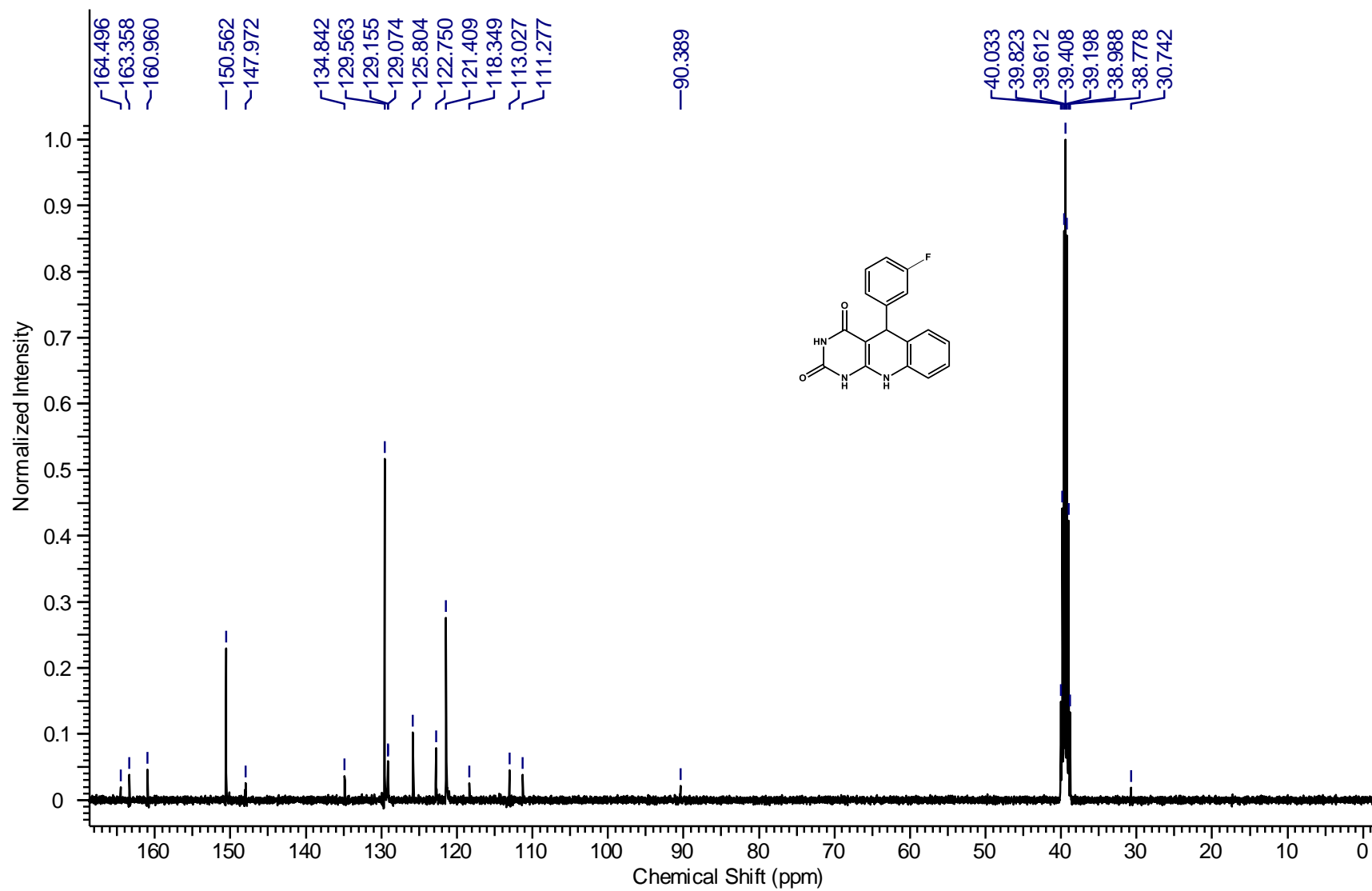


<sup>1</sup>H-NMR of 4q

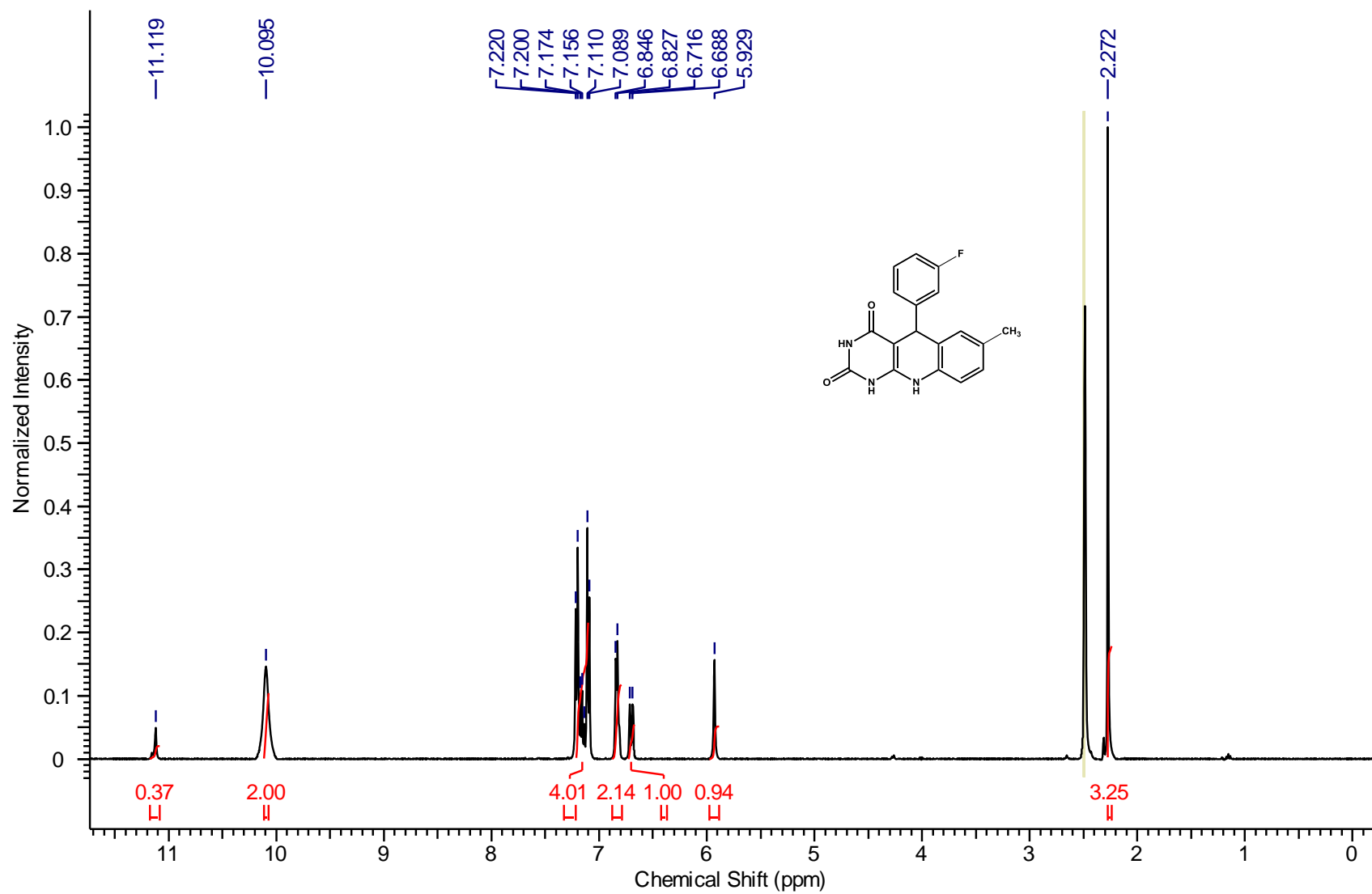




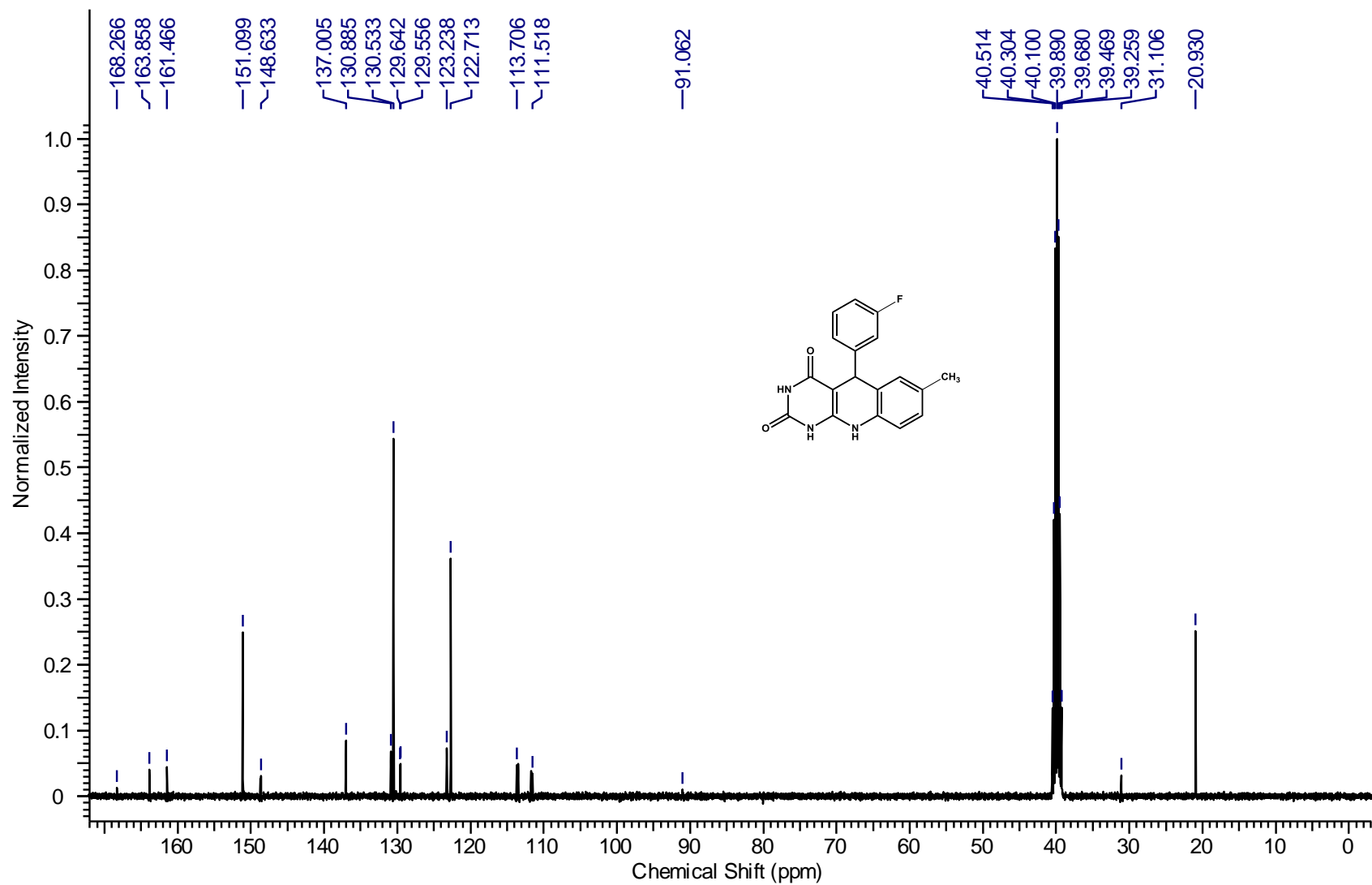
$^{13}\text{C}$ -NMR of 4q



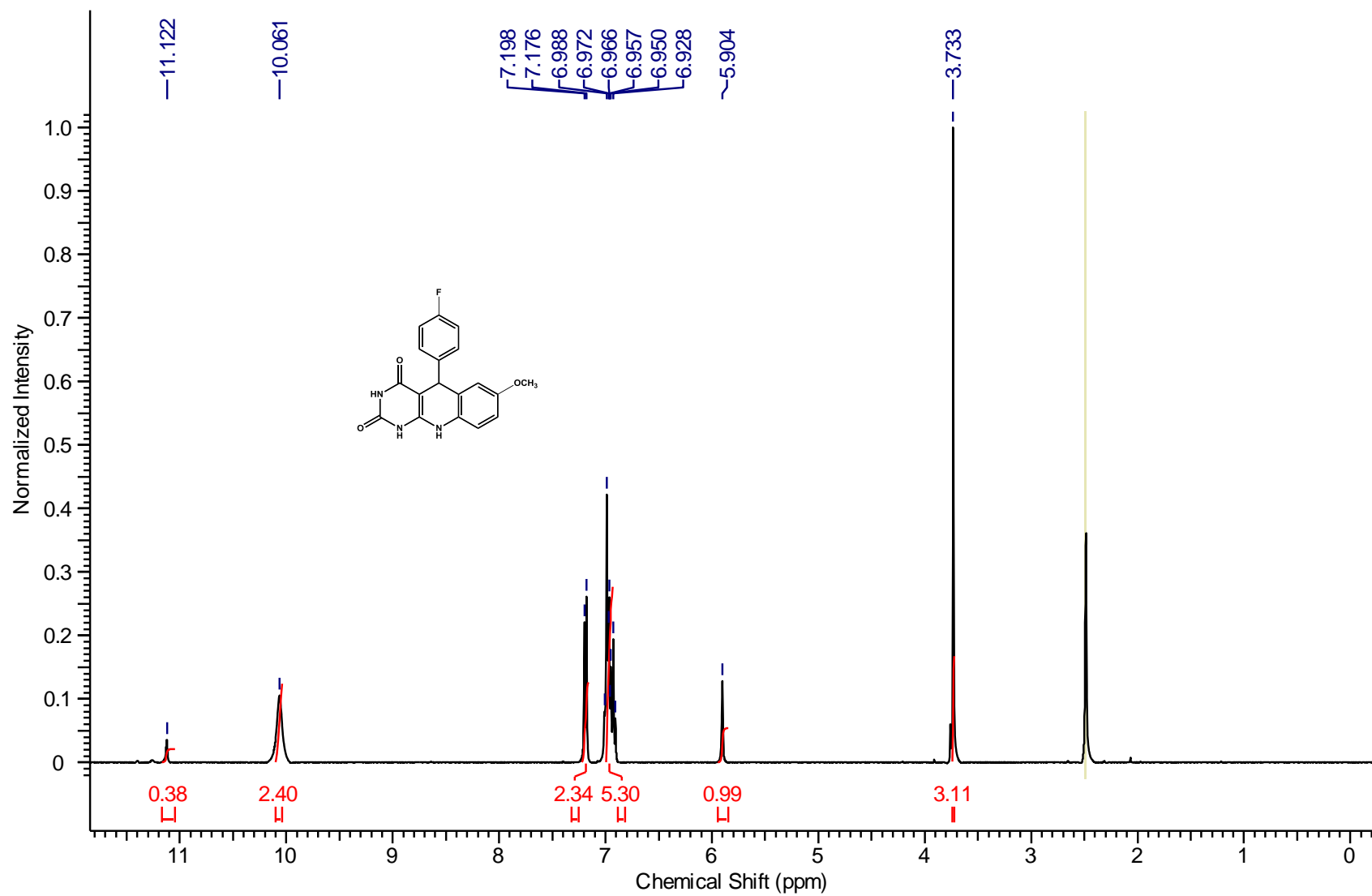
<sup>1</sup>H-NMR of 4r



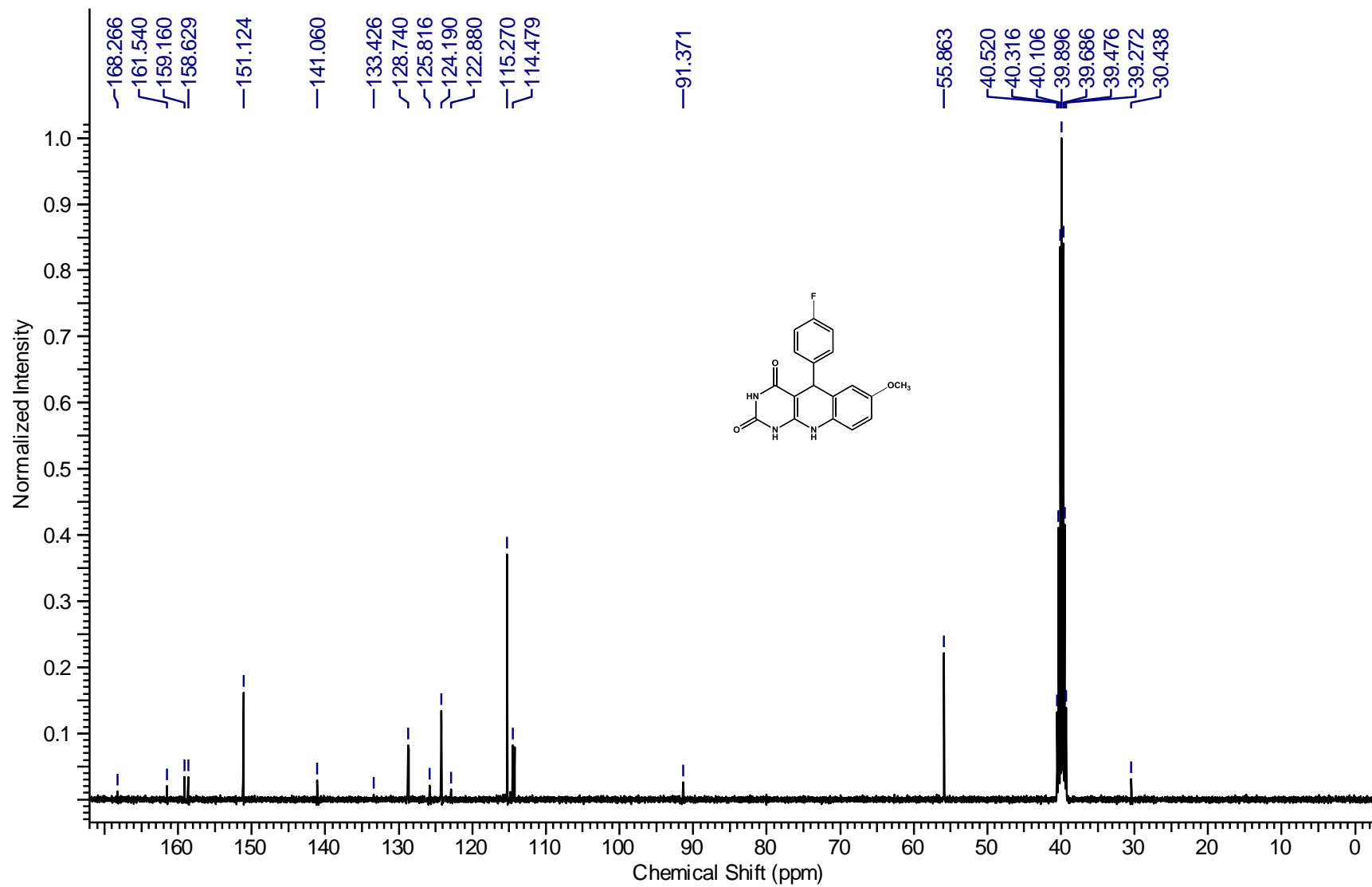
$^{13}\text{C}$ -NMR of 4r



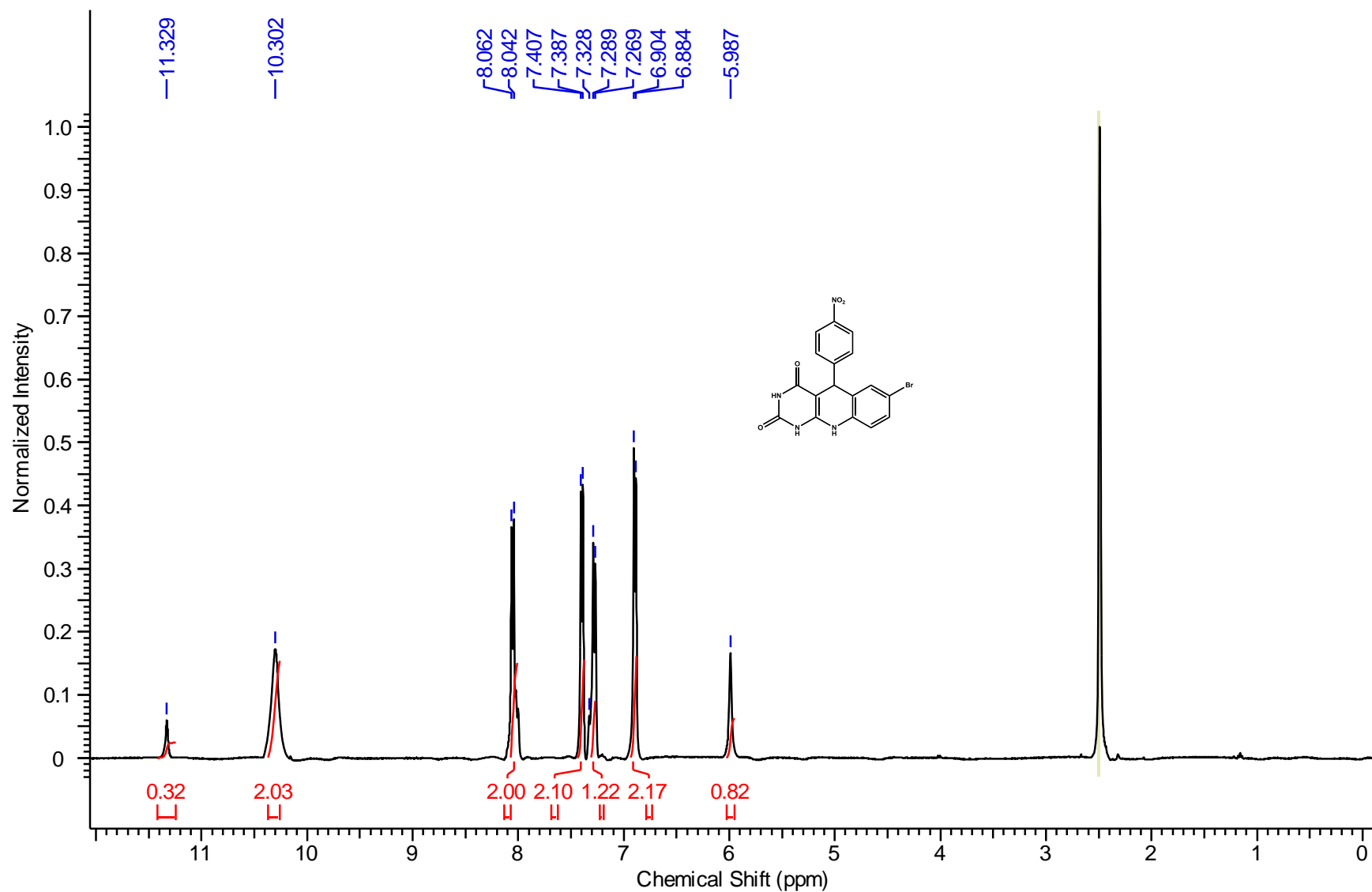
$^1\text{H-NMR}$  of 4s



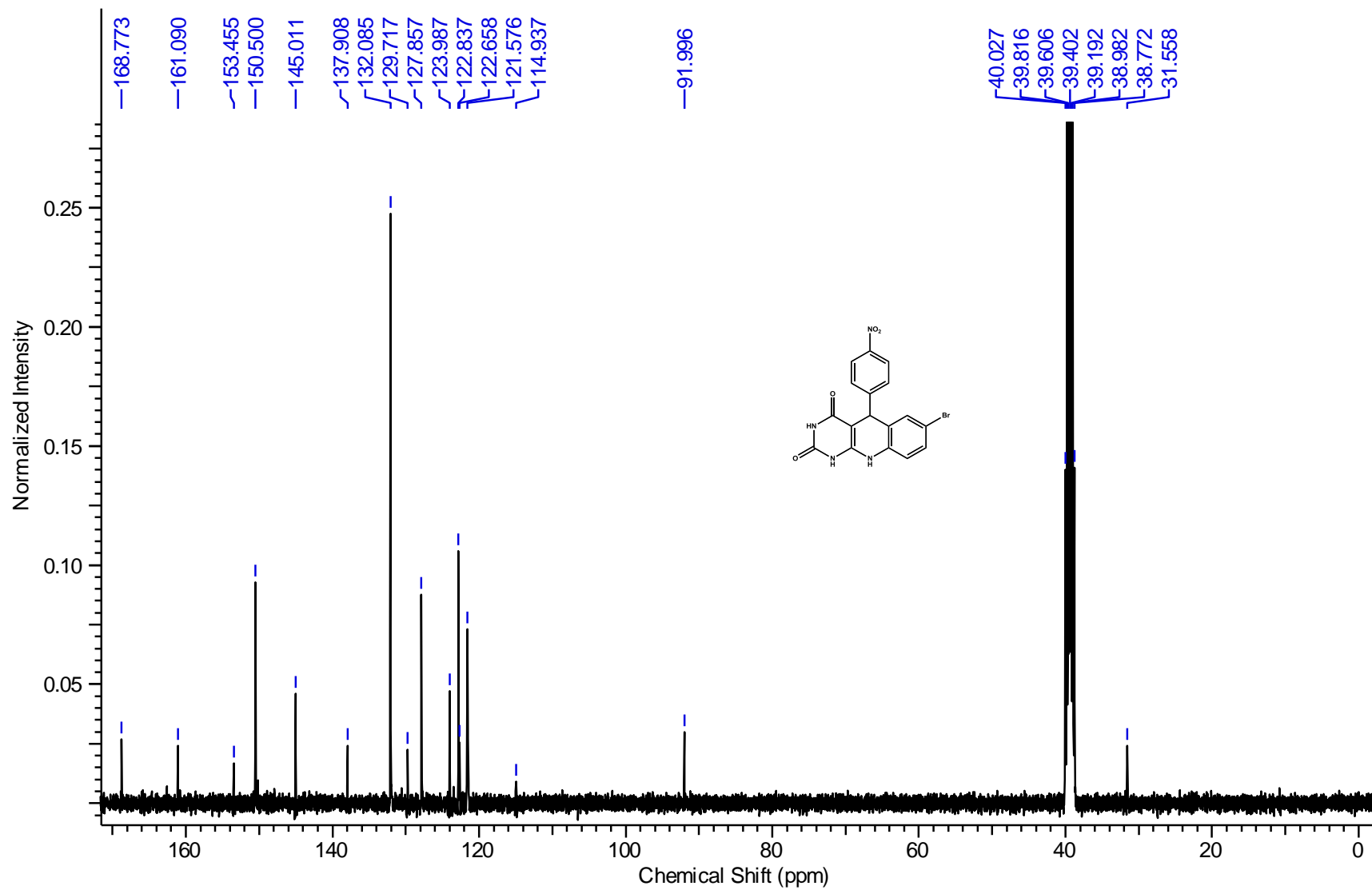
$^{13}\text{C}$ -NMR of 4s



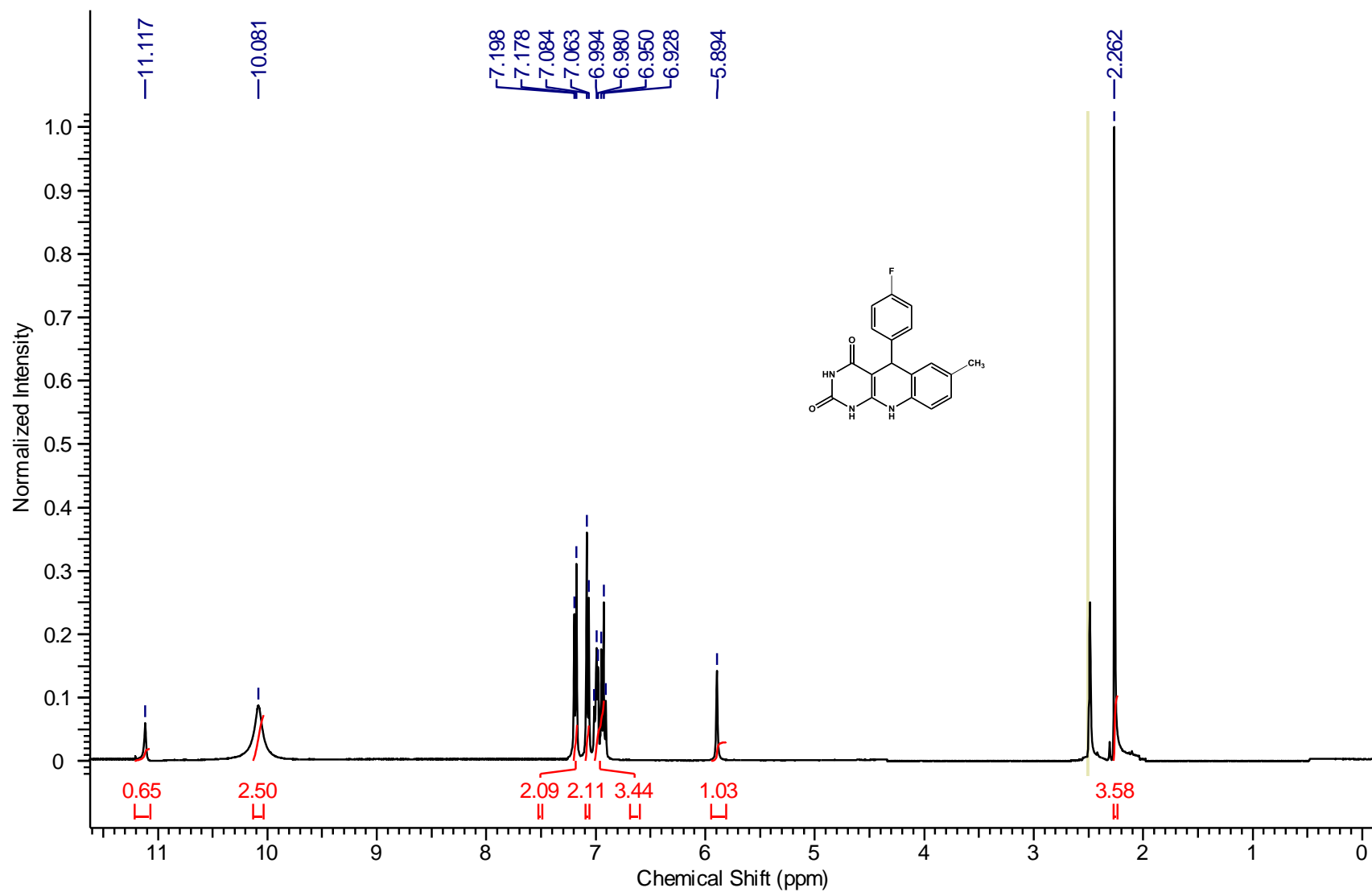
$^1\text{H-NMR}$  of 4t



$^{13}\text{C}$ -NMR of 4t

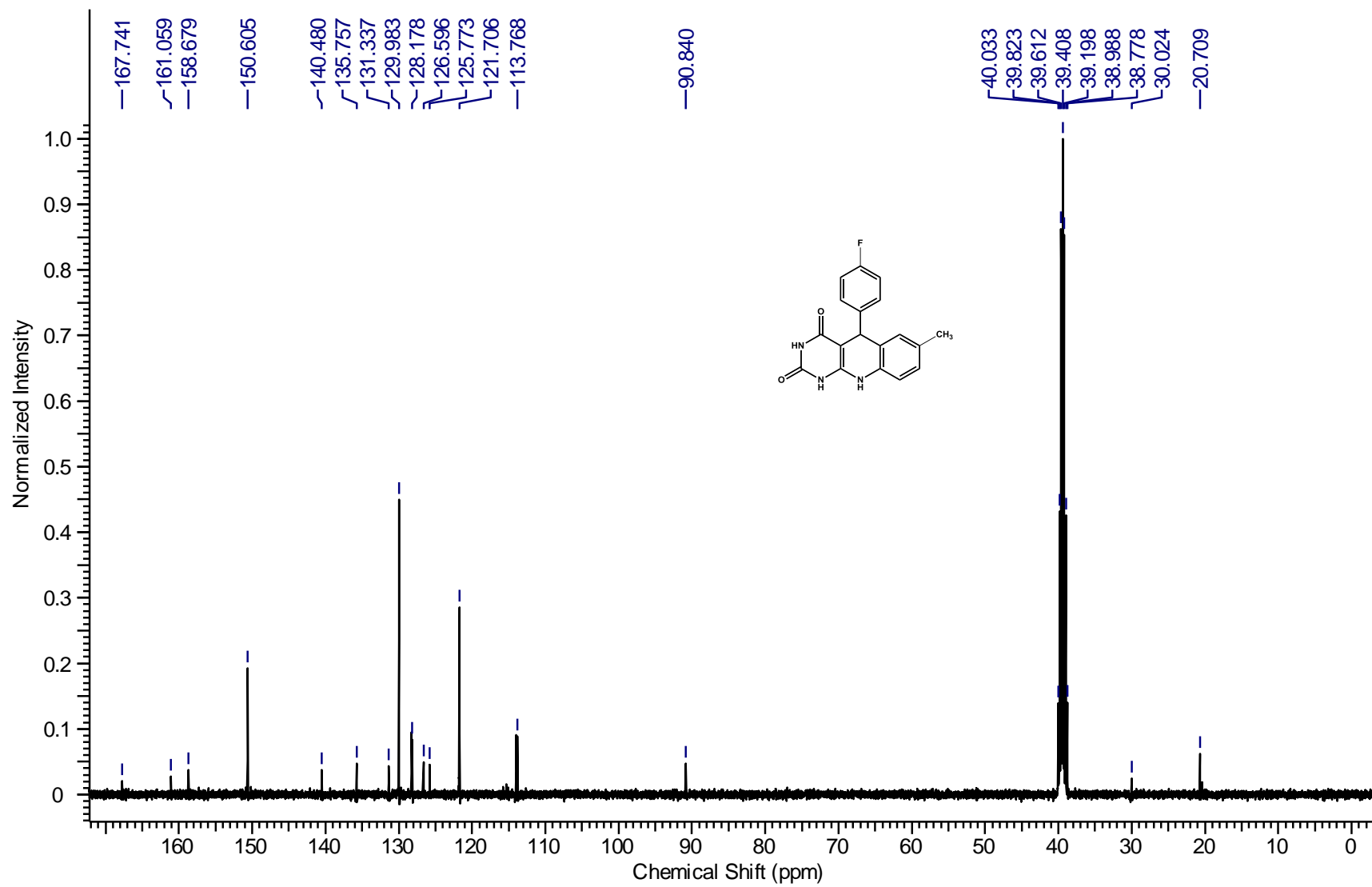


<sup>1</sup>H-NMR of 4u

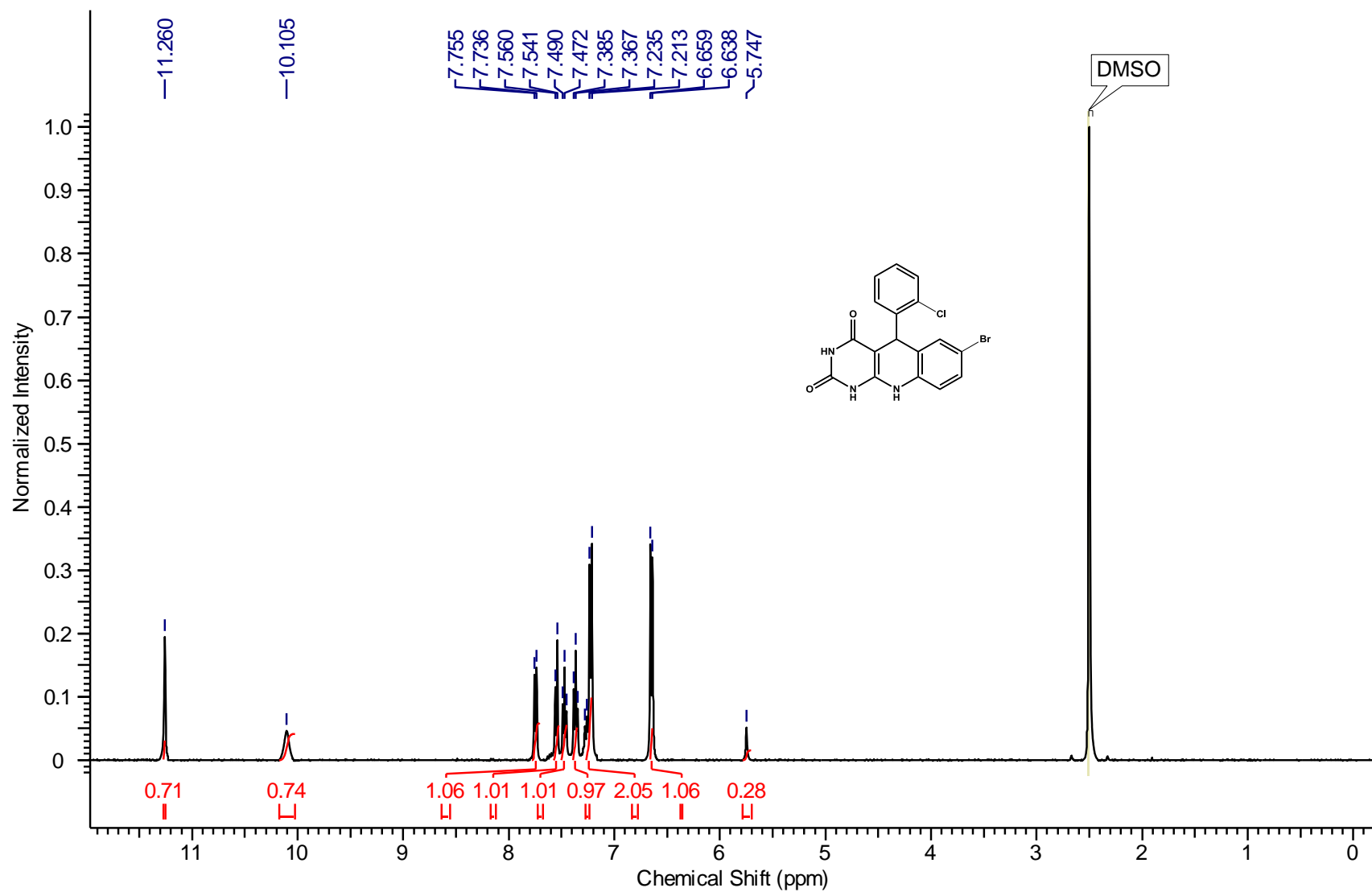




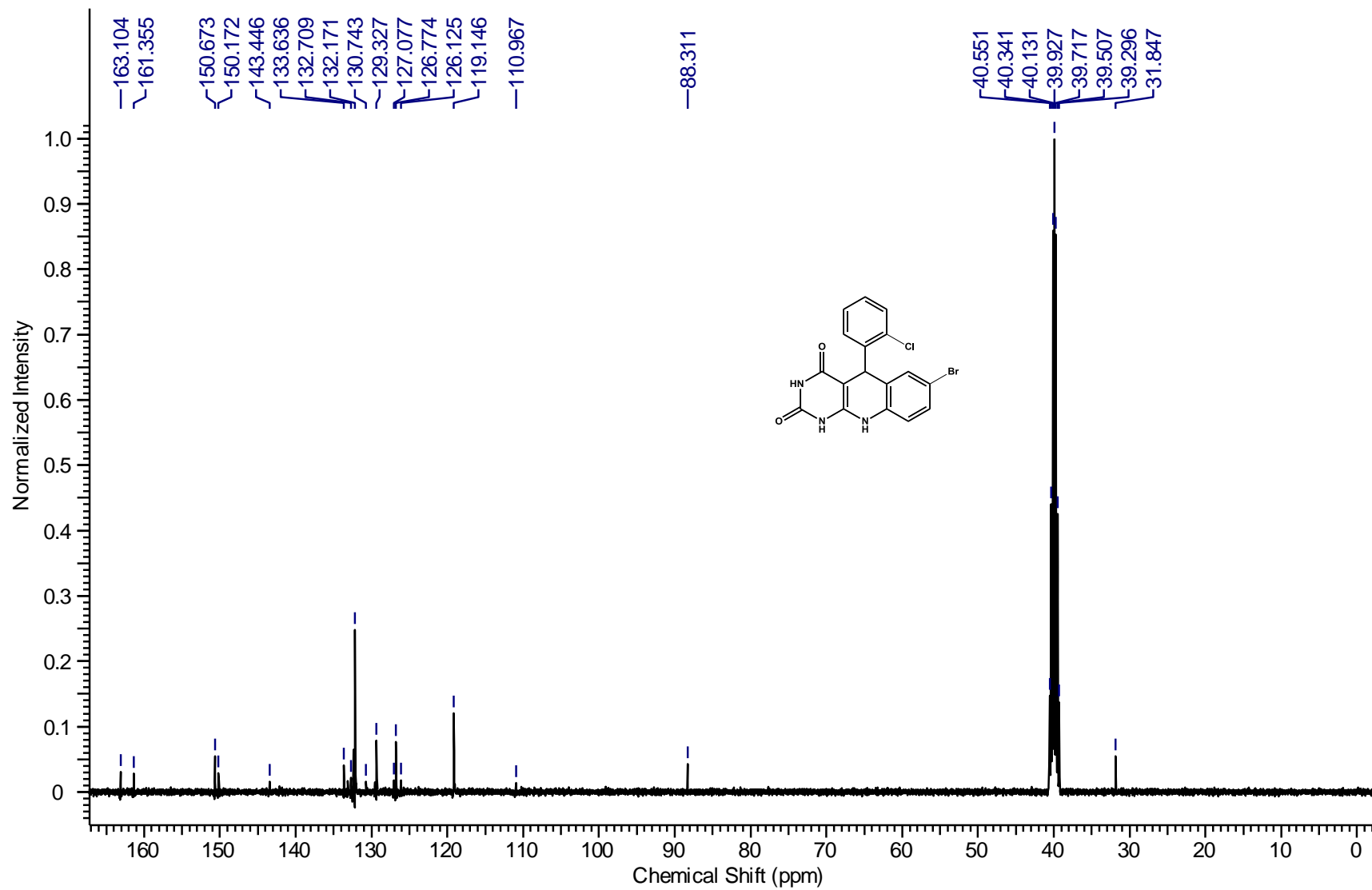
$^{13}\text{C}$ -NMR of 4u



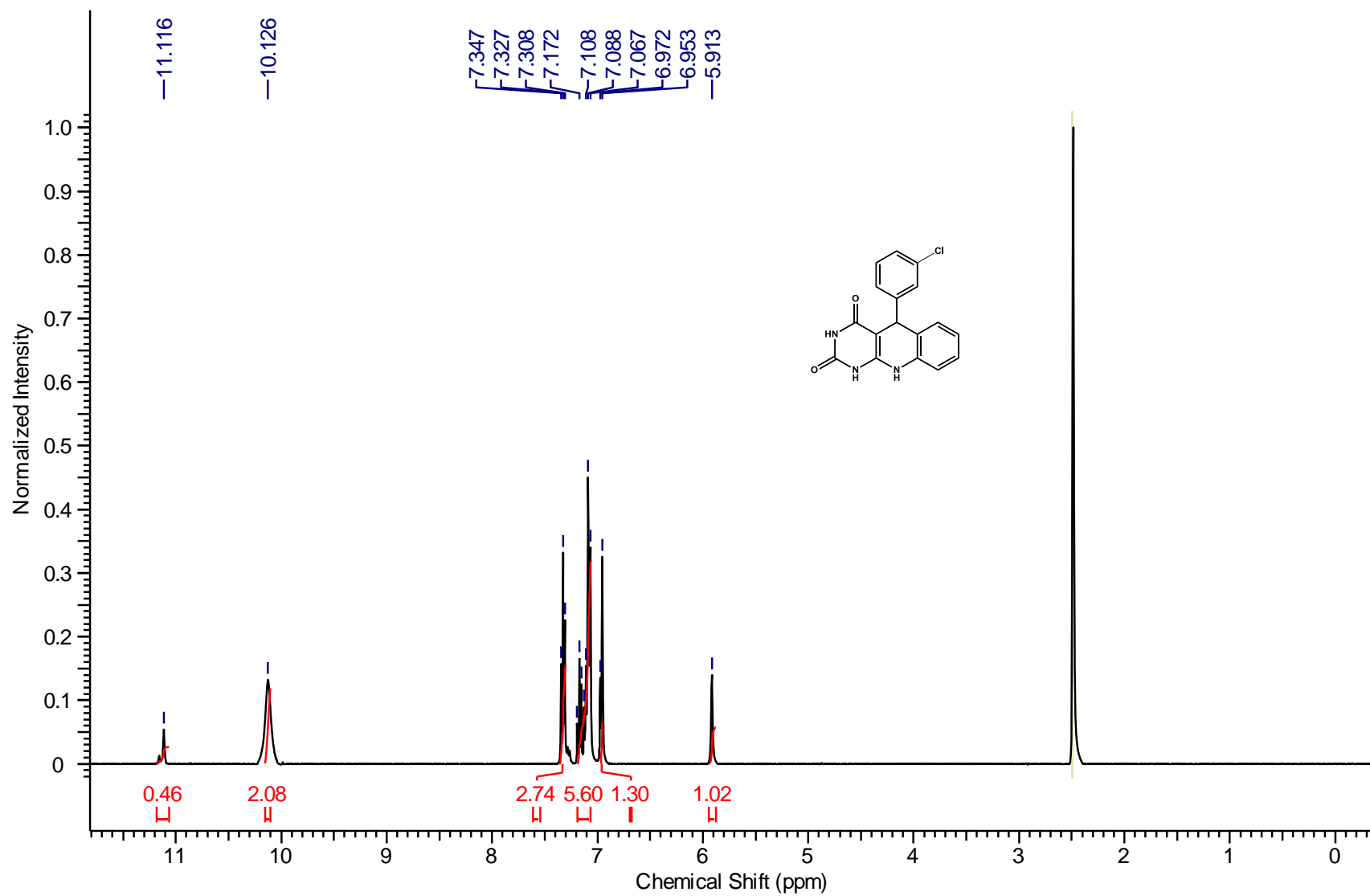
<sup>1</sup>H-NMR of 4v



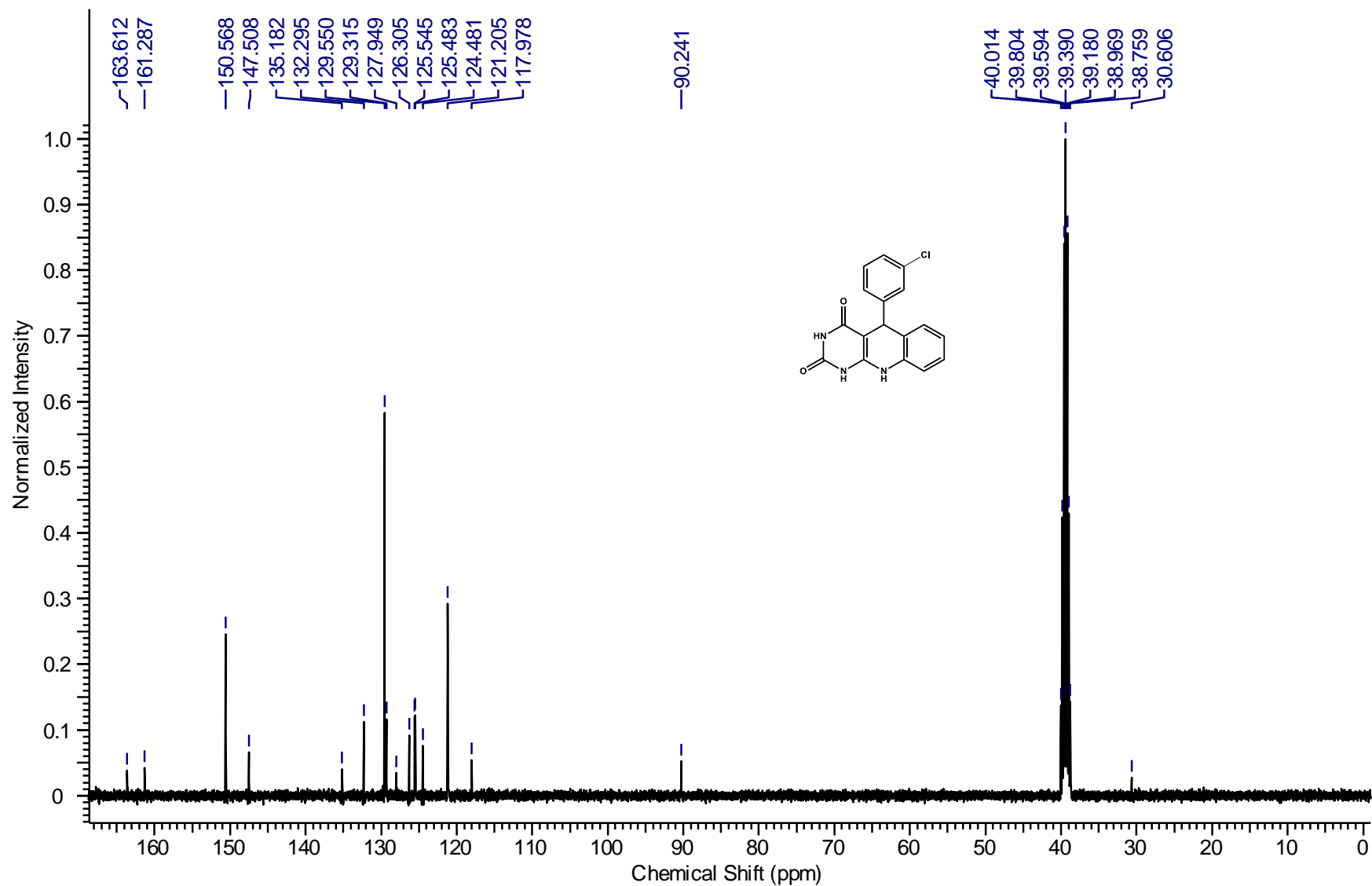
$^{13}\text{C}$ -NMR of 4v



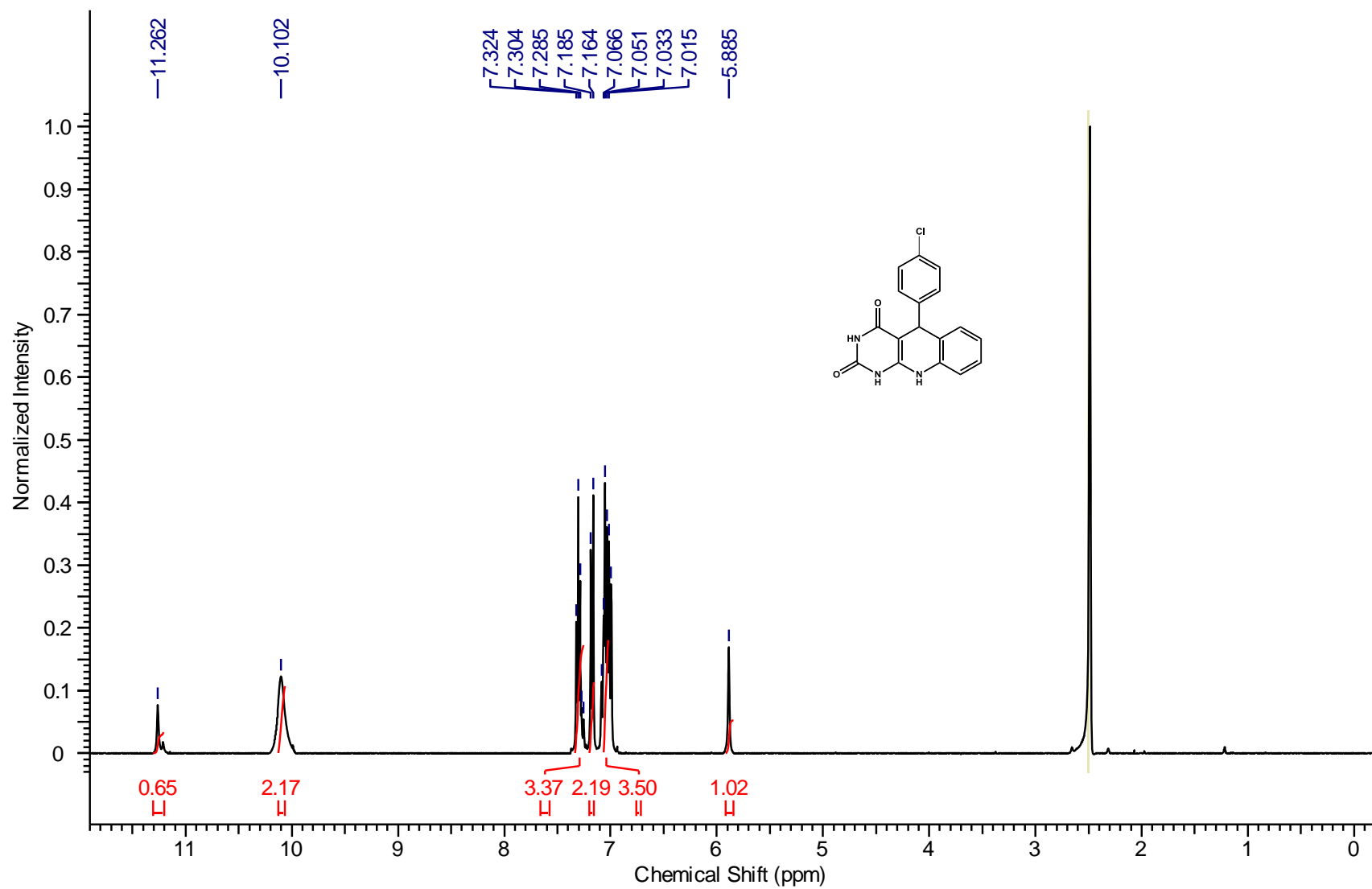
<sup>1</sup>H-NMR of 4w



$^{13}\text{C}$ -NMR of 4w



<sup>1</sup>H-NMR of 4x



$^{13}\text{C}$ -NMR of 4x

