Supporting Information

High-throughput C-H Activation in a Bead-Beater Homogenizer: Fast and Regioselective Access to 2-Arylindoles

Mainak Banerjee,*[a] Shravya B.,[a] Aboy Chatterjee,[a] Shamima Hussain,[b] and Amrita Chatterjee*[a]

[a]Department of Chemistry, Birla Institute of Technology and Science Pilani, KK Birla Goa Campus, NH 17B Bypass Road, Zuarinagar, Goa 403726, INDIA.

[b]UGC-DAE CSR, Kalpakkam Node, Kokilamedu 603104, TN, INDIA.

E-mail addresses: mainak@goa.bits-pilani.ac.in; amrita@goa.bits-pilani.ac.in

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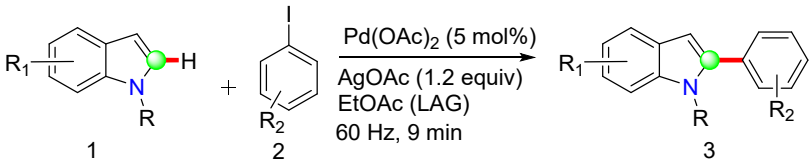
Experimental section

General experimental details

The fine chemicals were obtained from Sigma-Aldrich, TCI India, or BLD pharma and used directly without further purification. Common reagents and solvents of AR grade were obtained from local suppliers. The mechanochemical reactions were carried out in 2 mL homogenizing tubes made of polypropylene with 1 g of 2 mm SS ball in iGene Labserve, an indigenous bead beater homogenizer. The reactions were monitored by thin layer chromatography (TLC) carried out on 0.25 mm silica gel aluminum plates (60F-254) using UV light (254 or 365 nm) to monitor the progress of the reactions. The melting point was measured in the EZ-Melt, Automatic Melting Point Apparatus (Stanford Research System). ^{1}H NMR and ^{13}C NMR spectra were recorded on a Bruker Avance (500 MHz) NMR instrument with $CDCl_3$ as the solvent. Tetramethylsilane (TMS) was used as an internal standard for NMR spectroscopy. Chemical shifts are reported in parts per million (δ) units. Coupling constants are reported in hertz (Hz). Standard abbreviations are used for representing the multiplicity of NMR peaks, such as s (singlet), bs (broad singlet), d (doublet), dd (doublet of doublets), t (triplet), q (quartet), and m (multiplet). HRMS spectra were recorded on Agilent Technologies 6545 Q-TOF LC/MS mass spectrometer with ESI as the ion source.

*General procedure for C-2 arylation of indole derivatives in a homogenizer (**3**)*:



The starting *N*-alkylindoles (**1**) were either procured or prepared using the reported protocol.[1]

In a typical reaction, indole derivative, **1** (0.5 mmol), iodoarene **2** (0.55 mmol), $Pd(OAc)_2$ (0.025 mmol, 5 mol%), AgOAc (0.6 mmol) were taken in a 2 mL polypropylene Eppendorf tube containing EtOAc (0.2 mL) and 1 g SS balls of 2 mm dia. The capped tube was placed in the iGene bead beater homogenizer, closed by a rotor head, and homogenized at a frequency of 60 Hz for 3 × 3 min with a pause of 1 min after each pulse. The progress of the reaction was monitored by TLC. The product was taken out by the addition of a small volume of EtOAc (approx 0.5 mL) to the tube, the balls were rinsed with EtOAc (0.5 mL) and the combined organic extract was adsorbed in minimum amount of silica gel (230-400 mesh),

subjected to column chromatography and eluted with EtOAc-petroleum ether to afford the corresponding pure compound (**3**).

2. Reaction set-up for high throughput C-H activation

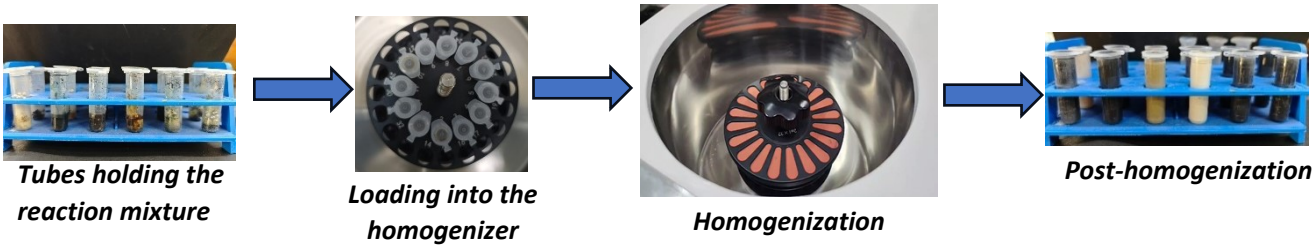


Figure. S1. A typical reaction set-up for high-throughput C2-H activation of indoles. 12 reactions were set at a time.

3. E-factor and Eco-scale score of the model reaction

Table S1. E-factor calculation of our model reaction.

Parameters	Values	Remarks
%Yield	81	Calculated for **3a**
Wt. of generated waste (mg)	378.5	
Wt. of end product (mg)	84	
E-factor = Wt. of generated waste/Wt. of end product	**4.5**	

Table S2: Eco-scale score calculation for our model reaction

Parameters	Penalty points	Remarks
%Yield = (100-%Yield)/2	9.5	Calculated for 3**a**
Price of reaction component	0	Inexpensive
Toxic chemical	5	
Safety	0	Nontoxic chemicals
Technical setup	2	**Bead beater homogenizer**
Temperature/Time	0	, 9 mins
Workup and purification	10	Classical chromatography

Sum of penalty points **26.5**

Eco-scale score = **73.5**

Notably, for many entries with yields ≥85% (e.g., **3h**), the Eco-score scale would be in the "excellent" category [>75].

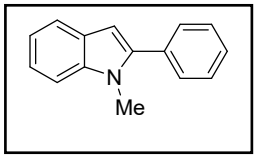
4. Comparative table of ligand free C-2 arylation of indole (Table S3)

Table S3. Comparative table of selected ligand free Pd(II)-catalyzed C-2 arylation of indole.

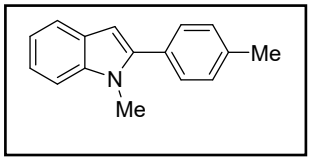
Sr. No.	Media/Method	Solvent	Substrate Scope	Temp. (°C)	Time (h)	Yield (%)	E. Factor	Ref. No.
Conventional homogeneous catalysis (selected examples)								
1	Organic media	AcOH	R = H, EDG	rt	15-24	29-90	63.0	2
2	Organic media	DMF	R = H, EDG	rt	15	58-99	13.9	3
3	Organic media	DMA	R = H	125	24-48	23-75	75.6	4
4	Organic media	DMSO	R = H	70	20	39-87	48.0	5
5	Organic media	EtOAc/ Me-THF	R = EDG	rt	0.5-16	40-92	25.2	6
6	Organic media	DCE	R = H, EDG, EWG	80	24	43-96	24.2	7
	Heterogenous catalysis (selected examples)							
7	Organic phase (MOF)	GLV	R = H, EDG, EWG	80	5	47-92	7.4	8
8	Aqueous (mesoporous silica)	H_2O	R = H, EDG	60	12	29-98	63.8	9
9	Aqueous (organometallic nano-vessel)	H_2O	R = H, EDG, EWG	50	12	80-93	19.8	10
	Green methods (selected examples)							
10	Micellar media	H_2O/EtOH	R = H	80	24	9-87	12.9	11
11	Micellar media	H_2O	R = H, EDG	25	1	52-90	14.4	12
12	Microwave	DMF/CH_3CN	R = H	100	4	41-83	34.7	13
13	"On-water"	H_2O	R = H, EDG	30	16	13-99	14.0	14
14	Mechanochemical	PEG-400	R = H, EDG, EWG	ambient	1-4	75-99	3.9	1

	Current work						
15	Homogenizer	EtOAc	R = H, EDG, EWG	ambient	6-9 min	80-90	current work

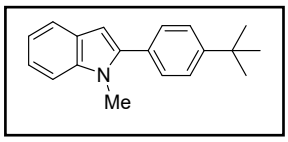
5. Spectral characterization



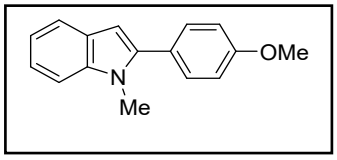
1-Methyl-2-phenyl-1*H*-indole (3a):[1] White solid, 84 mg (81%), m.p. 95-97 °C (lit. m.p. 99-102 °C); ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) 7.63 (d, *J* = 7.9 Hz, 1H), 7.50 (d, *J* = 7.2 Hz, 2H), 7.46 (t, *J* = 7.8 Hz, 2H), 7.39-7.33 (m, *J* = 8.4 Hz, 2H), 7.24 (t, *J* = 6.7 Hz, 1H), 7.14 (t, *J* = 7.3 Hz, 1H), 6.56 (s, 1H), 3.74 (s, 3H); ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$): δ (ppm) 141.6, 138.4, 132.9, 129.4, 128.5, 128.0, 127.9, 121.7, 120.5, 119.9, 109.7, 101.7, 31.2; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ Calcd for $C_{15}H_{13}N$ 208.1120; Found 208.1099.



1-Methyl-2-*p*-tolyl-1*H*-indole (3b):[1] White solid, 90 mg (81%), m.p. 95-97 °C (lit. m.p. 96-98 °C); ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) 7.62 (d, *J* = 7.8 Hz, 1H), 7.40 (d, *J* = 7.8 Hz, 2H), 7.35 (d, *J* = 8.1 Hz, 1H), 7.28-7.21 (m, 3H), 7.13 (t, *J* = 7.2 Hz, 1H), 6.53 (s, 1H), 3.72 (s, 3H), 2.42 (s, 3H); ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$): δ (ppm) 141.7, 138.3, 137.8, 129.9, 129.3, 129.2, 128.0, 121.5, 120.4, 119.8, 109.6, 101.3, 31.1, 21.3: HRMS (ESI-TOF) *m/z*: $[M + H]^+$ Calcd for $C_{16}H_{15}N$ 222.1278; Found 222.1270.

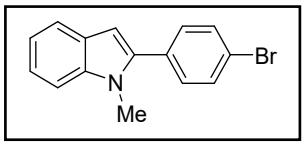


2-(4-*tert*-Butylphenyl)-1-methyl-1*H*-indole (3c):[1] White solid, 116 mg (88%), m.p. 55-58 °C (lit. m.p. 55-60 °C); ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) 7.63 (d, *J* = 8.0 Hz, 1H), 7.50-7.44 (m, 4H), 7.35 (d, *J* = 7.6 Hz, 1H), 7.23 (t, *J* = 8.0 Hz, 1H), 7.13 (t, *J* = 7.6 Hz, 1H), 6.55 (s, 1H), 3.75 (s, 3H), 1.38 (s, 9H); ^{13}C {^{1}H} NMR (100 MHz, $CDCl_3$): δ (ppm) 150.9, 141.7, 138.3, 129.9, 129.1, 128.0, 125.4, 121.5, 120.4, 119.8, 109.6, 101.4, 34.7, 31.2; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ Calcd for $C_{19}H_{21}N$ 264.1747; Found 264.1736.

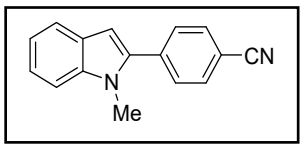


2-(4-Methoxyphenyl)-1-methyl-1*H*-indole (3d):[1] Off-white solid, 89 mg (75%), m.p. 115-117 °C (lit. m.p. 117-120 °C); ^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.67 (d, *J* = 8.8 Hz, 1H), 7.47

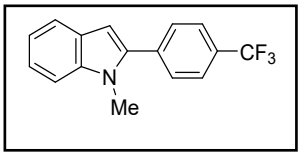
(dt, J_1 = 3.0 Hz, J_2 = 11 Hz, 2H), 7.40 (d, J = 8.5 Hz, 1H), 7.23 (td, J_1 = 1.2 Hz, J_2 = 7.2 Hz, 1H), 7.13 (td, J_1 = 0.8 Hz, J_2 = 8.0 Hz, 1H), 7.27 (dt, J_1 = 2.8 Hz, J_2 = 6.8 Hz, 2H), 6.50 (s, 1H), 3.86 (s, 3H), 3.71 (s, 3H); ^{13}C {^{1}H} NMR (100 MHz, $CDCl_3$): δ (ppm) 159.5, 141.5, 138.2, 130.7, 128.0, 125.3, 121.4, 120.3, 119.8, 114.0, 109.6, 101.0, 55.4, 31.1; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ Calcd for $C_{16}H_{15}NO$ 238.1226; Found 238.1220.



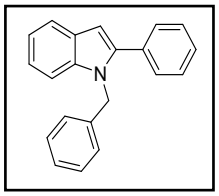
2-(4-Bromophenyl)-1-methyl-1*H*-indole (3f):[1] White solid, 114 mg (80%), m.p. 99-101 °C (lit. m.p. 99-102 °C); ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) 7.63 (d, J = 7.6 Hz, 1H), 7.59 (dt, J_1 = 2.4 Hz, J_2 = 6.4 Hz, 2H), 7.38-7.34 (m, 3H), 7.26 (td, J_1 = 1.2 Hz, J_2 = 6.8 Hz, 1H), 7.15 (td, J_1 = 1.2 Hz, J_2 = 7.2 Hz, 1H), 6.56 (d, J = 0.8 Hz, 1H), 3.73 (s, 3H); ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$): δ (ppm) 140.3, 138.5, 131.7, 130.8, 127.9, 122.2, 122.0, 120.6, 120.1, 109.7, 102.0, 31.2; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ Calcd for $C_{15}H_{12}BrN$ 286.0226 (for ^{79}Br) and 288.0207 (for ^{81}Br); Found 286.0233 (for ^{79}Br) and 288.0212 (for ^{81}Br).



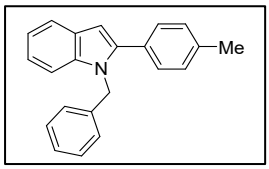
4-(1-Methyl-1*H*-indol-2-yl)benzonitrile (3f):[1] Light brown solid, 99 mg (85%), m.p. 157-158 °C (lit. m.p. 161-162 °C); ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) 7.77 (d, J_1 = 5Hz, 2H), 7.70 (d, J_1 = 5Hz, 1H), 7.64 (d, J_1 = 5Hz, 2H), 7.43 (d, J_1 = 10 Hz, 1H), 7.35 (t, J_1 = 10 Hz, 1H), 7.23 (t, J_1 = 10 Hz, 1H), 6.70 (s, 3H), 3.80 (s, 3H); ^{13}C {^{1}H} NMR (100 MHz, $CDCl_3$): δ (ppm) 139.3, 139.1, 137.6, 132.3, 129.5, 127.8, 122.8, 121.0, 120.4, 118.6, 111.2, 109.9, 103.6, 31.5; IR (KBr): ṽ 3070, 2939, 2221, 1928, 1602, 1465, 844, 796, 754 cm^{-1}; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ Calcd for $C_{16}H_{12}N_2$ 233.1073; Found 233.1062.



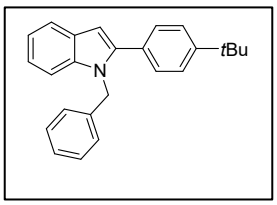
1-Methyl-2-(4-(trifluoromethyl)phenyl)-1*H*-indole (3g):[1] White solid, 113 mg (82%), m.p. 65-67 °C (lit. m.p. 65-68 °C); ; ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) 7.76 (d, J = 8.4 Hz, 2H), 7.68 (t, J = 8.8 Hz, 3H), 7.43 (d, J = 8.4 Hz, 1H), 7.33 (t, J = 6.8 Hz, 1H), 7.21 (t, J = 7.2 Hz, 1H), 6.67 (s, 1H), 3.80 (s, 3H); ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$): δ (ppm) 139.9, 138.8, 136.4, 129.8 (q, $^2J_{C\text{-}F}$ = 32.4 Hz), 129.4, 128.2, 127.8, 125.5 (q, $^3J_{C\text{-}F}$ = 3.8 Hz), 123.9 (q, $^1J_{C\text{-}F}$ = 272.0 Hz), 122.4, 120.8, 120.2, 109.8, 102.9, 31.3; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ Calcd for $C_{16}H_{12}F_3N$ 276.0995; Found 276.0985.



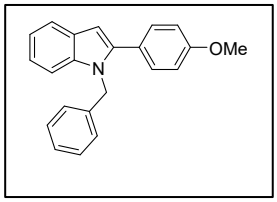
1-Benzyl-2-phenyl-1*H*-indole (3h):[1] Off white solid, 127 mg (90%), m.p. 36-38 °C (lit. m.p. 35-40 °C); ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) 7.68-7.65 (m, 1H), 7.43-7.40 (m, 2H), 7.38-7.33 (m, 3H), 7.27-7.21 (m, 3H), 7.17-7.12 (m, 3H), 7.01 (d, J = 8.0 Hz, 2H), 6.64 (s, 1H), 5.35 (s, 2H); ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$): δ (ppm) 141.8, 138.2, 138.0, 132.7, 129.2, 128.8, 128.6, 128.3, 128.0, 127.2, 126.0, 122.0, 120.6, 120.2, 110.6, 102.3, 47.7; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ Calcd for $C_{21}H_{17}N$ 284.1434; Found 284.1442.



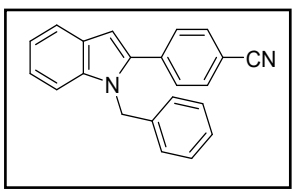
1-Benzyl-2-*p*-tolyl-1*H*-indole (3i):[1] White solid, 134 mg (89%), m.p. 79-82 °C (lit. m.p. 79-92 °C); ^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.67-7.63 (m, 1H), 7.33-7.31 (m, 2H), 7.28-7.21 (m, 3H), 7.18-7.11 (m, 5H), 7.02 (d, J = 8.2 Hz, 2H), 6.62 (s, 1H), 5.35 (s, 2H), 2.37 (s, 3H); ^{13}C {^{1}H} NMR (100 MHz, $CDCl_3$): δ (ppm) 141.9, 138.3, 137.98, 137.94, 129.8, 129.3, 129.1, 128.7, 128.4, 127.1, 126.0, 121.7, 120.4, 120.1, 110.5, 102.0, 47.7, 21.2; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ Calcd for $C_{22}H_{19}N$ 298.1591; Found 298.1602.



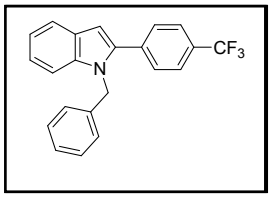
1-Benzyl-2-(4-*tert*-butylphenyl)-1*H*-indole (3j):[1] White solid, 150 mg (88%), m.p. 120-122 °C (lit. m.p. 120-125 °C); ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) 7.66-7.64 (m, 1H), 7.40-7.36 (m, 4H), 7.28-7.22 (m, 3H), 7.15-7.11 (m, 3H), 7.04 (d, J = 7.2 Hz, 2H), 6.63 (s, 1H), 5.37 (s, 2H), 1.33 (s, 9H); ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$): δ (ppm) 151.1, 141.9, 138.3, 137.9, 129.7, 128.8, 128.7, 128.4, 127.1, 126.0, 125.5, 121.7, 120.4, 120.1, 110.5, 102.0, 47.8, 34.7, 31.3; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ Calcd for $C_{25}H_{25}N$ 340.2040; Found 340.2028.



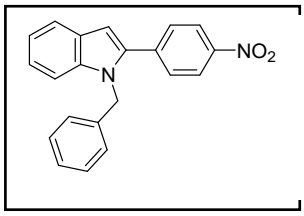
1-Benzyl-2-(4-methoxyphenyl)-1*H*-indole (3k):[1] White solid, 141 mg (90%), m.p. 98-100 °C (lit. m.p. 99-100 °C); ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) 7.71-7.69 (m, 1H), 7.41-7.37 (m, 2H), 7.34-7.27 (m, 3H), 7.22-7.16 (m, 3H), 7.07 (d, J = 8.0 Hz, 2H), 6.95 (dt, J_1 = 3.7 Hz, J_2 = 11.5 Hz, 2H), 6.64 (s, 1H), 5.39 (s, 2H), 3.87 (s, 3H); ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$): δ (ppm) 159.6, 141.7, 138.3, 137.8, 130.5, 128.8, 127.6, 127.2, 126.0, 125.1, 121.7, 120.4, 120.1, 114.0, 110.5, 101.7, 55.4, 47.7; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ Calcd for $C_{22}H_{19}NO$ 314.1539; Found 314.1550.



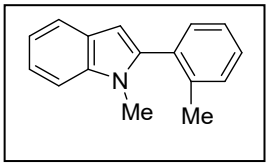
4-(1-Benzyl-1*H*-indol-2-yl)benzonitrile (3l):[1] Light brown solid, 101 mg (87%), m.p. 159-161 °C (lit. m.p. 161-162 °C); ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) 7.74-7.71 (m, 1H), 7.69-7.66 (m, 2H), 7.57-7.54 (m, 2H), 7.35-7.29 (m, 3H), 7.25-7.19 (m, 3H), 7.04 (d, *J* = 7.9 Hz, 2H), 6.78 (s, 1H), 5.46 (s, 2H); ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$): δ (ppm) 139.5, 138.8, 137.6, 137.2 , 132.3, 129.3, 128.9, 128.0, 127.5, 125.8, 123.0, 121.1, 120.7, 118.7, 111.3, 110.7, 104.2, 47.9; HRMS (ESI-TOF) *m/z*: [M + H]$^+$ Calcd for $C_{22}H_{16}N_2$ 309.1387; Found 309.1383.



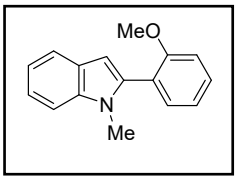
1-Benzyl-2-(4-(trifluoromethyl)phenyl)-1*H*-indole (3m):[1] White solid, 158 mg (90%), m.p. 62-64 °C (lit. m.p. 62-65 °C); ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) 7.69 (d, *J* = 7.5 Hz, 1H), 7.62 (d, *J* = 8.2 Hz, 2H), 7.53 (d, *J* = 8.2 Hz, 2H), 7.29-7.23 (m, 3H), 7.20-7.16 (m, 3H), 7.02 (d, *J* = 7.6 Hz, 2H), 6.72 (s, 1H), 5.36 (s, 2H); ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$): δ (ppm) 140.1, 138.4, 137.8, 136.2, 129.9 (q, $^2J_{C\text{-}F}$ = 32.6 Hz), 129.3, 128.9, 128.1, 127.4, 125.8, 125.5 (q, $^3J_{C\text{-}F}$ = 3.7 Hz), 124.1 (q, $^1J_{C\text{-}F}$ = 270.0 Hz), 122.6, 120.9, 120.5, 110.6, 103.5, 47.8; HRMS (ESI-TOF) *m/z*: [M + H]$^+$ Calcd for $C_{22}H_{16}F_3N$ 352.1308; Found 352.1298.



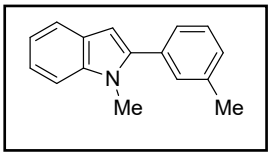
1-Benzyl-2-(4-nitrophenyl)-1*H*-indole (3n): White solid, 138 mg (89%), m.p. 155-158 °C (lit. m.p. 155-156 °C); ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) 8.25 (d, *J* = 8.2 Hz, 2H), 7.74 (d, *J* = 7.7 Hz, 1H), 7.61 (d, *J* = 8.2 Hz, 2H), 7.35-7.22 (m, 6H), 7.01 (d, *J* = 7.2 Hz, 2H), 6.83 (s, 1H), 5.42 (s, 2H); ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$): δ (ppm) 147.1, 139.1, 139.0, 137.5, 129.4, 129.0, 128.0, 127.5, 125.7, 124.1, 123.9, 123.2, 121.1, 120.8, 110.7, 104.7, 48.0; HRMS (ESI-TOF) *m/z*: [M + H]$^+$ Calcd for $C_{21}H_{16}N_2O_2$ 329.1285; Found 309.1292.



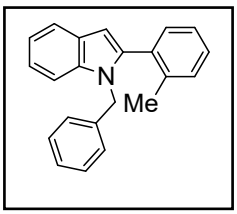
1-Methyl-2-*o*-tolyl-1*H*-indole (3o):[1] White solid, 90 mg (81%), m.p. 88-90 °C (lit. m.p. 90-92 °C); ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) 7.69 (d, *J* = 7.8 Hz, 1H), 7.41-7.29 (m, 6H), 7.20 (t, *J* = 7.5 Hz, 1H), 6.49 (s, 1H), 3.56 (s, 3H), 2.26 (s, 3H); ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$): δ (ppm) 140.5, 138.1, 137.3, 132.5, 131.1, 130.1, 128.6, 128.0, 125.5, 121.3, 120.4, 119.6, 109.4, 101.5, 30.3, 20.0; HRMS (ESI-TOF) *m/z*: [M + H]$^+$ Calcd for $C_{16}H_{15}N$ 222.1277; Found 222.1283.



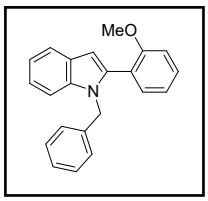
2-(2-Methoxyphenyl)-1-methyl-1*H*-indole (3p):[1] Pale yellow solid, 96 mg (81%), m.p. 74-75 °C (lit. m.p. 75-77 °C); ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) 7.64 (d, *J* = 7.8 Hz, 1H), 7.42 (t, *J* = 7.9 Hz, 1H), 7.36 (t, *J* = 8.2 Hz, 2H), 7.23 (t, *J* = 7.9 Hz, 1H), 7.12 (t, *J* = 7.3 Hz, 1H), 7.05 (t, *J* = 7.4 Hz, 1H), 6.99 (d, *J* = 8.4 Hz, 1H), 6.51 (s, 1H), 3.79 (s, 3H), 3.58 (s, 3H); ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$): δ (ppm) 157.5, 138.6, 137.7, 132.6, 130.1, 128.0, 122.0, 121.3, 120.7, 120.5, 119.4, 110.9, 109.4, 101.7, 55.5, 30.8; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ Calcd for $C_{16}H_{15}NO$ 238.1226; Found 238.1214.



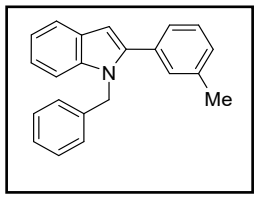
1-Methyl-2-*m*-tolyl-1*H*-indole (3q):[1] White solid, 88 mg (80%), m.p. 35-36 °C (lit. m.p. 35-37 °C); ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) 7.68 (d, *J* = 7.9 Hz, 1H), 7.42-7.35 (m, 4H), 7.31-7.26 (m, 2H), 7.20 (t, *J* = 7.6 Hz, 1H), 6.61 (s, 1H), 3.80 (s, 3H), 2.49 (s, 3H); ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$): δ (ppm) 141.7, 138.3, 138.2, 132.8, 130.1, 128.6, 128.3, 128.0, 126.5, 121.6, 120.4, 119.8, 109.6, 101.5, 31.2, 21.5; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ Calcd for $C_{16}H_{15}N$ 222.1277; Found 222.1272.



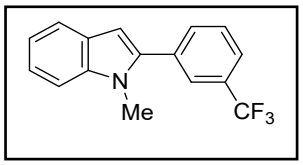
1-Benzyl-2-*o*-tolyl-1*H*-indole (3r):[1] Colourless thick oil, 134 mg (90%), ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) 7.75 (d, *J* = 7.8, 1H), 7.38-7.30 (m, 4H), 7.26-7.19 (m, 6H), 6.95 (d, *J* = 7.2, 2H), 6.59 (s, 1H), 5.22 (s, 2H), 2.21 (s, 3H); ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$): δ (ppm) 140.3, 138.2, 137.9, 136.9, 132.3, 131.1, 130.2, 128.8, 128.5, 128.4, 127.1, 126.4, 125.5, 121.5, 120.5, 119.9, 110.5, 102.5, 47.3, 20.1; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ Calcd for $C_{22}H_{19}N$ 298.1591; Found 298.1599.



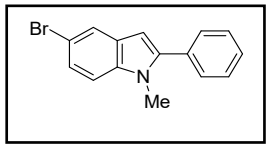
1-Benzyl-2-(2-methoxyphenyl)-1*H*-indole (3s):[1] Colourless thick oil, 140 mg (90%); ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) 7.70 (d, *J* = 7.2, 1H), 7.44-7.37 (m, 2H), 7.24-7.15 (m, 6H), 7.05-6.97 (m, 4H), 6.62 (s, 1H), 5.23 (s, 2H), 3.65 (s, 3H); ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$): δ (ppm) 157.5, 138.6, 138.3, 137.2, 132.8, 130.1, 128.43, 128.36, 126.8, 126.4, 121.8, 121.4, 120.7, 120.5, 119.6, 110.7, 110.5, 102.6, 55.1, 47.9; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ Calcd for $C_{22}H_{19}NO$ 314.1539; Found 314.1528.



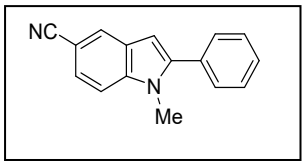
1-Benzyl-2-*m*-tolyl-1*H*-indole (3t):[1] White solid, 126 mg (85%), m.p. 75-76 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) 7.75 (d, *J* = 7.2, 1H), 7.38-7.18 (m, 10H), 7.10 (d, *J* = 7.2, 2H), 6.71 (s, 1H), 5.43 (s, 2H), 2.41 (s, 3H); ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$): δ (ppm) 142.0, 138.4, 138.2, 138.0, 132.6, 130.1, 128.9, 128.8, 128.45, 128.40, 127.1, 126.2, 126.0, 121.8, 120.5, 120.1, 110.5, 102.2, 47.8, 21.4; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ Calcd for $C_{22}H_{19}N$ 298.1591; Found 298.1604.



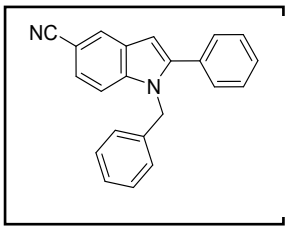
1-Methyl-2-(3-(trifluoromethyl)phenyl)-1*H*-indole (3u):[1] Pale yellow solid, 110 mg (80%), m.p. 55-57 °C (lit. m.p. 55-57 °C); ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) 7.82 (s, 1H), 7.74-7.68 (m, 3H), 7.63 (t, *J* = 7.8 Hz, 1H), 7.42 (d, *J* = 8.4 Hz, 1H), 7.33 (t, *J* = 7.9 Hz, 1H), 7.21 (t, *J* = 7.5 Hz, 1H), 6.67 (s, 1H), 3.79 (s, 3H); ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$): δ (ppm) 139.8, 138.6, 133.7, 132.5 (q, $^{4}J_{C\text{-}F}$ = 1.2 Hz), 131.2 (q, $^{2}J_{C\text{-}F}$ = 32 Hz), 129.1, 127.8, 126.0 (q, $^{3}J_{C\text{-}F}$ = 3.7 Hz), 124.51 (q, $^{3}J_{C\text{-}F}$ = 3.7 Hz), 124.49 (q, $^{1}J_{C\text{-}F}$ = 273.0 Hz), 122.3, 120.7, 120.2, 109.7, 102.6, 31.3; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ Calcd for $C_{16}H_{12}F_3N$ 276.0995; Found 276.0968.



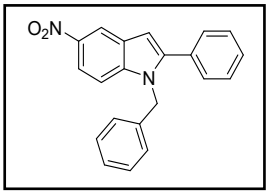
5-Bromo-1-methyl-2-phenyl-1*H*-indole (3v):[1] White solid, 102 mg (72%), m.p. 108-110 °C (lit. m.p. 108-110 °C); ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) 7.79 (s, 1H), 7.53-7.45 (m, 5H), 7.36 (d, *J* = 8.5 Hz, 1H), 7.26 (t, *J* = 8.7 Hz, 1H), 6.54 (s, 1H), 3.75 (s, 3H); ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$): δ (ppm) 142.7, 137.0, 132.3, 129.6, 129.4, 128.6, 128.2, 124.4, 122.9, 113.1, 111.1, 101.1, 31.3; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ Calcd for $C_{15}H_{12}BrN$ 286.0226 (for ^{79}Br) and 288.0207 (for ^{81}Br); Found 286.022 (for ^{79}Br) and 288.0201 (for ^{81}Br).



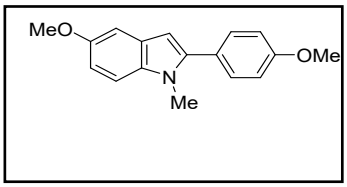
1-Methyl-2-phenyl-1*H*-indole-5-carbonitrile (3w):[1] White solid, 102 mg (87%), m.p. 165–166 °C (lit. m.p. 166–170 °C); ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) 7.99 (s, 1H), 7.53–7.48 (m, 6H), 7.42 (d, *J* = 8.5 Hz, 1H), 6.64 (s, 1H), 3.79 (s, 3H); ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$): δ (ppm) 143.9, 139.7, 131.6, 129.4, 128.74, 128.67, 127.7, 125.9, 124.5, 120.8, 110.4, 102.8, 102.3, 31.4; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ calcd for $C_{16}H_{12}N_2$, 233.1073; found, 233.1067.



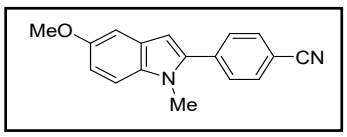
1-Benzyl-2-phenyl-1*H*-indole-5-carbonitrile (3x):[15] White solid, 120 mg (78%), m.p. 86-88 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) 8.03 (s, 1H), 7.45 (bs, 5H),7.39 (d, *J* = 8.4 Hz, 1H) 7.34-7.29 (m, 2H), 7.25 (d, *J* = 7.6 Hz, 2H), 7.00 (d, *J* = 7.6 Hz, 2H), 6.74 (s, 1H), 5.42 (s, 2H); ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$): δ (ppm) 144.2, 139.3, 137.1, 131.5, 129.3, 129.0, 128.87, 128.82, 128.0, 127.6, 126.0, 125.8, 124.8, 120.7, 111.4, 103.2, 102.9, 47.9; HRMS (ESI-TOF) *m/z*: [M + H]$^+$ Calcd for $C_{22}H_{16}N_2$ 309.1395; Found 309.1399.



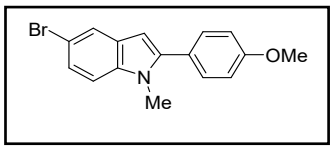
1-Benzyl-5-nitro-2-phenyl-1*H*-indole (3y):[16] Off white solid, 126 mg (77%), m.p. 55-58 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) 8.64 (s, 1H), 8.07 (dd, J_1 = 2.4 Hz, J_2 = 9.0 Hz, 1H), 7.45 (bs, 5H), 7.36-7.28 (m, 3H), 7.22 (d, *J* = 9.0 Hz, 1H), 7.00 (d, *J* = 7.2 Hz, 2H), 6.82 (s, 1H), 5.43 (s, 2H); ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$): δ (ppm) 145.0, 142.1, 140.6, 136.9, 131.4, 129.2, 129.0, 128.9, 128.8, 127.7, 127.5, 125.8, 117.6, 117.5, 110.4, 104.3, 48.1; HRMS (ESI-TOF) *m/z*: [M + H]$^+$ Calcd for $C_{21}H_{16}N_2O_2$ 329.1285; Found 329.1287.



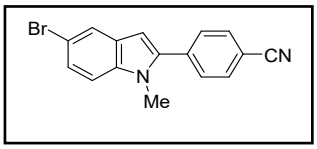
5-Methoxy-2-(4-methoxyphenyl)-1-methyl-1*H*-indole (3z):[1] Yellowish solid, 114 mg (85%), m.p. 76-78 °C (lit. m.p. 78-80 °C); ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) 7.46 (d, *J* = 8.5 Hz, 2H), 7.27 (d, *J* = 8.7 Hz, 1H), 7.14 (s, 1H), 7.03 (d, *J* = 8.5 Hz, 2H), 6.93 (d, *J* = 6.4 Hz, 1H), 6.47 (s, 1H), 3.91 (s, 6H), 3.73 (s, 3H); ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$): δ (ppm) 159.4, 154.3, 142.0, 133.6, 130.5, 128.3, 125.4, 114.0, 111.5, 110.2, 102.1, 100.7, 55.9, 55.3, 31.2; HRMS (ESI-TOF) *m/z*: [M + H]$^+$ Calcd for $C_{17}H_{17}NO_2$ 268.1332; Found 268.1324.



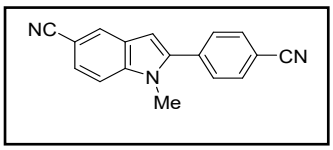
4-(5-Methoxy-1-methyl-1*H*-indol-2-yl)benzonitrile (3aa):[1] Light pink solid, 107 mg (82%), m.p. 120-121 °C (lit. m.p. 118-120 °C); ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) 7.76 (d, *J* = 8.2 Hz, 2H), 7.63 (d, *J* = 8.2 Hz, 2H), 7.30 (d, *J* = 9.0 Hz, 1H), 7.13 (s, 1H), 6.99 (d, *J* = 8.8 Hz, 1H), 6.60 (s, 1H), 3.90 (s, 3H), 3.76 (s, 3H); ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$): δ (ppm) 154.6, 139.8, 137.3, 134.5, 132.3, 129.4, 128.0, 118.8, 113.2, 111.0, 110.7, 103.1, 102.3, 55.9, 31.6; HRMS (ESI-TOF) *m/z*: [M + H]$^+$ Calcd for $C_{17}H_{14}N_2O$ 263.1179; Found 263.1175.



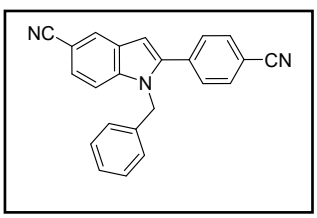
5-Bromo-2-(4-methoxyphenyl)-1-methyl-1*H*-indole (3ab):[1] Yellow solid, 123 mg (78%), m.p. 98-99 °C (lit. m.p. 98-100 °C); ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) 7.75 (s, 1H), 7.44 (d, *J* = 8.6 Hz, 2H), 7.32 (d, *J* = 8.6 Hz, 1H), 7.23 (d, *J* = 8.7 Hz, 1H), 7.03 (d, *J* = 8.5 Hz, 2H), 6.46 (s, 1H), 3.90 (s, 3H), 3.72 (s, 3H); ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$): δ (ppm) 159.7, 142.6, 136.8, 130.6, 129.6, 124.6, 124.1, 122.6, 114.0, 112.9, 110.9, 100.5, 55.4, 31.2; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ Calcd for $C_{16}H_{14}BrNO$ 316.0332 (for ^{79}Br) and 318.0312 (for ^{81}Br); Found 316.0326 (for ^{79}Br) and 318.0307 (for ^{81}Br).



4-(5-Bromo-1-methyl-1*H*-indol-2-yl)benzonitrile (3ac):[1] White solid, 117 mg (75%), m.p. 158-160 °C (lit. m.p. 158-160 °C); ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) 7.81-7.76 (m, 3H), 7.63 (d, *J* = 8.2 Hz, 2H), 7.38 (d, *J* = 8.7 Hz, 1H), 7.26 (d, *J* = 8.7 Hz, 1H), 6.60 (s, 1H), 3.76 (s, 3H); ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$): δ (ppm) 140.4, 137.6, 136.7, 132.4, 129.6, 129.3, 125.5, 123.3, 118.6, 113.5, 111.6, 111.3, 102.8, 31.6; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ Calcd for $C_{16}H_{11}BrN_2$ 311.0179 (for ^{79}Br) and 313.0158 (for ^{81}Br); Found 311.0174 (for ^{79}Br) and 313.0156 (for ^{81}Br).

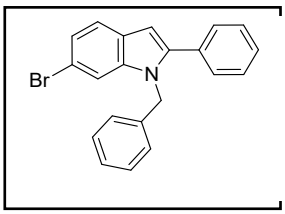


2-(4-Cyanophenyl)-1-methyl-1*H*-indole-5-carbonitrile (3ad):[1] White solid, 92 mg (71%), m.p. 202-204 °C (lit. m.p. 206-211 °C); ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) 8.01 (s, 1H), 7.82 (d, *J* = 8.0 Hz, 2H), 7.66 (d, *J* = 7.9 Hz, 2H), 7.53 (d, *J* = 8.7 Hz, 1H), 7.45 (d, *J* = 8.5 Hz, 1H), 6.73 (s, 1H), 3.82 (s, 3H); ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$): δ (ppm) 141.5, 140.2, 136.1, 132.5, 129.7, 127.4, 126.4, 125.4, 120.5, 118.4, 112.2, 110.7, 103.9, 103.5, 31.7; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ Calcd for $C_{17}H_{11}N_3$ 258.1026; Found 258.1023.

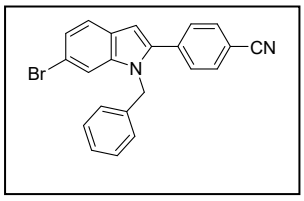


1-Benzyl-2-(4-cyanophenyl)-1*H*-indole-5-carbonitrile (3ae): White solid, 127 mg (76%), m.p. 156-159 °C (lit. m.p. 155-156 °C); ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) 8.05 (s, 1H), 7.71 (d, *J* = 8.2 Hz, 1H), 7.55 (d, *J* = 8.0 Hz, 2H), 7.44 (dd, J_1 = 1.6 Hz, J_2 = 8.5 Hz, 1H), 7.33-7.29 (m, 4H), 6.98 (d, *J* = 6.1 Hz, 2H), 6.82 (s, 1H), 5.42 (s, 2H); ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$): δ (ppm) 141.8, 139.9, 136.5, 136.0, 132.5, 129.6,

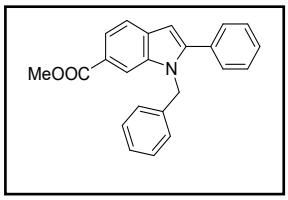
129.2, 127.9, 127.7, 126.5, 125.7, 125.6, 120.3, 118.3, 112.4, 111.5, 104.5, 103.9, 48.1; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ Calcd for $C_{23}H_{15}N_3$ 334.1339; Found 334.1345.



1-Benzyl-6-bromo-2-phenyl-1*H*-indole (3af): White solid, 126 mg (70%), m.p. 108-110 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) 7.67 (d, *J* = 8.2, 2H), 7.57 (d, *J* = 8.4, 1H), 7.52 (d, *J* = 8.2, 2H), 7.40 (s, 1H), 7.35-7.27 (m, 4H), 7.00 (d, *J* = 7.4 Hz, 2H), 6.73 (s, 1H), 5.34 (s, 2H); ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$): δ (ppm) 142.5, 138.8, 137.6, 132.1, 129.1, 128.9, 128.6, 128.3, 127.4, 127.1, 125.8, 123.4, 121.7, 115.3, 113.4, 102.4, 47.7; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ Calcd for $C_{21}H_{16}BrN$ 362.0539 (for ^{79}Br) and 364.0519 (for ^{81}Br); Found 362.0559 (for ^{79}Br) and 364.0512 (for ^{81}Br).



4-(1-Benzyl-6-bromo-1*H*-indol-2-yl)benzonitrile (3ag): White solid, 140 mg (72%), m.p. 158-160 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) 7.68 (d, *J* = 8.0 Hz, 2H), 7.57 (d, *J* = 8.4 Hz, 1H), 7.52 (d, *J* = 8.2 Hz, 2H), 7.40 (s, 1H), 7.35-7.27 (m, 4H), 7.00 (d, *J* = 7.4 Hz, 2H), 6.73 (s, 1H), 5.34 (s, 2H); ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$): δ (ppm) 140.1, 139.5, 137.0, 136.6, 132.4, 129.3, 129.1, 127.7, 126.8, 125.6, 124.0, 122.2, 118.5, 116.5, 113.5, 111.7, 104.2, 47.9; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ Calcd for $C_{22}H_{15}BrN_2$ 387.0492 (for ^{79}Br) and 389.0471 (for ^{81}Br); Found 387.0478 (for ^{79}Br) and 389.0486 (for ^{81}Br).



1-Benzyl-2-phenyl-1*H*-indole-6-carboxylate (3ah): White solid, 126 mg (74%), m.p. 95-97 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) 8.01 (s, 1H), 7.87 (d, *J* = 8.2 Hz, 1H), 7.70 (d, *J* = 8.2 Hz, 1H), 7.47-7.40 (m, 5H), 7.31-7.24 (m, 3H), 7.00 (d, *J* = 7.6 Hz, 2H), 6.71 (s, 1H), 5.46 (s, 2H), 3.91 (s, 3H); ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$): δ (ppm) 168.1, 145.0, 137.7, 137.3, 132.0, 131.9, 129.2, 128.8, 128.6, 127.3, 125.9, 123.4, 121.3, 120.0, 112.7, 102.7, 51.9, 47.7; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ Calcd for $C_{23}H_{19}NO_2$ 342.1489; Found 342.1475.

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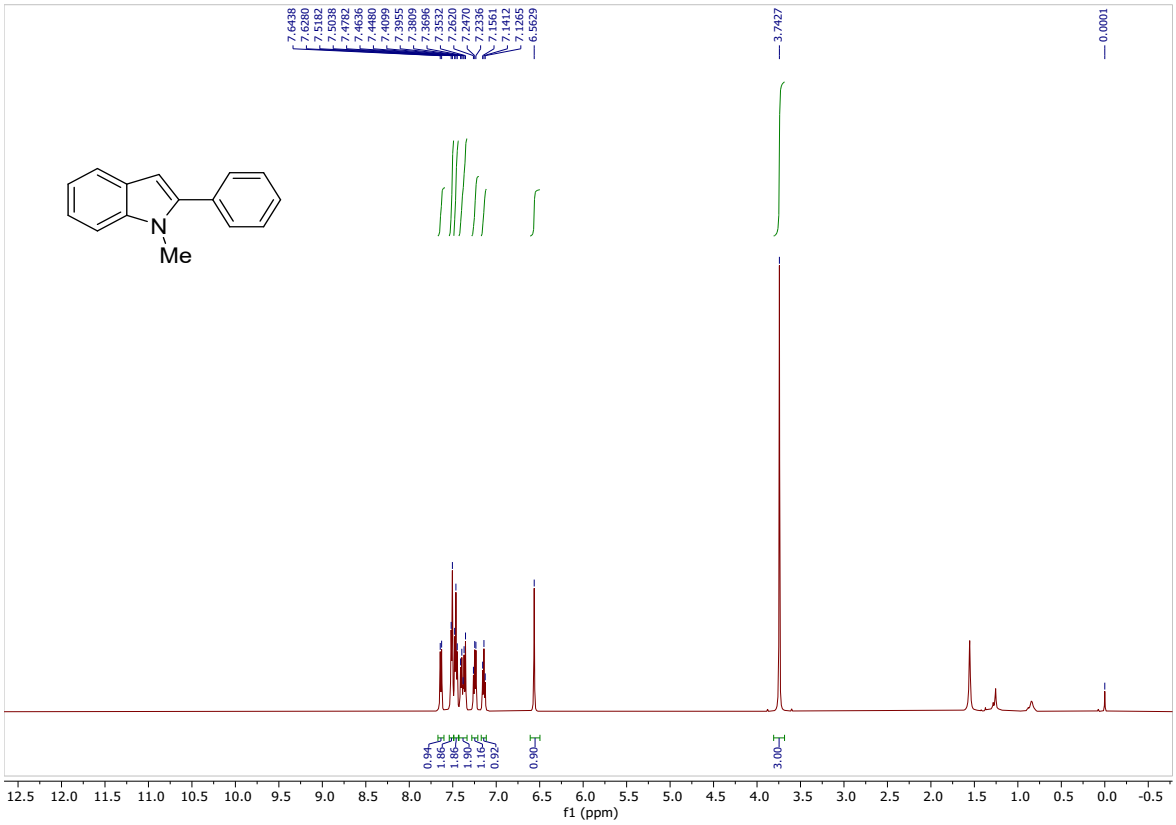
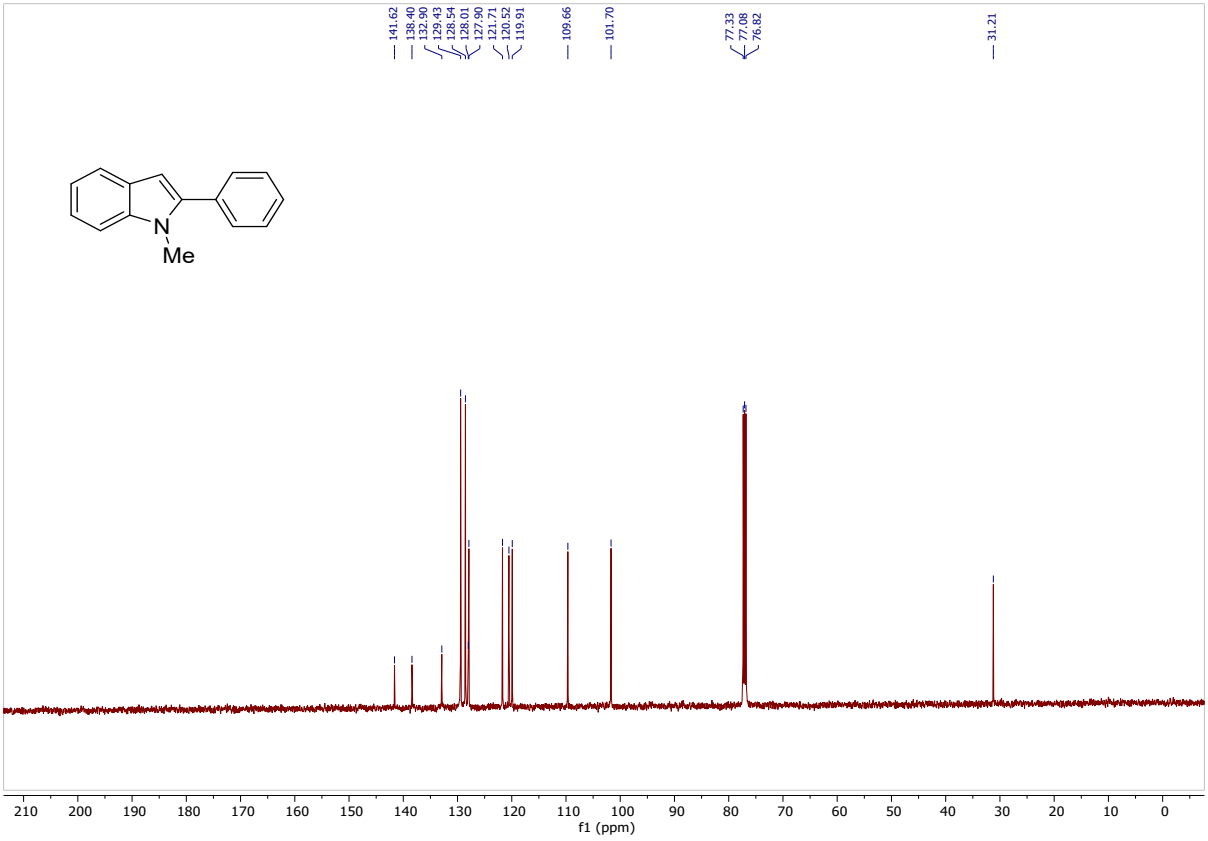
7. Copies of ^{1}H & ^{13}C NMR of 2-arylindole derivatives

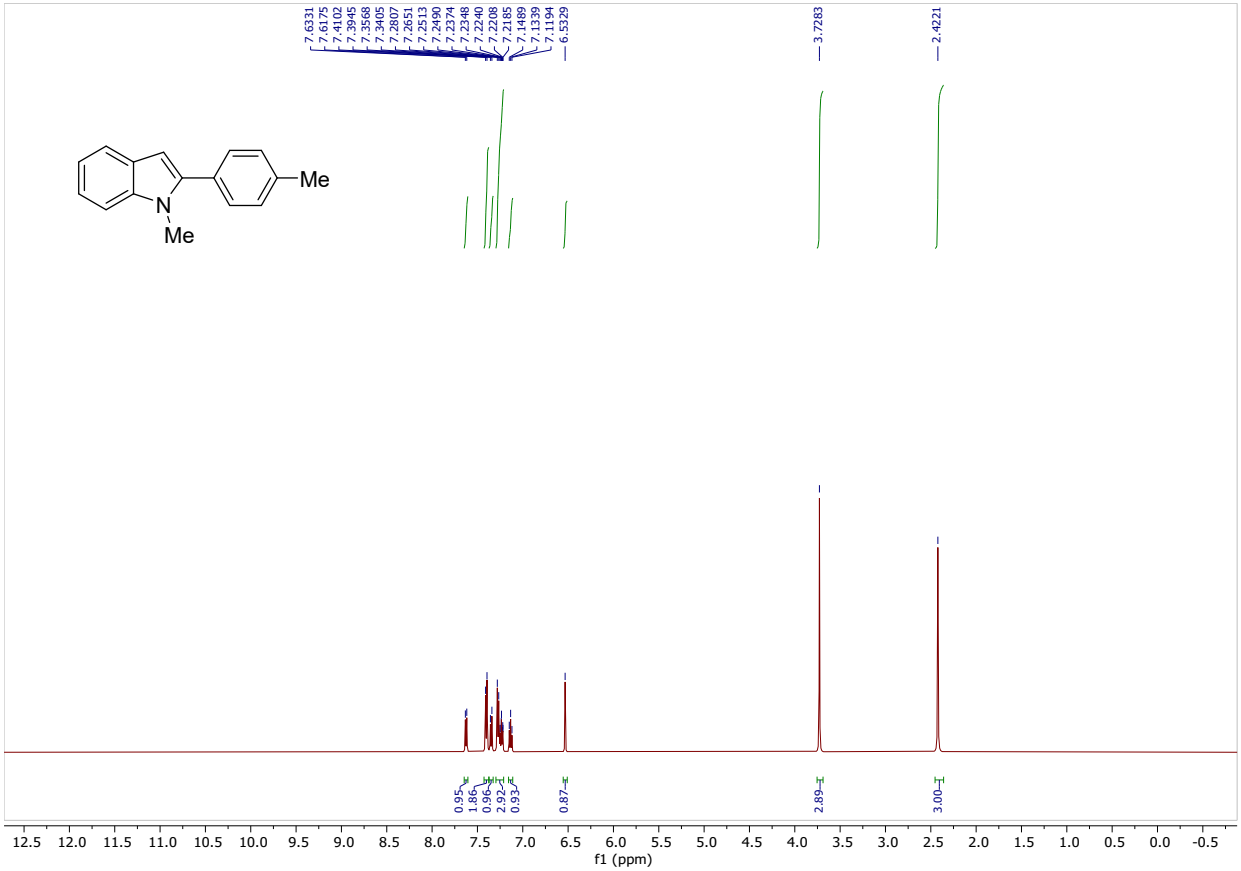
^{1}H NMR spectrum of compound **3a**, ($CDCl_3$, 500 MHz).



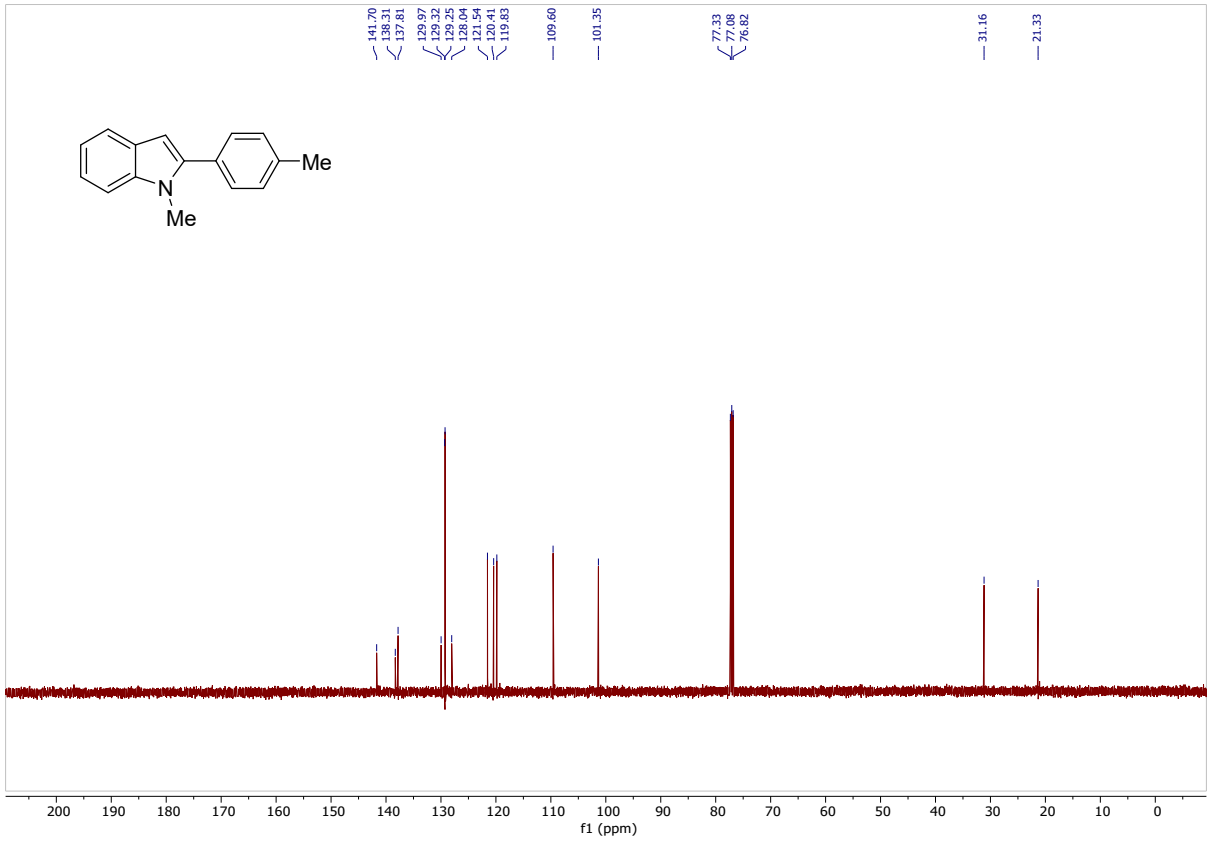
^{13}C NMR spectrum of compound **3a**, ($CDCl_3$, 125 MHz).



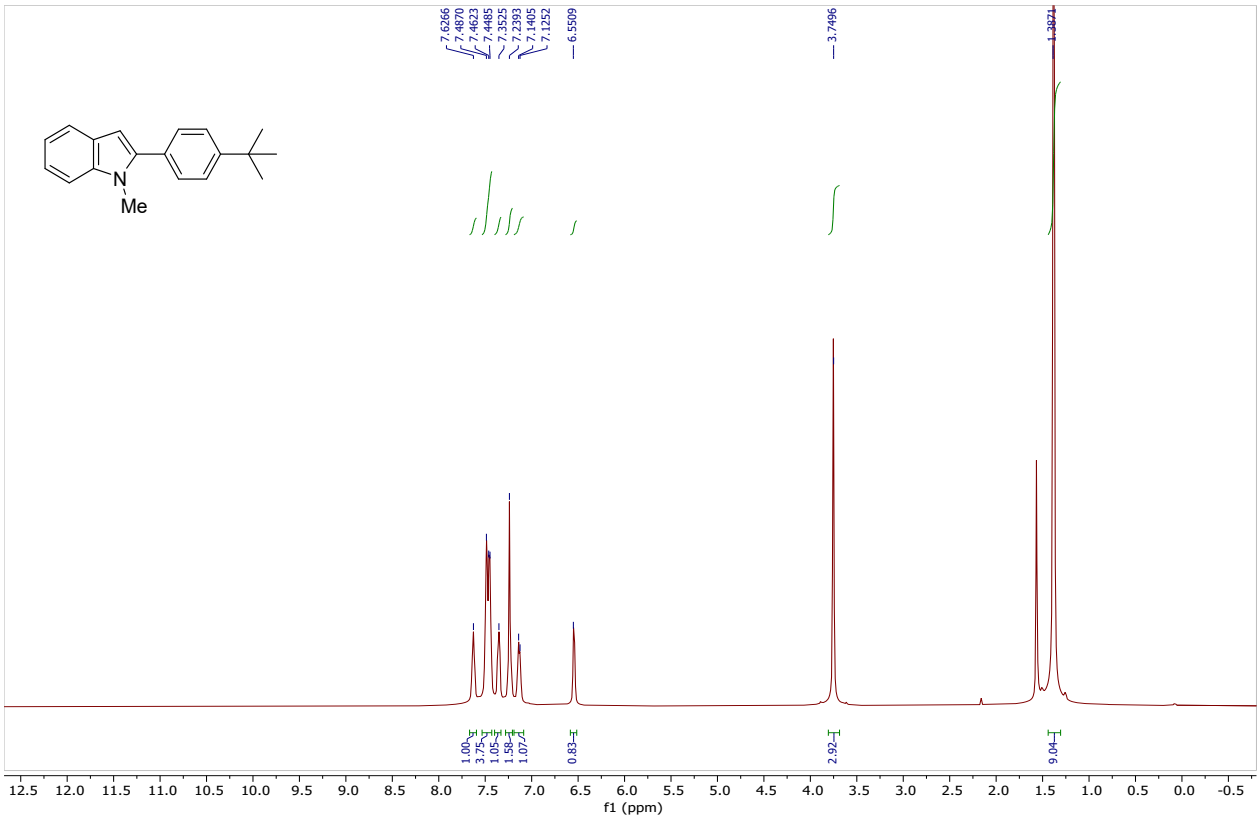
^{1}H NMR spectrum of compound **3b**, ($CDCl_3$, 500 MHz).



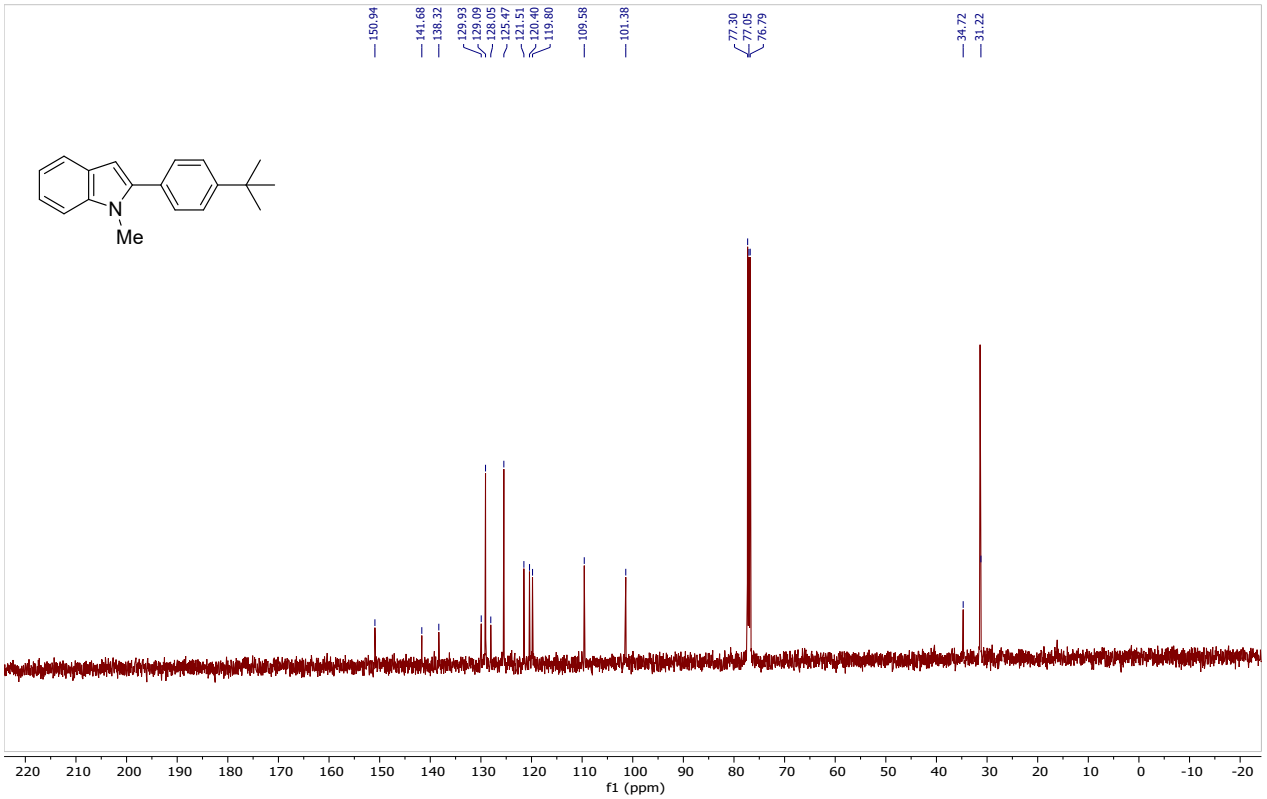
^{13}C NMR spectrum of compound **3b**, ($CDCl_3$, 125 MHz).



^{1}H NMR spectrum of compound **3c**, ($CDCl_3$, 500 MHz).



^{13}C NMR spectrum of compound **3c**, ($CDCl_3$, 125 MHz).



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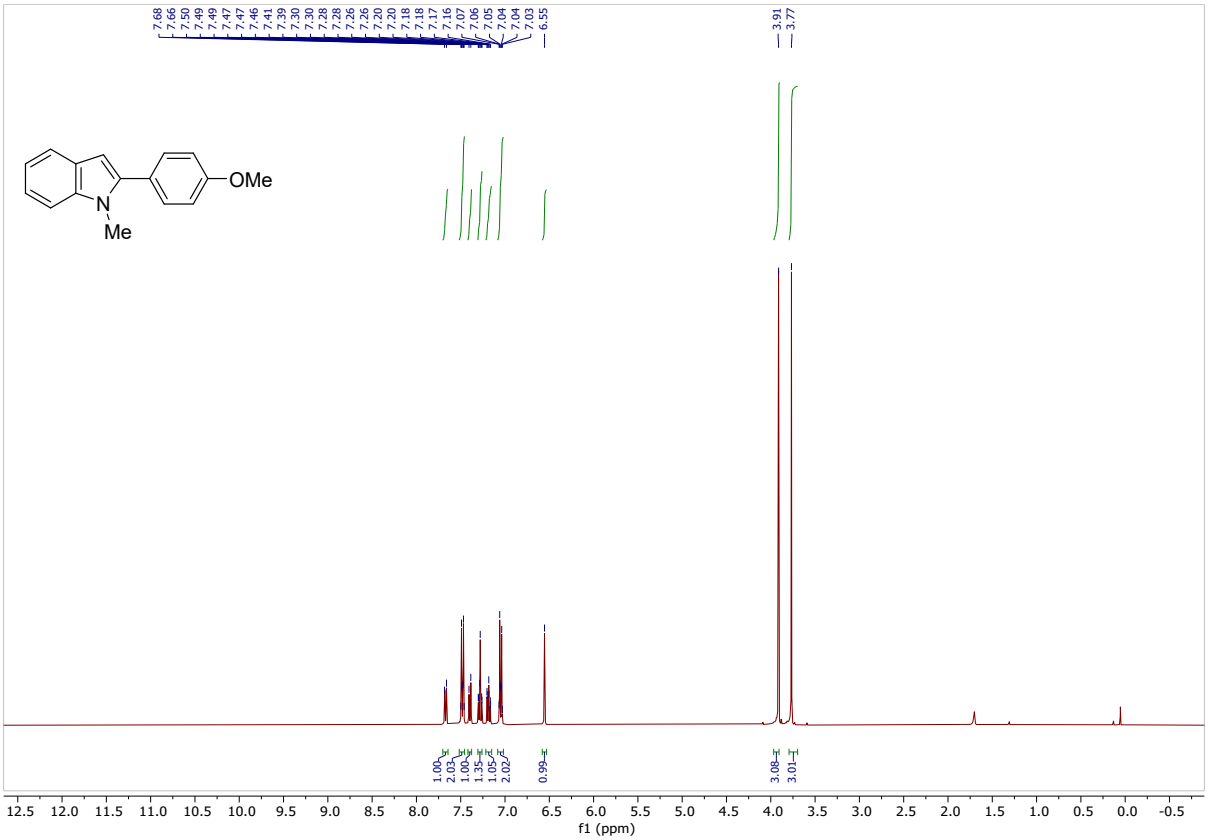
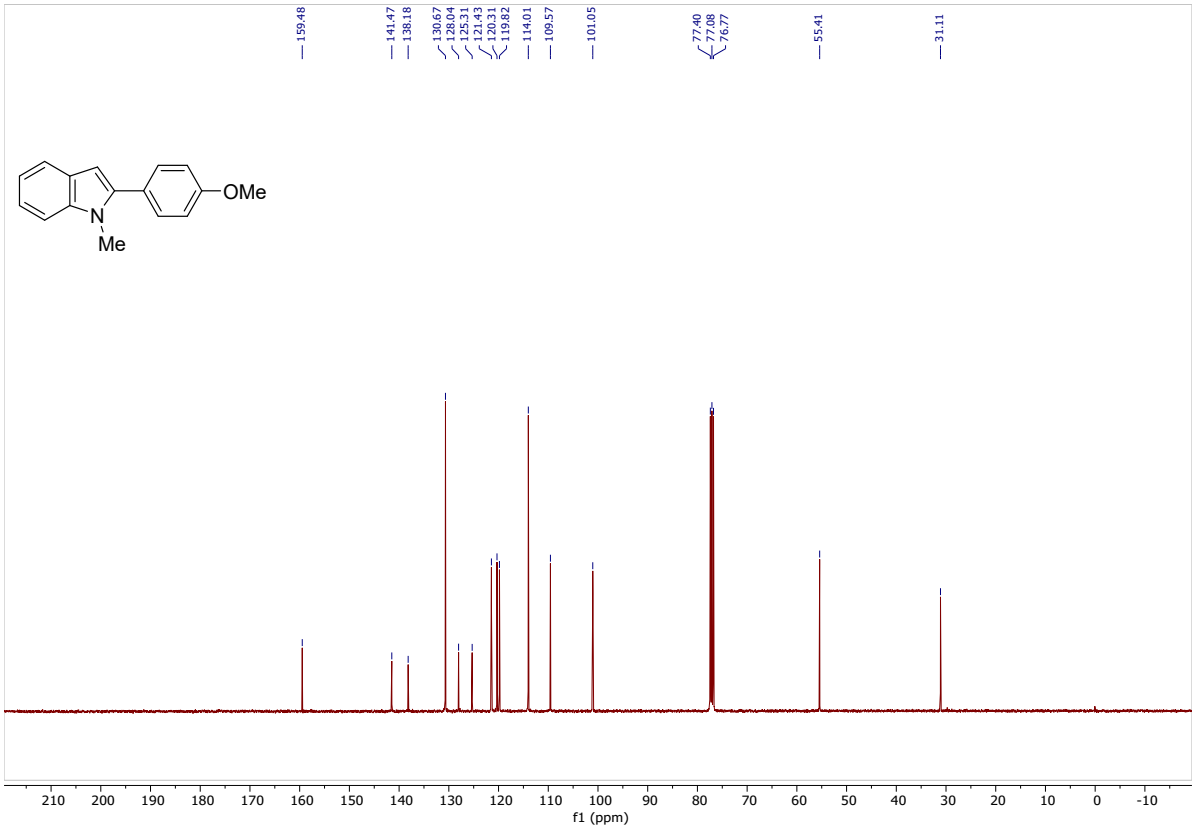
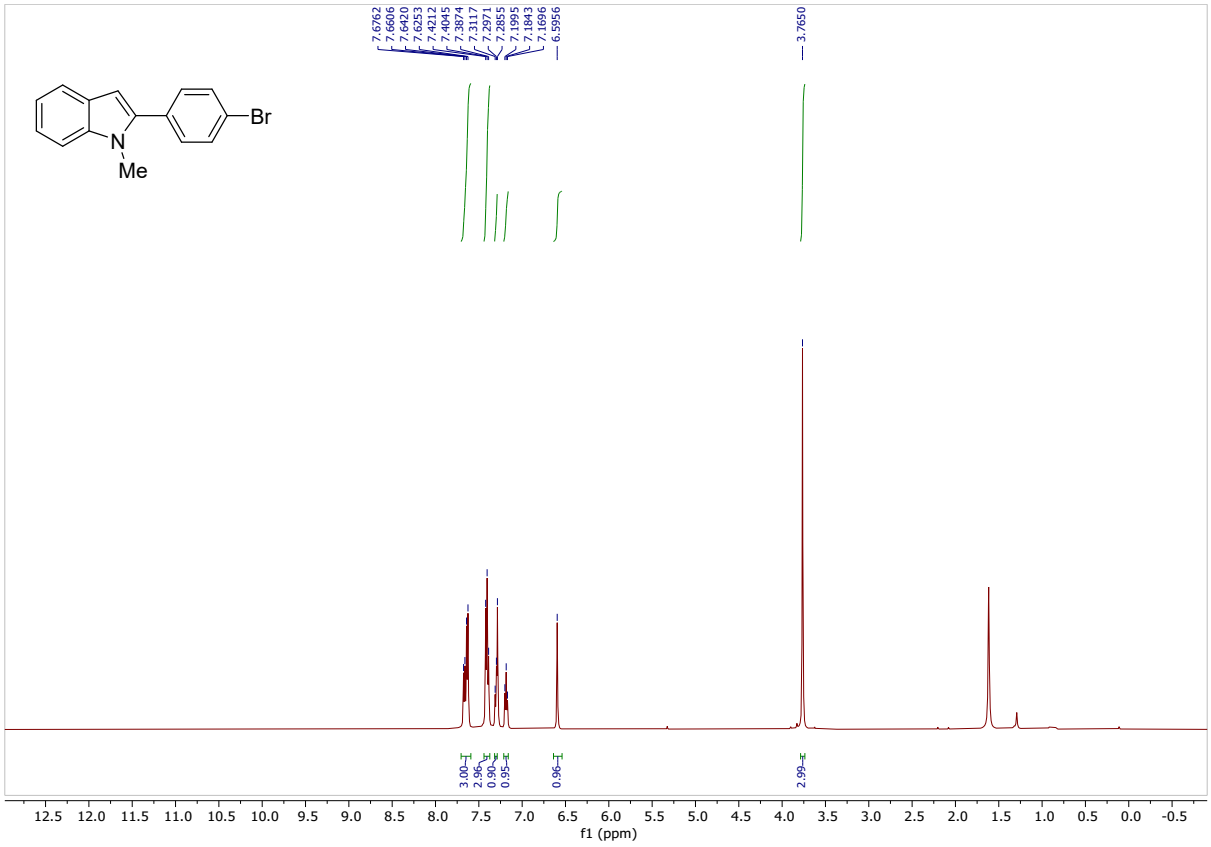


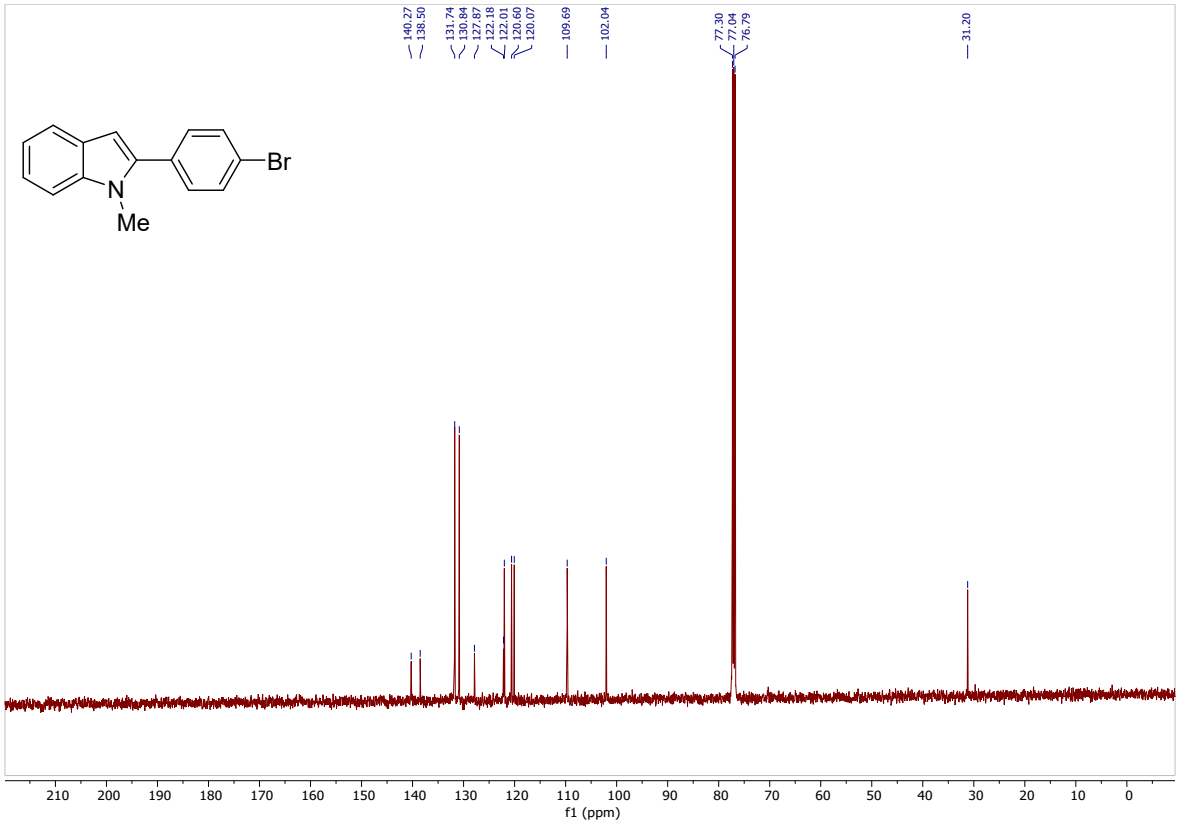
^{13}C NMR spectrum of compound **3d**, ($CDCl_3$, 125 MHz).



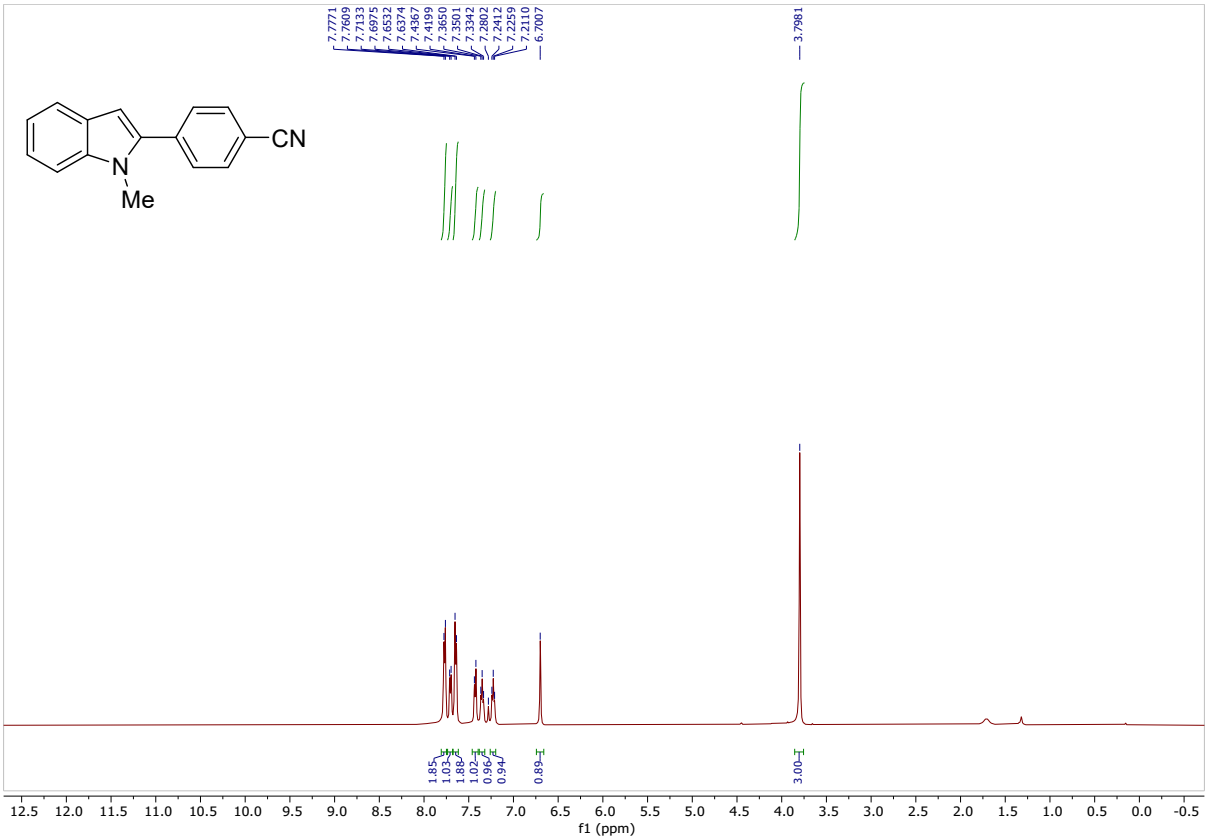
^{1}H NMR spectrum of compound **3e**, ($CDCl_3$, 500 MHz).



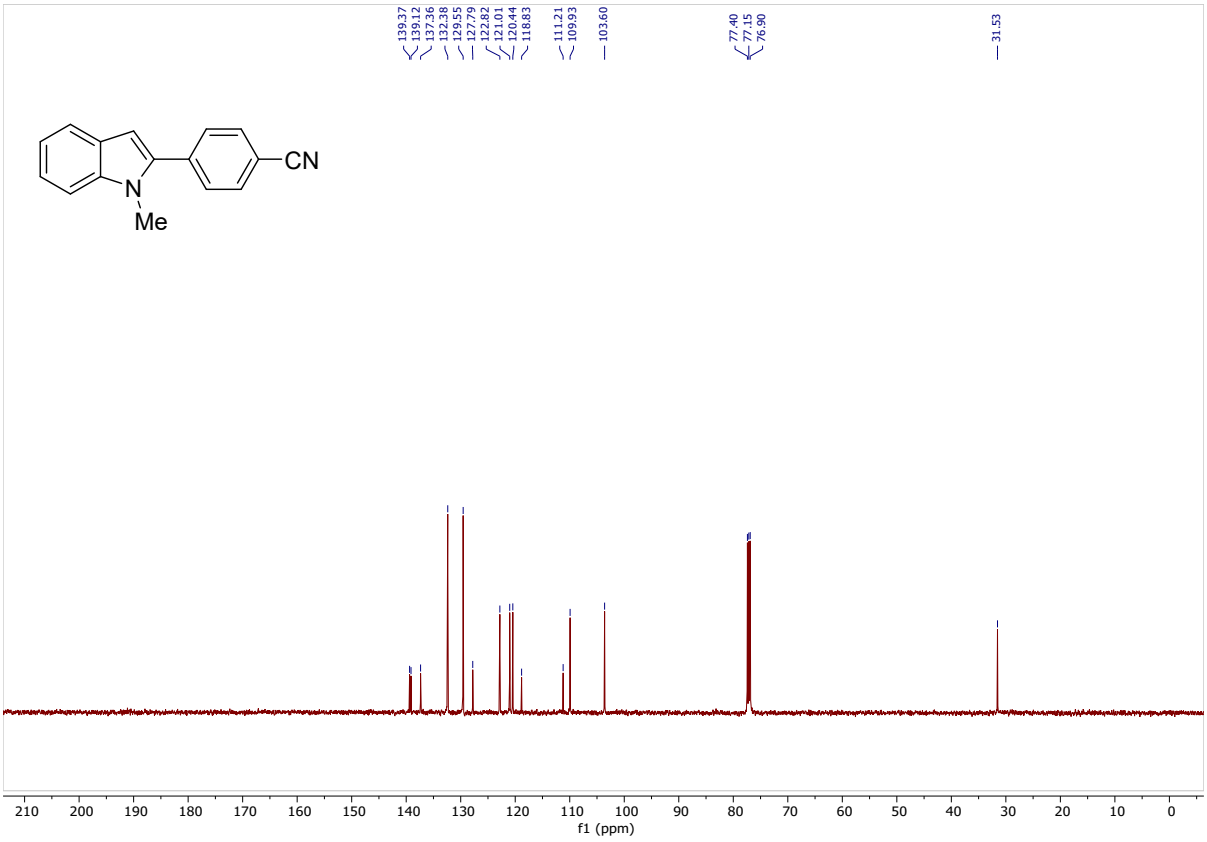
^{13}C NMR spectrum of compound **3e**, ($CDCl_3$, 125 MHz).



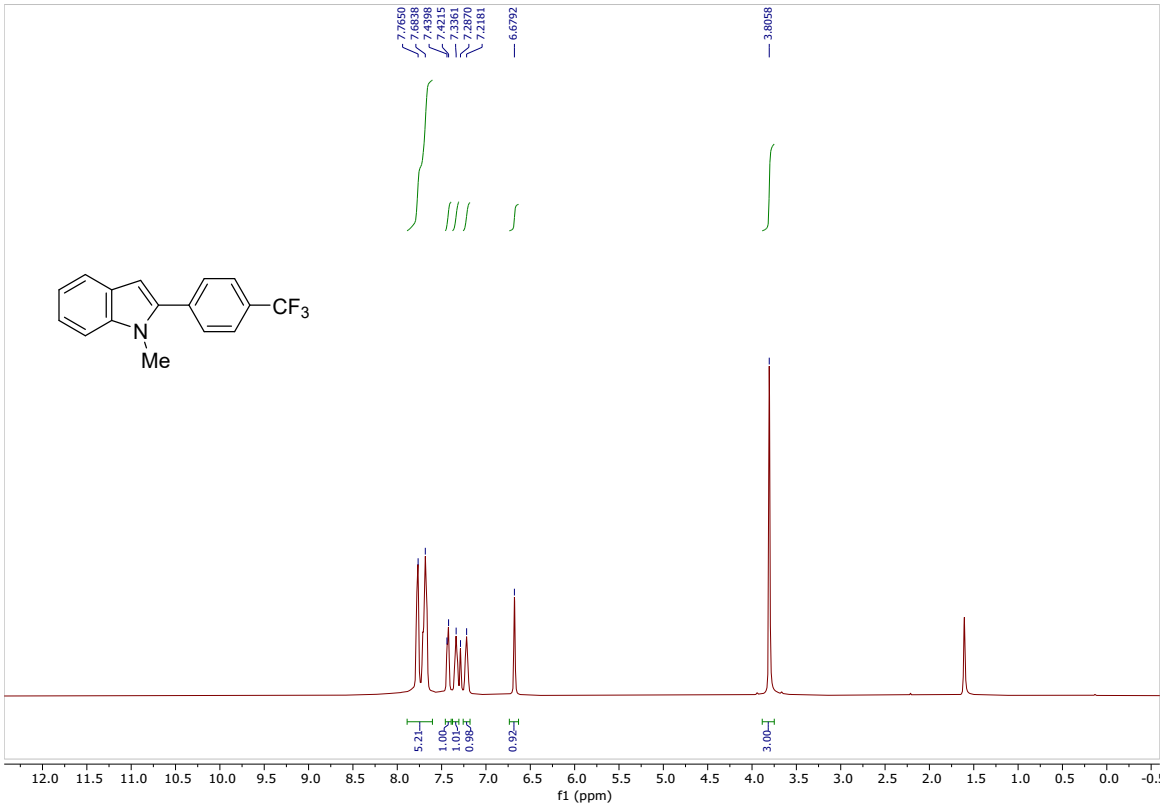
^{1}H NMR spectrum of compound **3f**, ($CDCl_3$, 500 MHz).



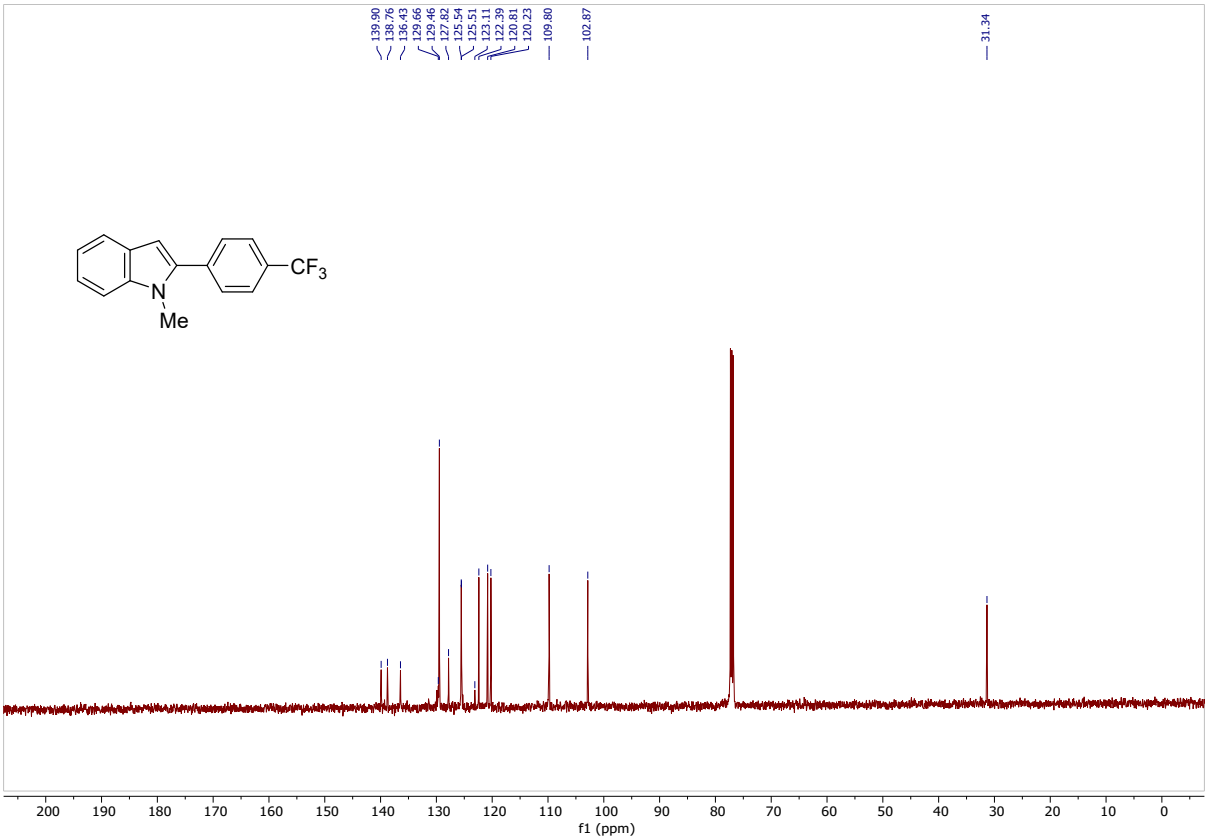
^{13}C NMR spectrum of compound **3f**, ($CDCl_3$, 125 MHz).



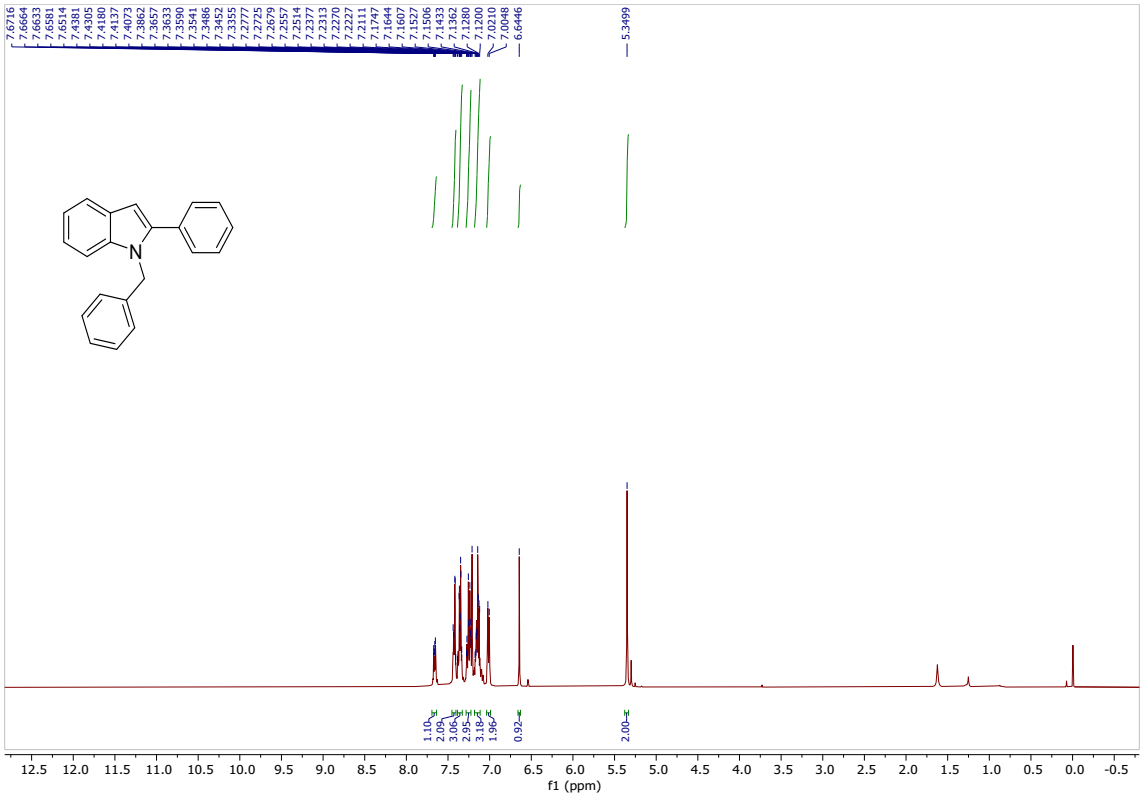
^{1}H NMR spectrum of compound **3g**, ($CDCl_3$, 500 MHz).



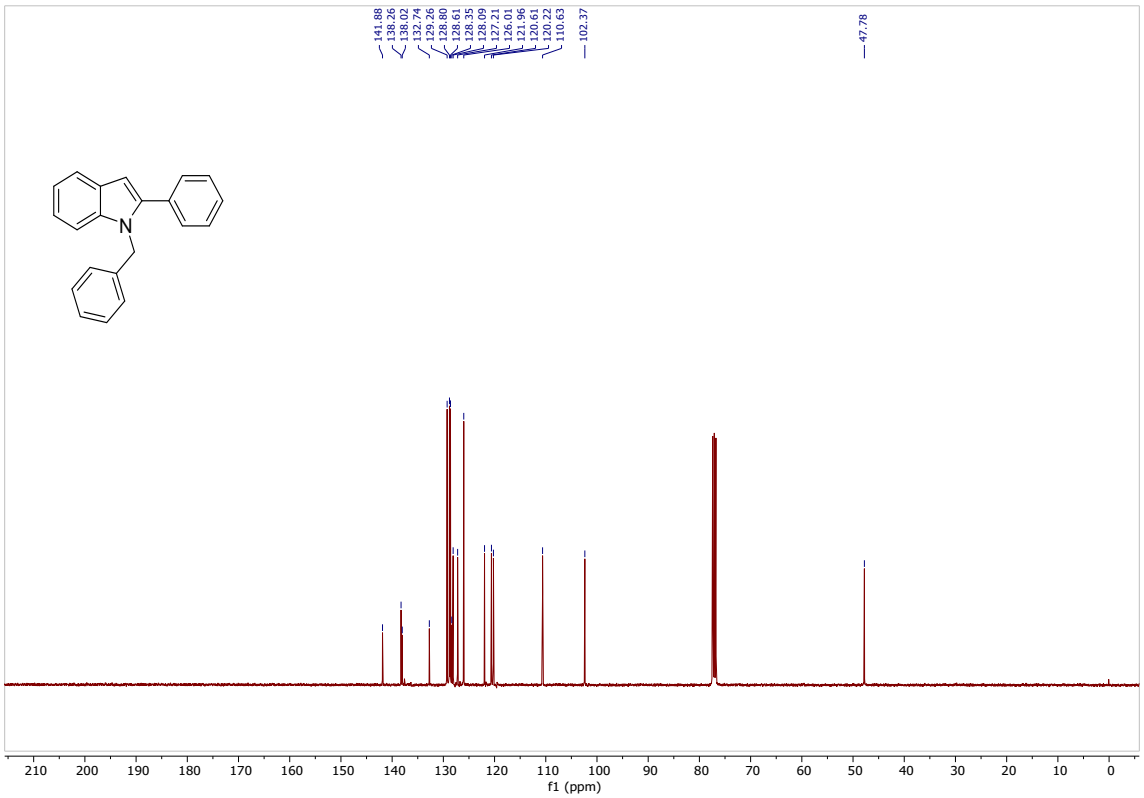
^{13}C NMR spectrum of compound **3g**, ($CDCl_3$, 125 MHz).



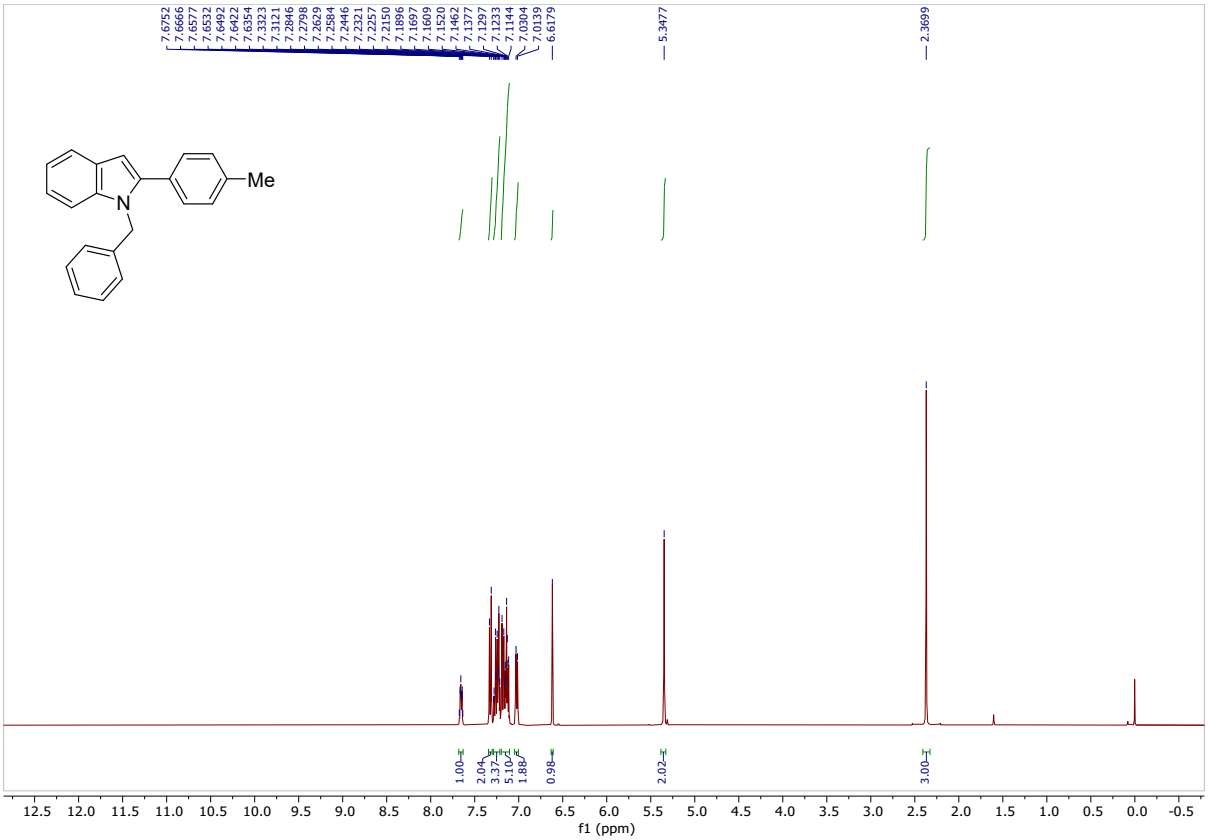
^{1}H NMR spectrum of compound **3h**, ($CDCl_3$, 500 MHz).



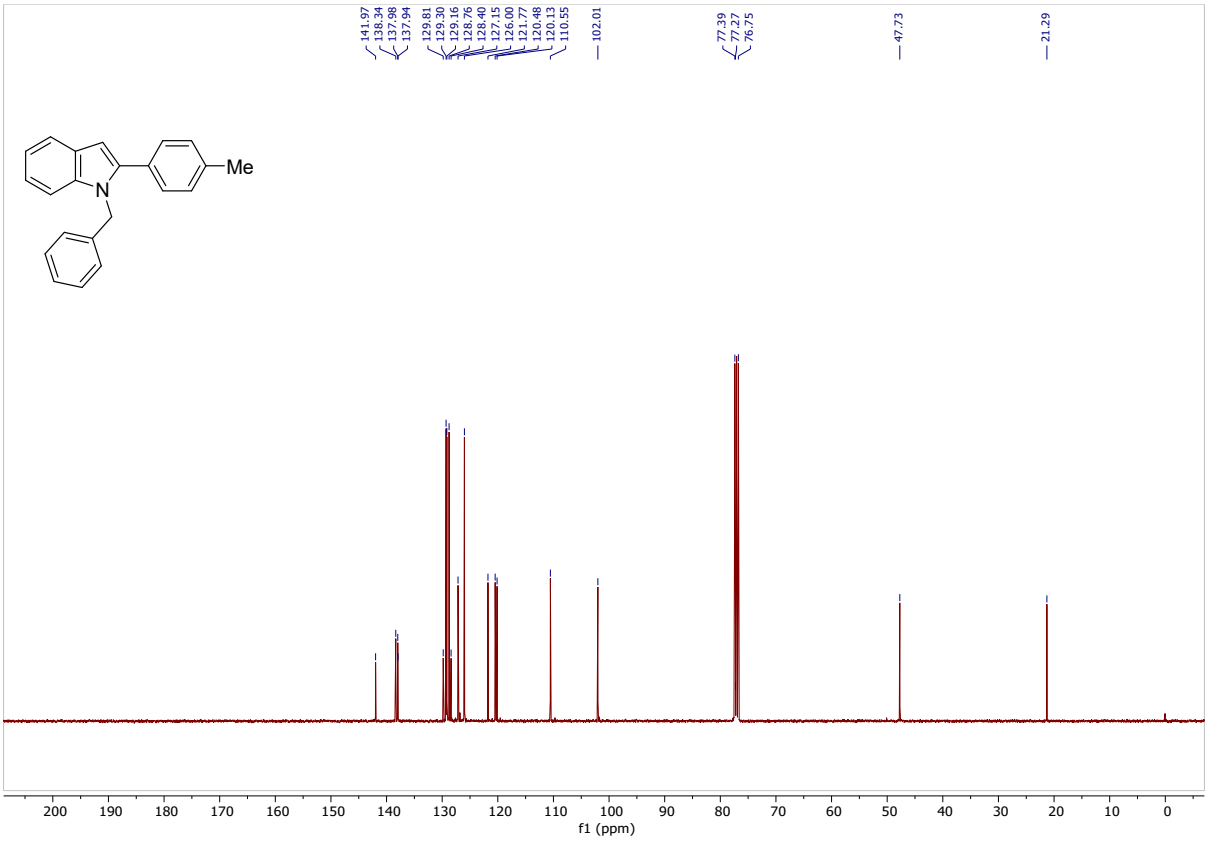
^{13}C NMR spectrum of compound **3h**, ($CDCl_3$, 125 MHz).



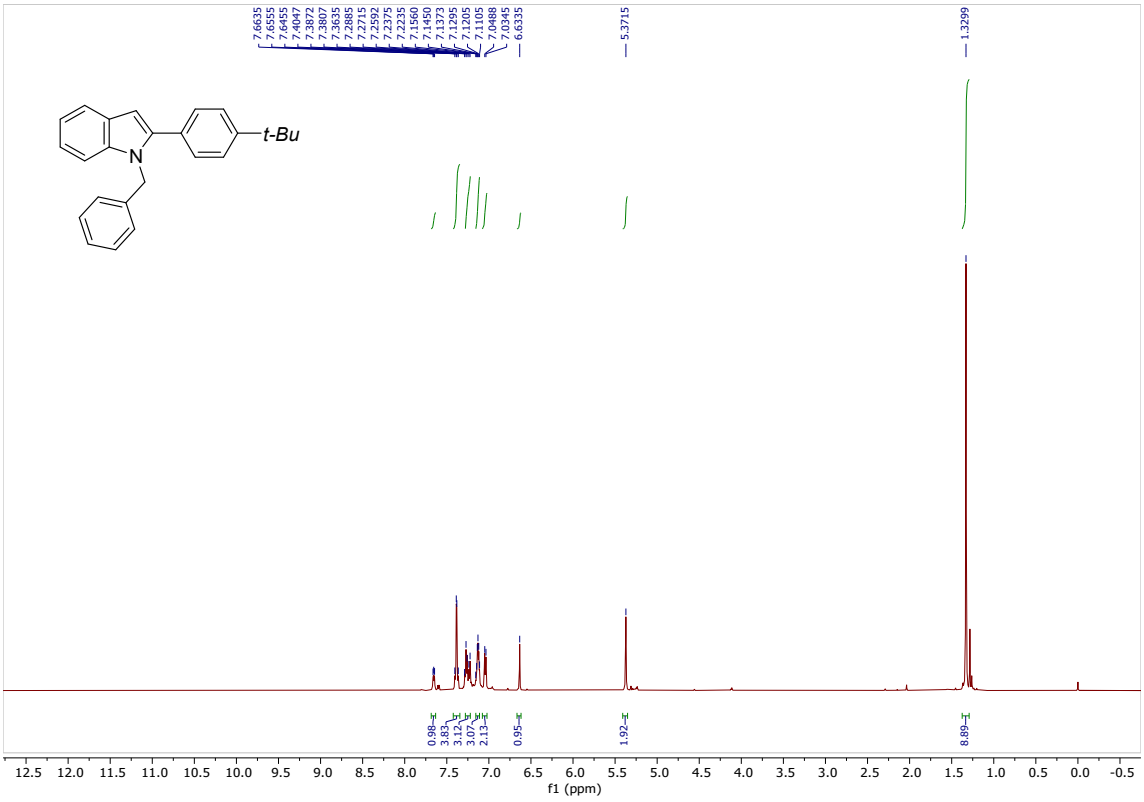
^{1}H NMR spectrum of compound **3i**, ($CDCl_3$, 500 MHz).



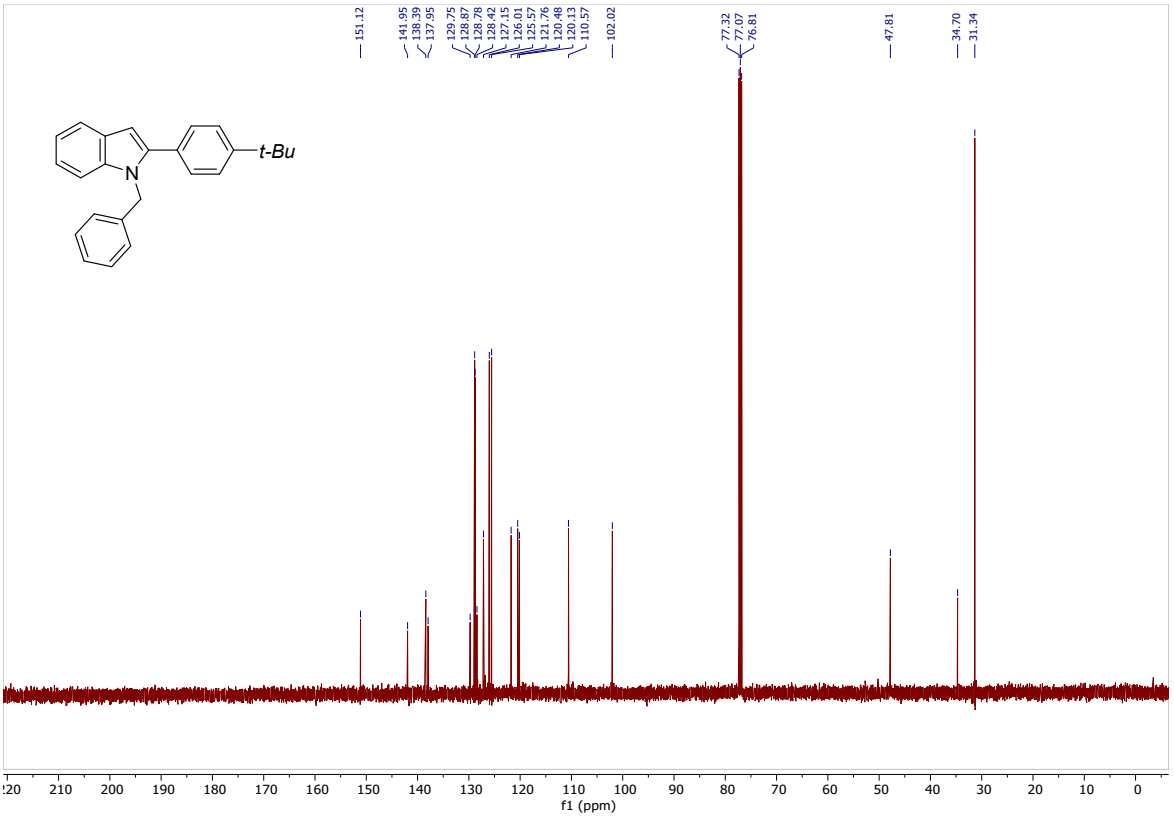
^{13}C NMR spectrum of compound **3i**, ($CDCl_3$, 125 MHz).



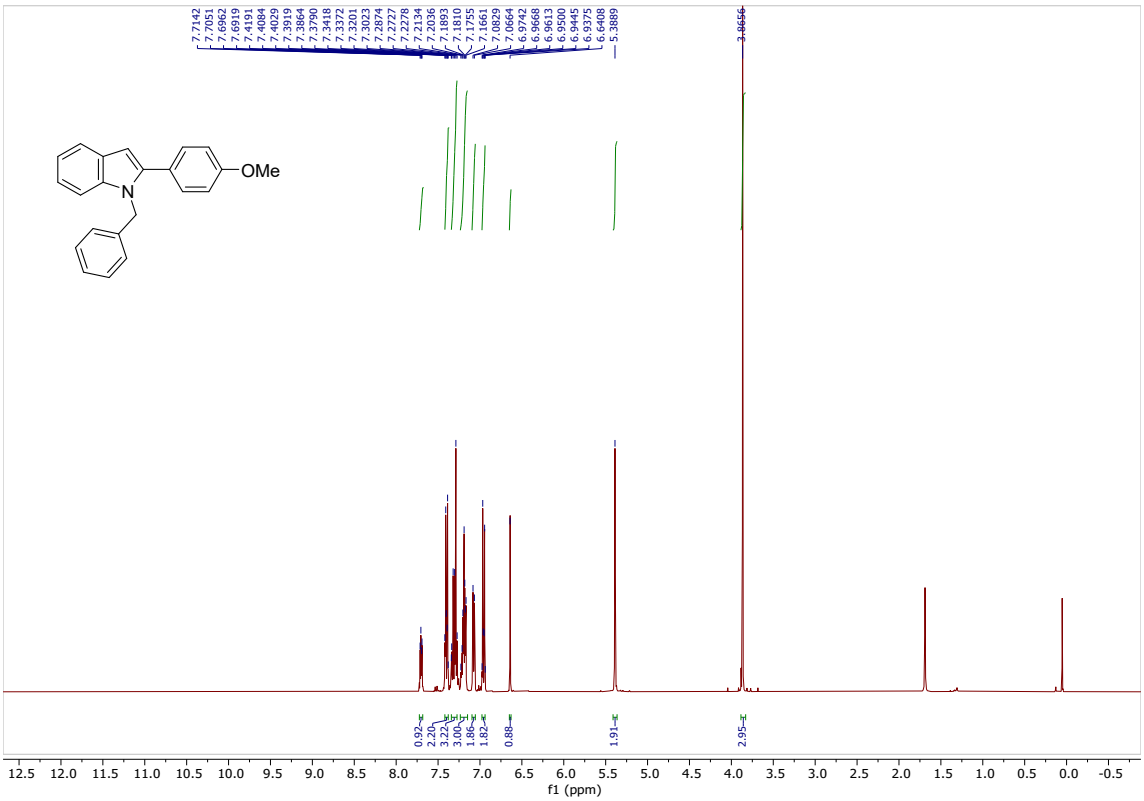
^{1}H NMR spectrum of compound **3j**, ($CDCl_3$, 500 MHz).



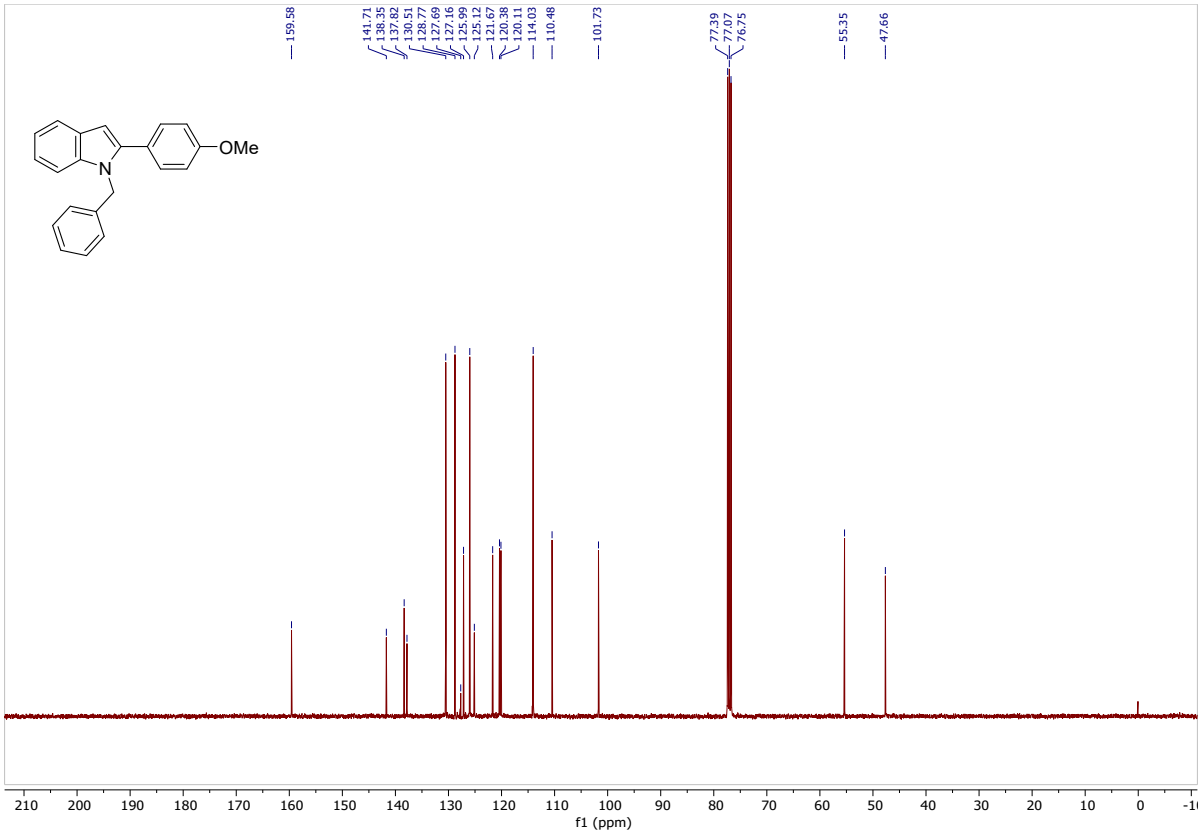
^{13}C NMR spectrum of compound **3j**, ($CDCl_3$, 125 MHz).



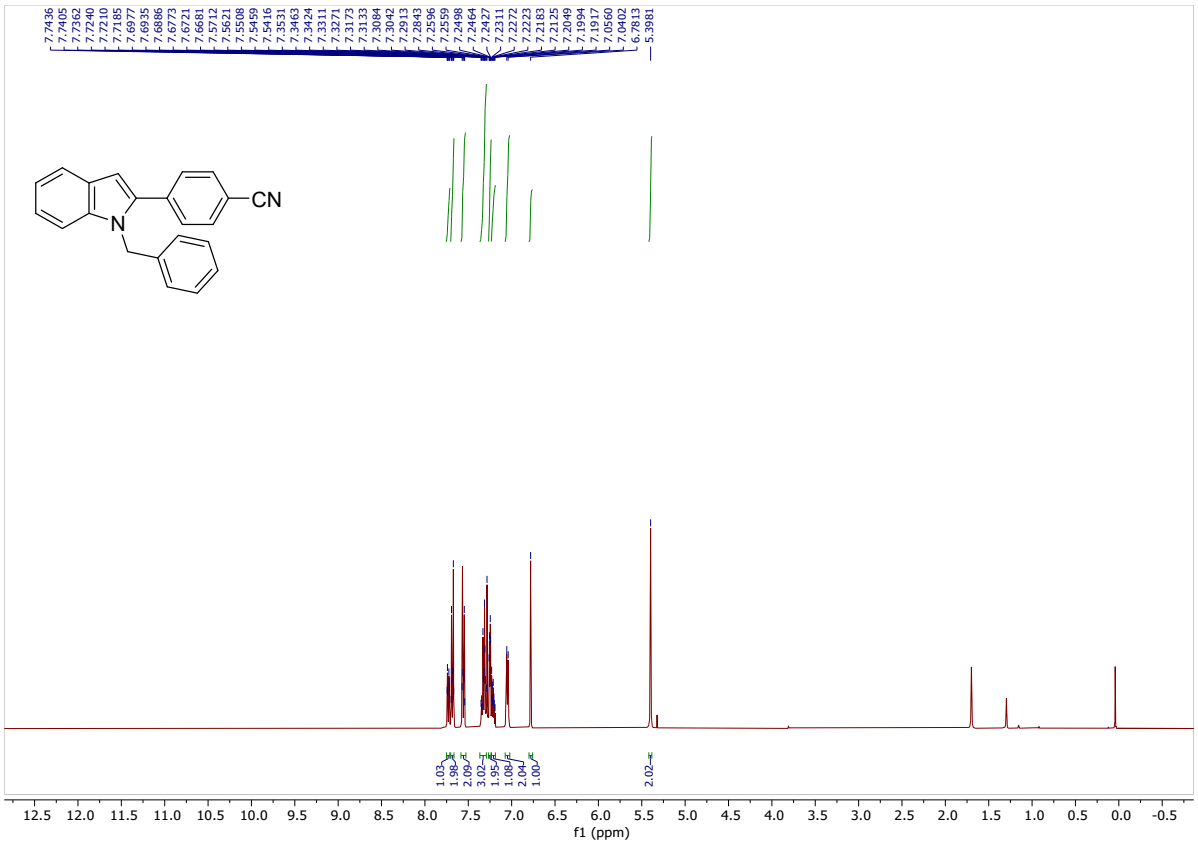
^{1}H NMR spectrum of compound **3k**, ($CDCl_3$, 500 MHz).



^{13}C NMR spectrum of compound **3k**, ($CDCl_3$, 125 MHz).



^{1}H NMR spectrum of compound **3l**, ($CDCl_3$, 500 MHz).



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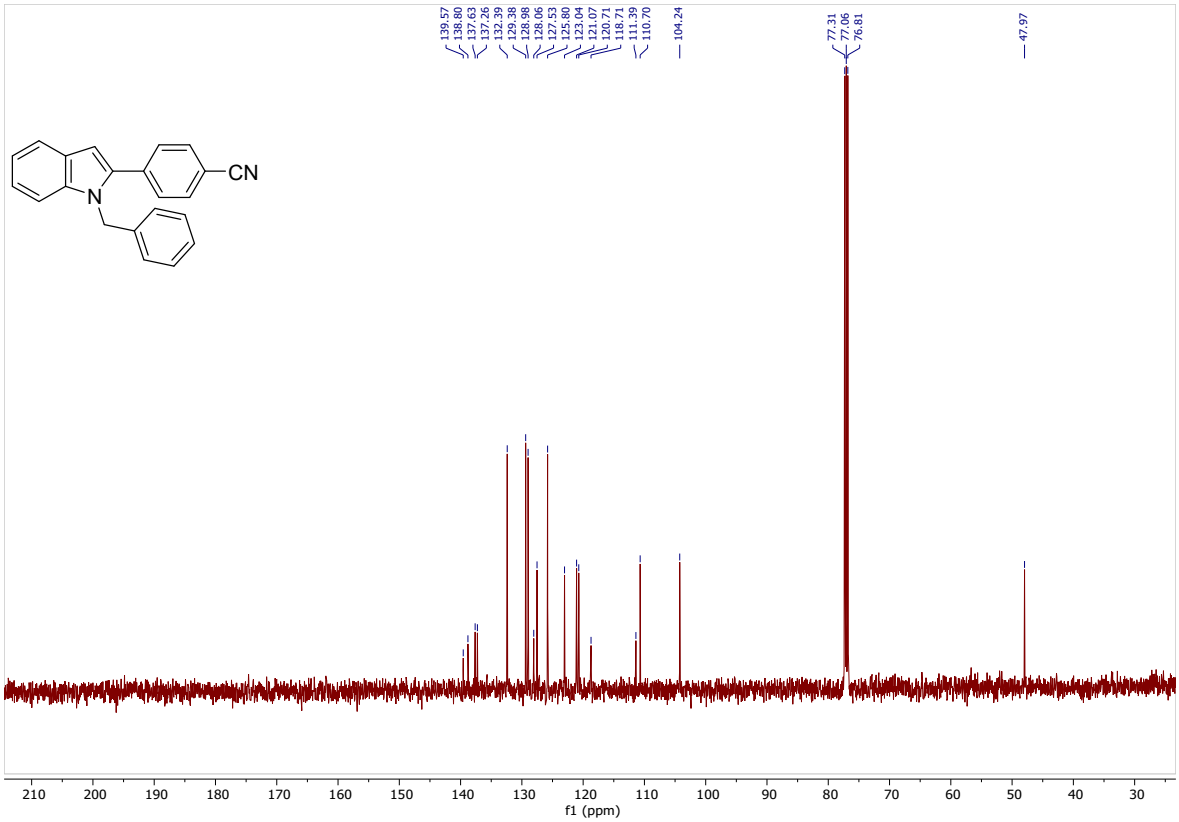

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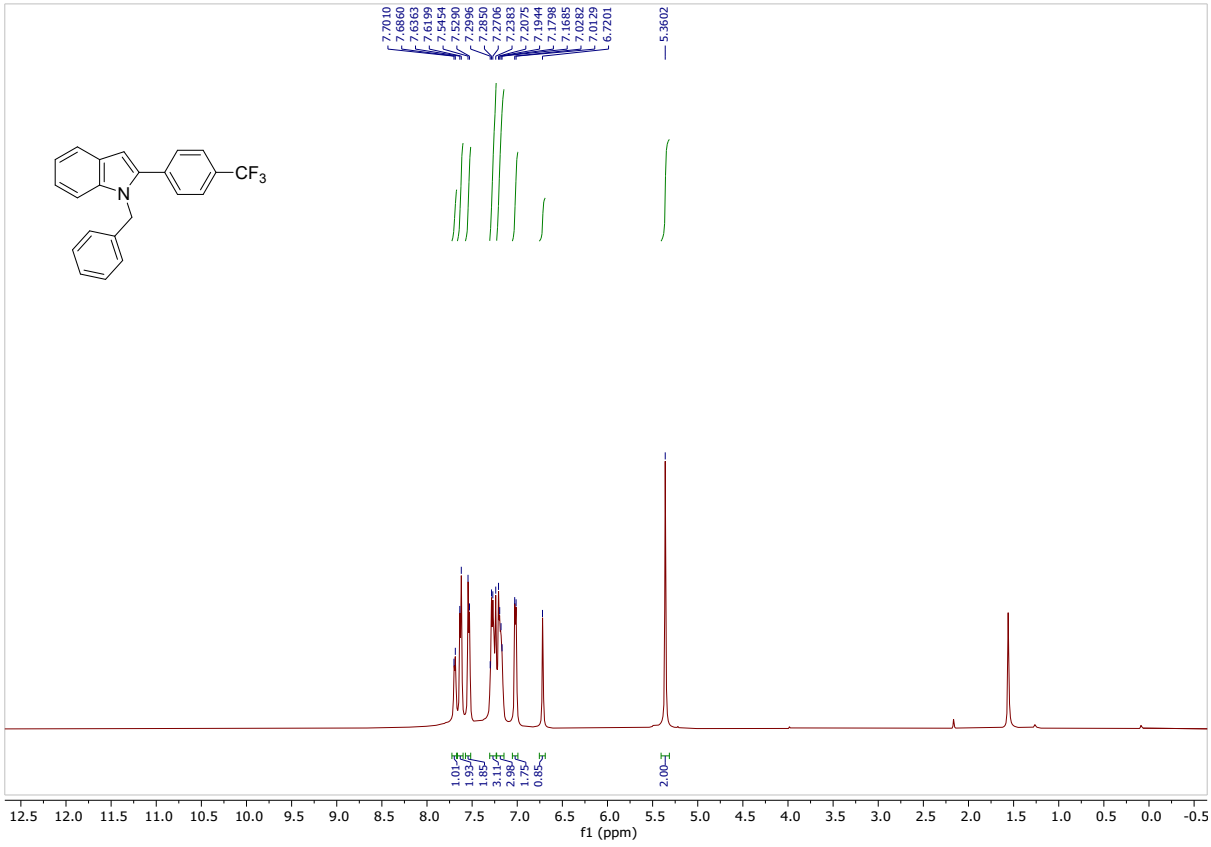
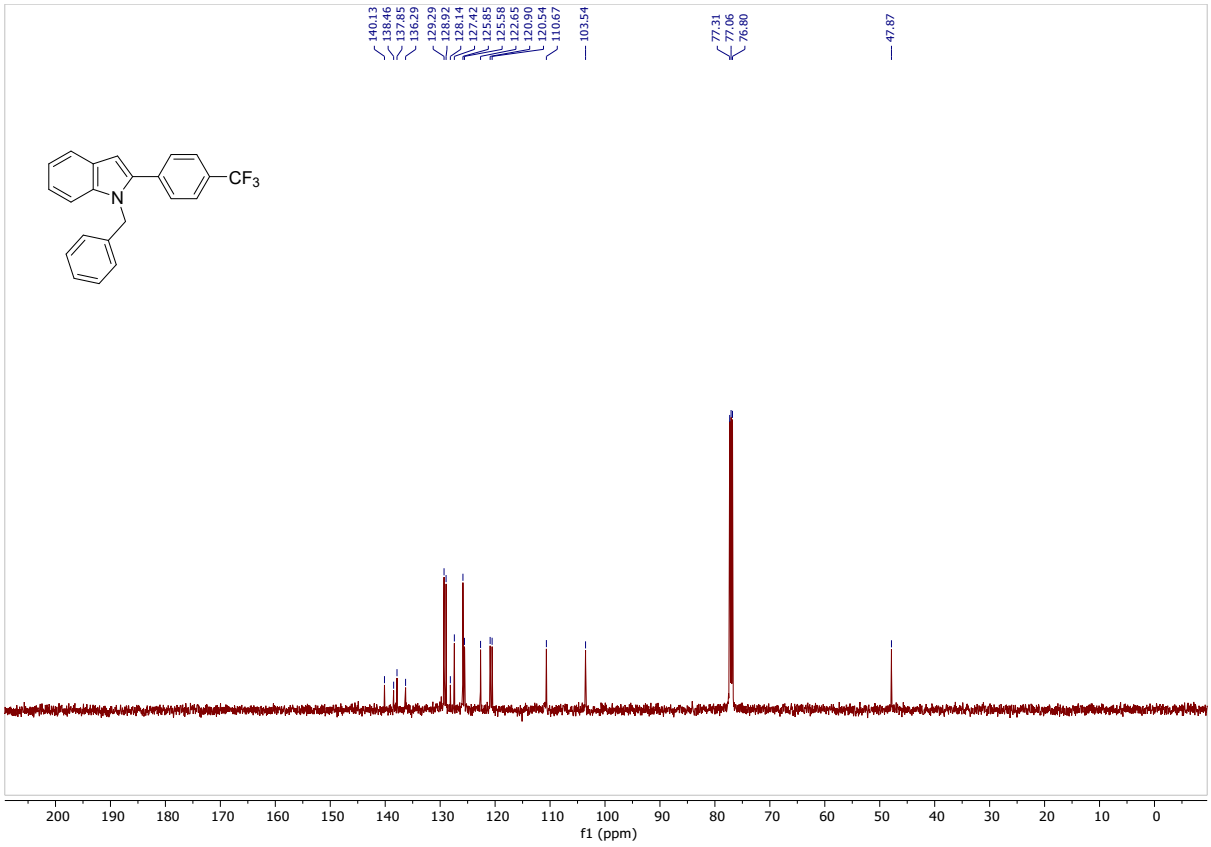
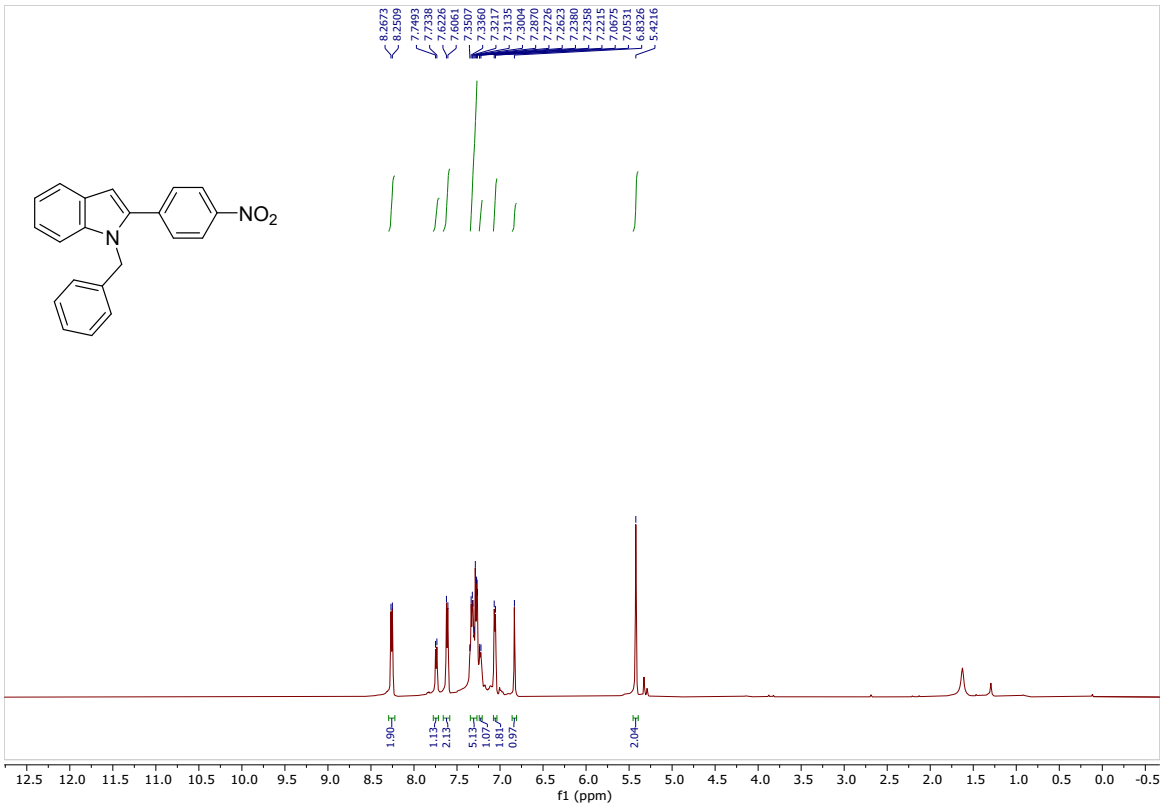


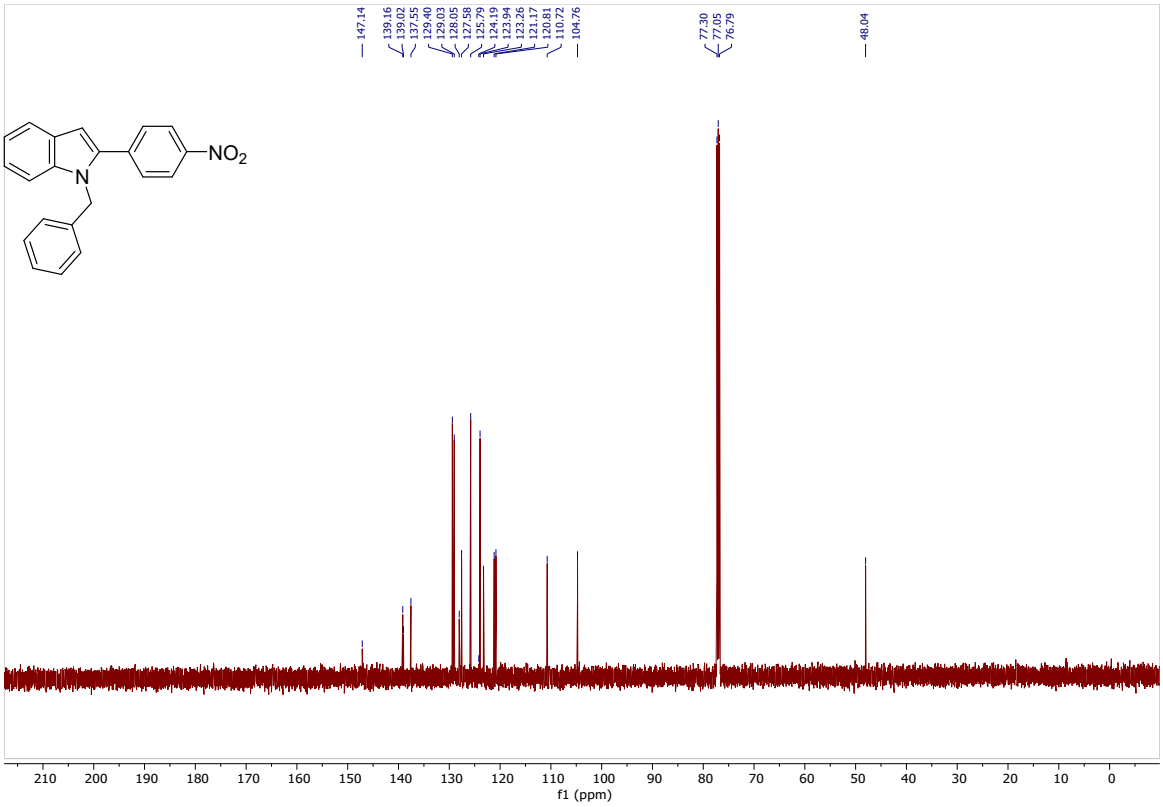
^{13}C NMR spectrum of compound **3m**, ($CDCl_3$, 125 MHz).



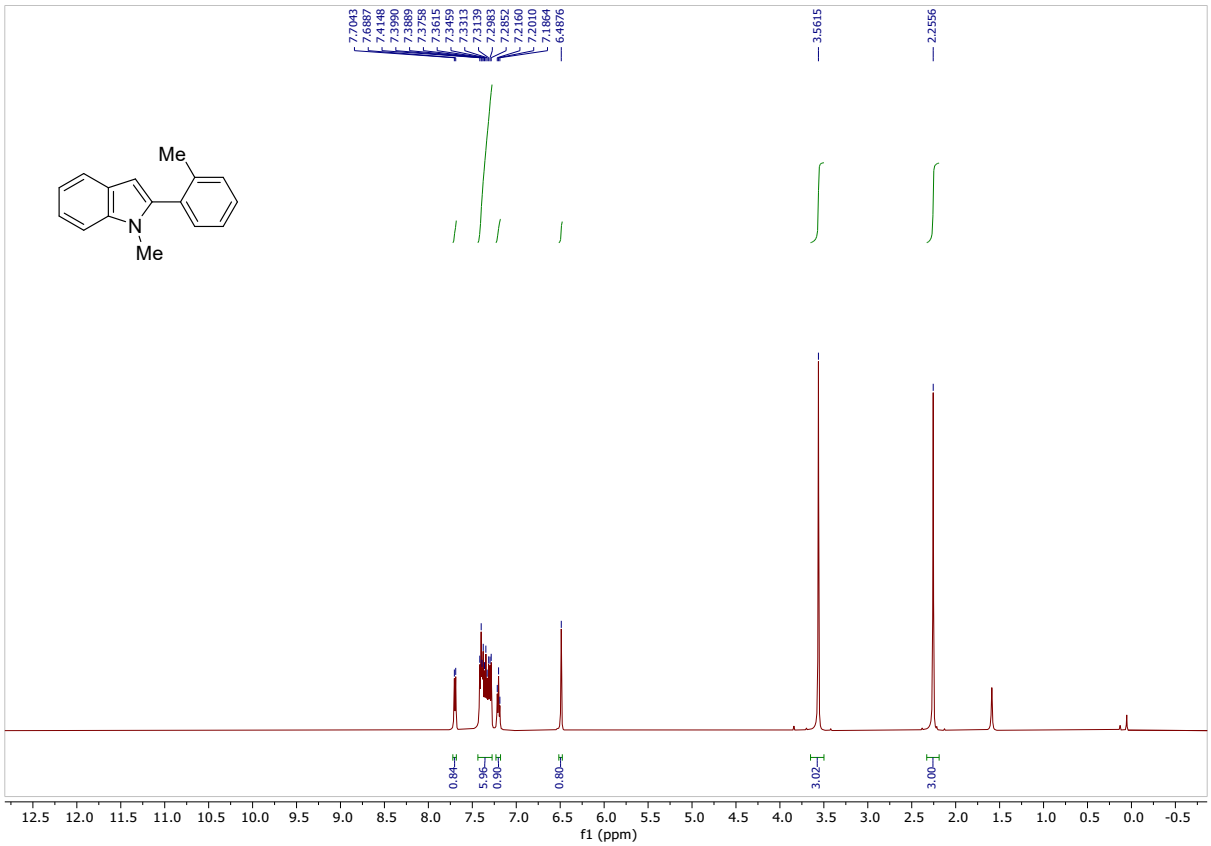
^{1}H NMR spectrum of compound **3n**, ($CDCl_3$, 500 MHz).



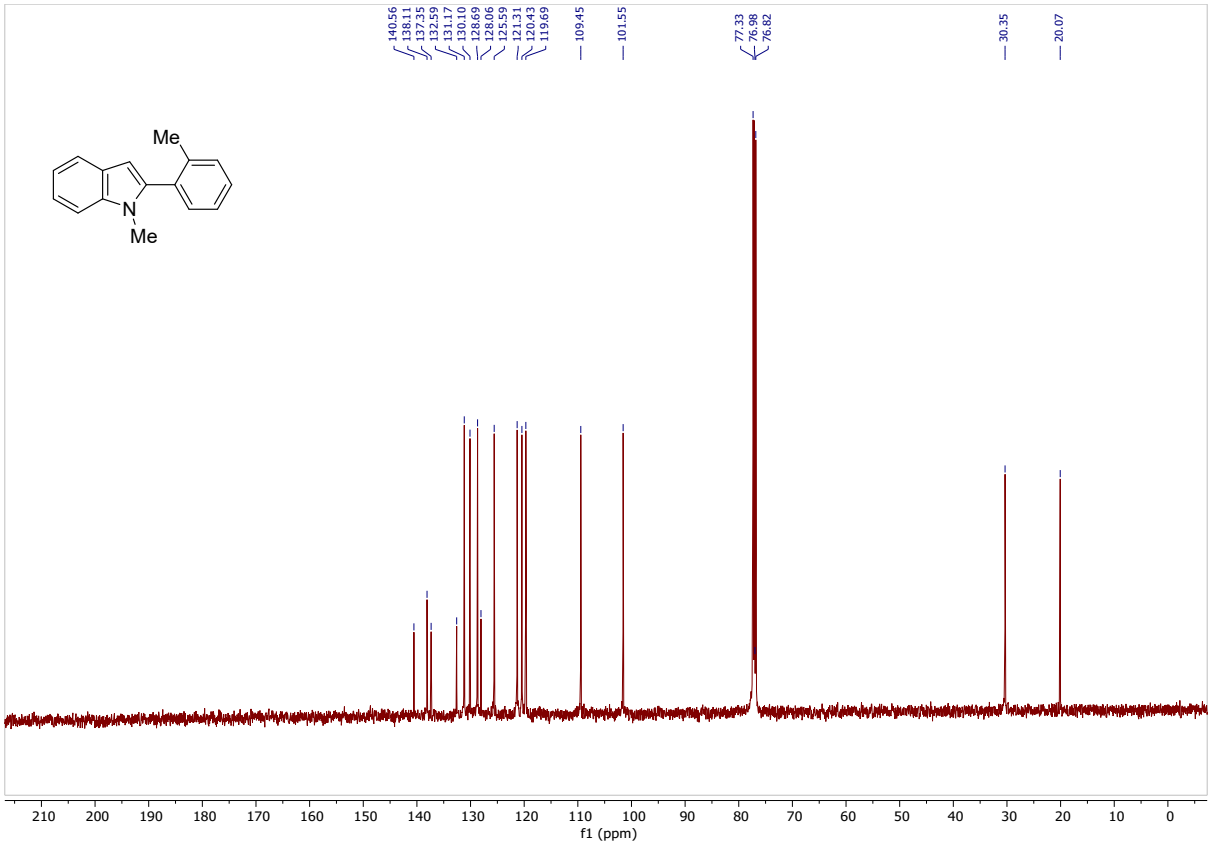
^{13}C NMR spectrum of compound **3n**, ($CDCl_3$, 125 MHz).



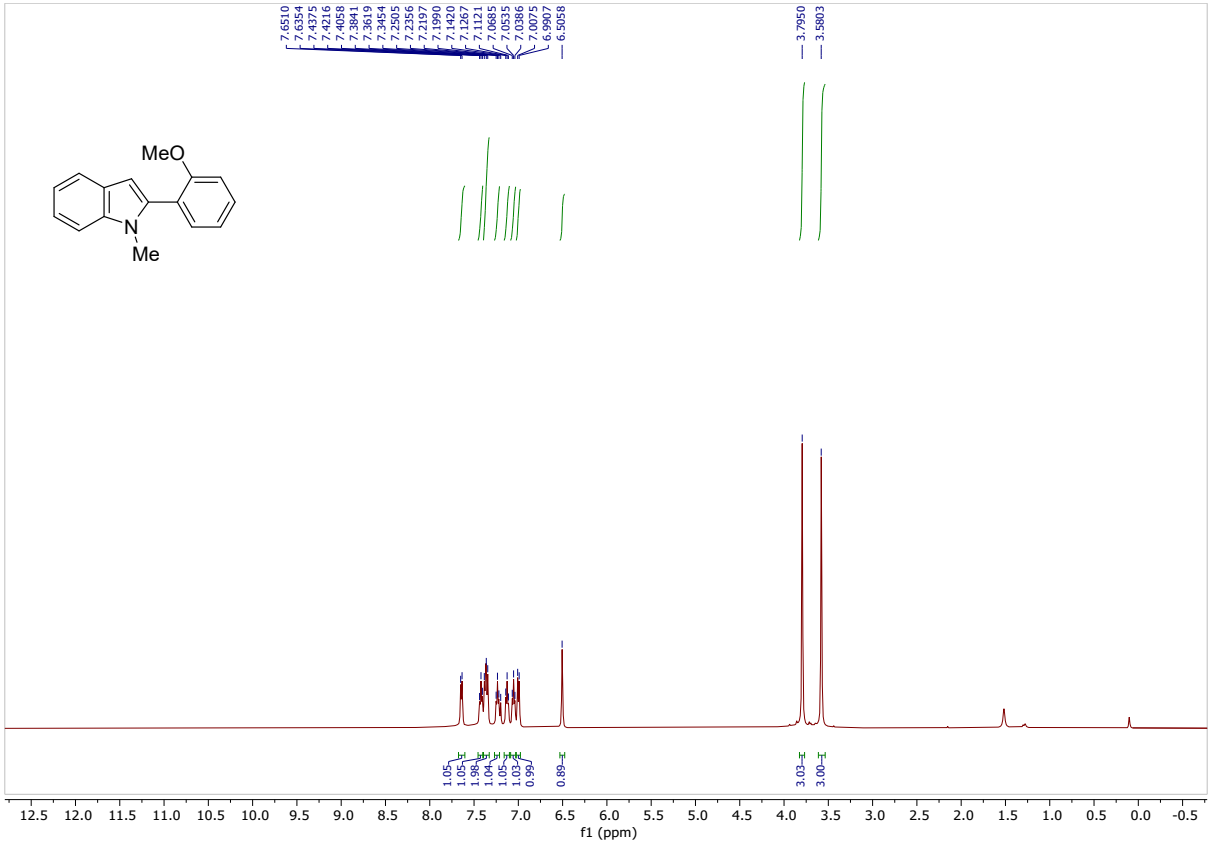
^{1}H NMR spectrum of compound **3o**, ($CDCl_3$, 500 MHz).



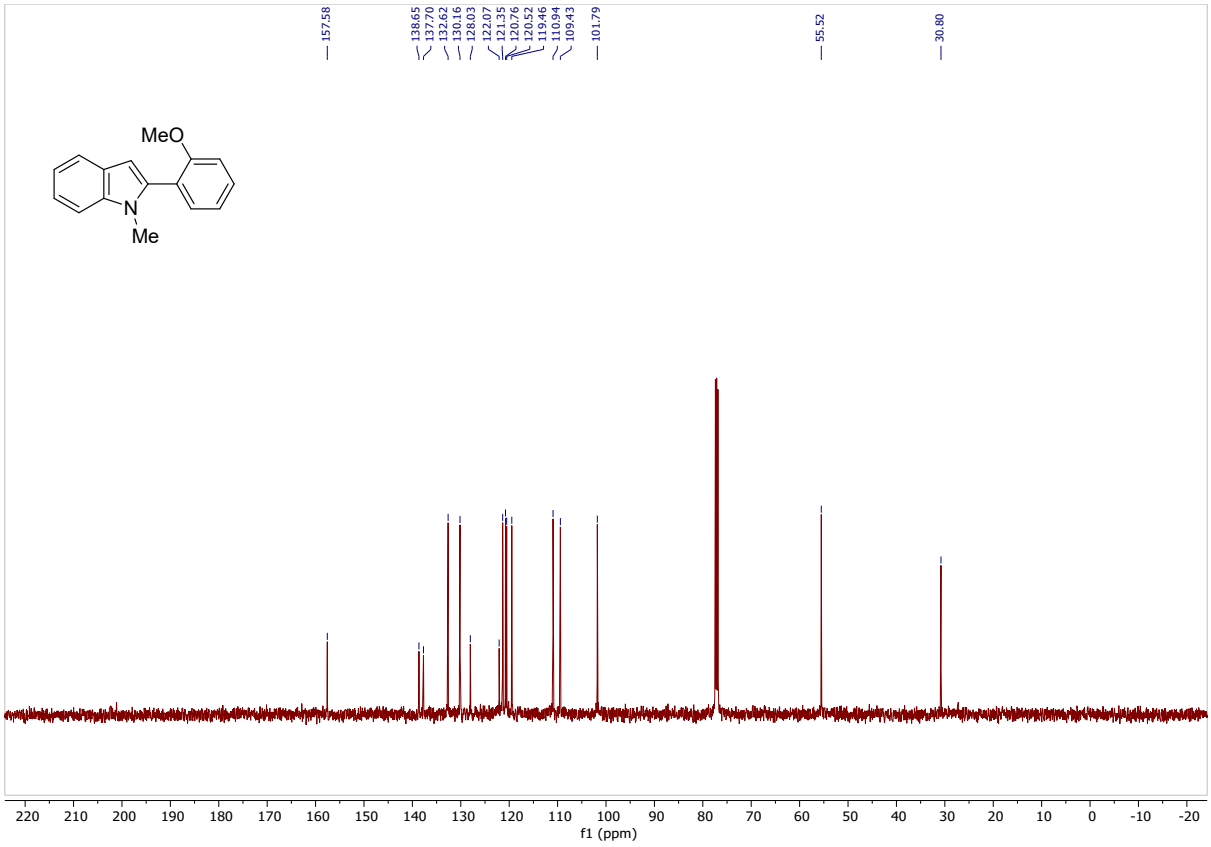
^{13}C NMR spectrum of compound **3o**, ($CDCl_3$, 125 MHz).



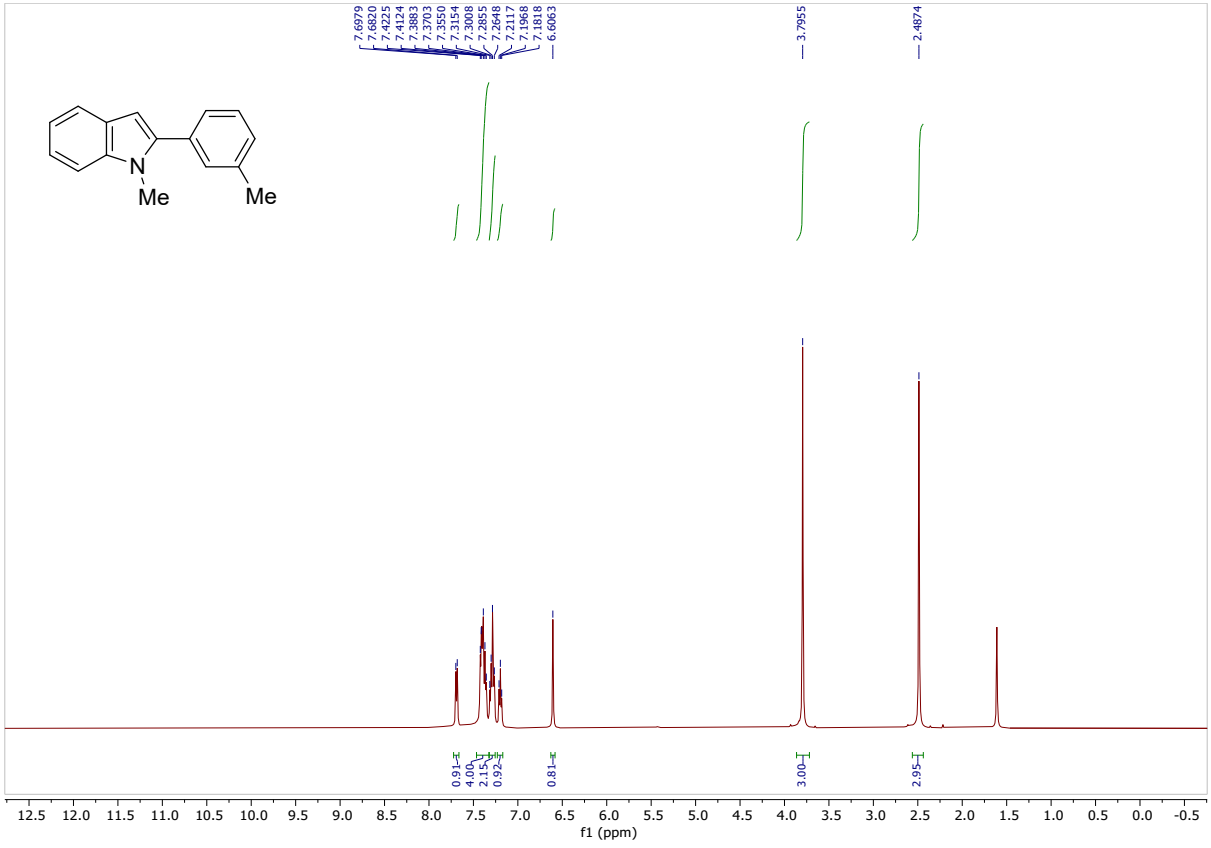
^{1}H NMR spectrum of compound **3p**, ($CDCl_3$, 500 MHz).



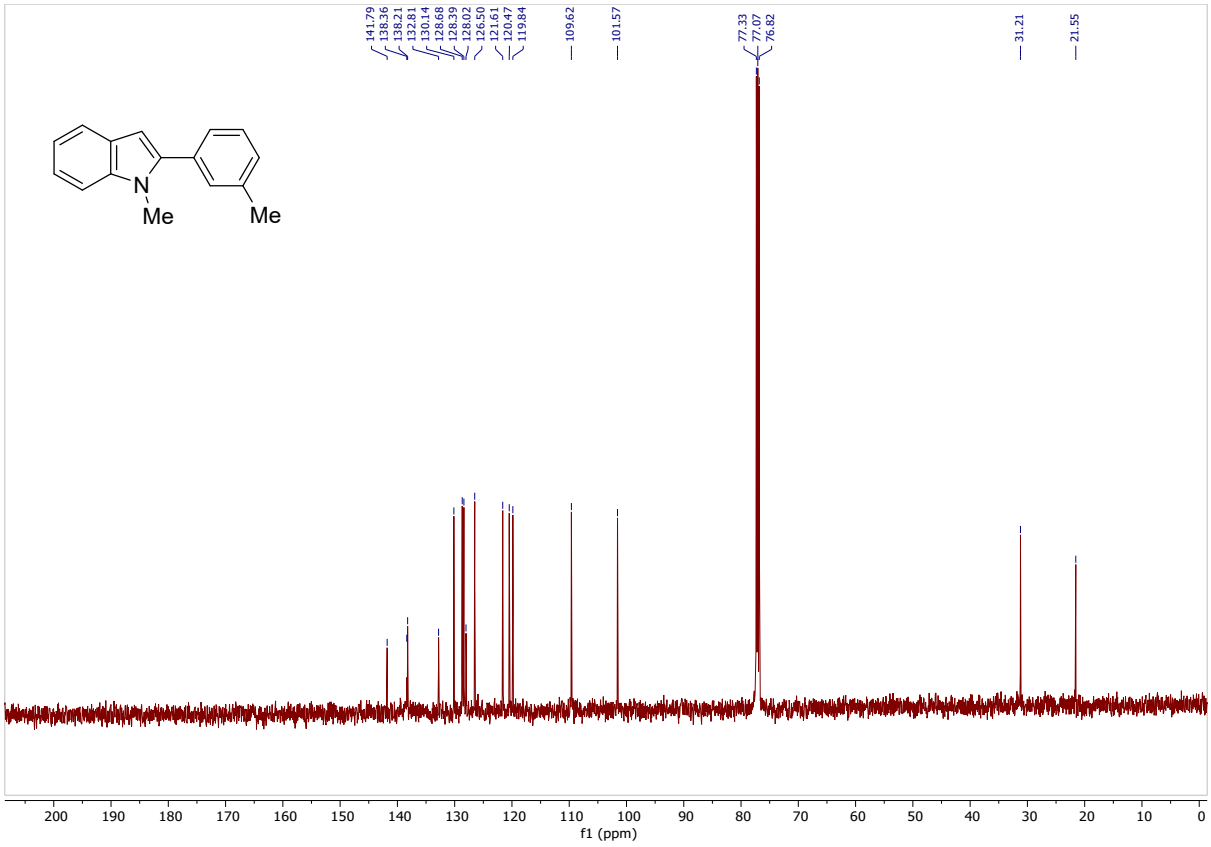
^{13}C NMR spectrum of compound **3p**, ($CDCl_3$, 125 MHz).



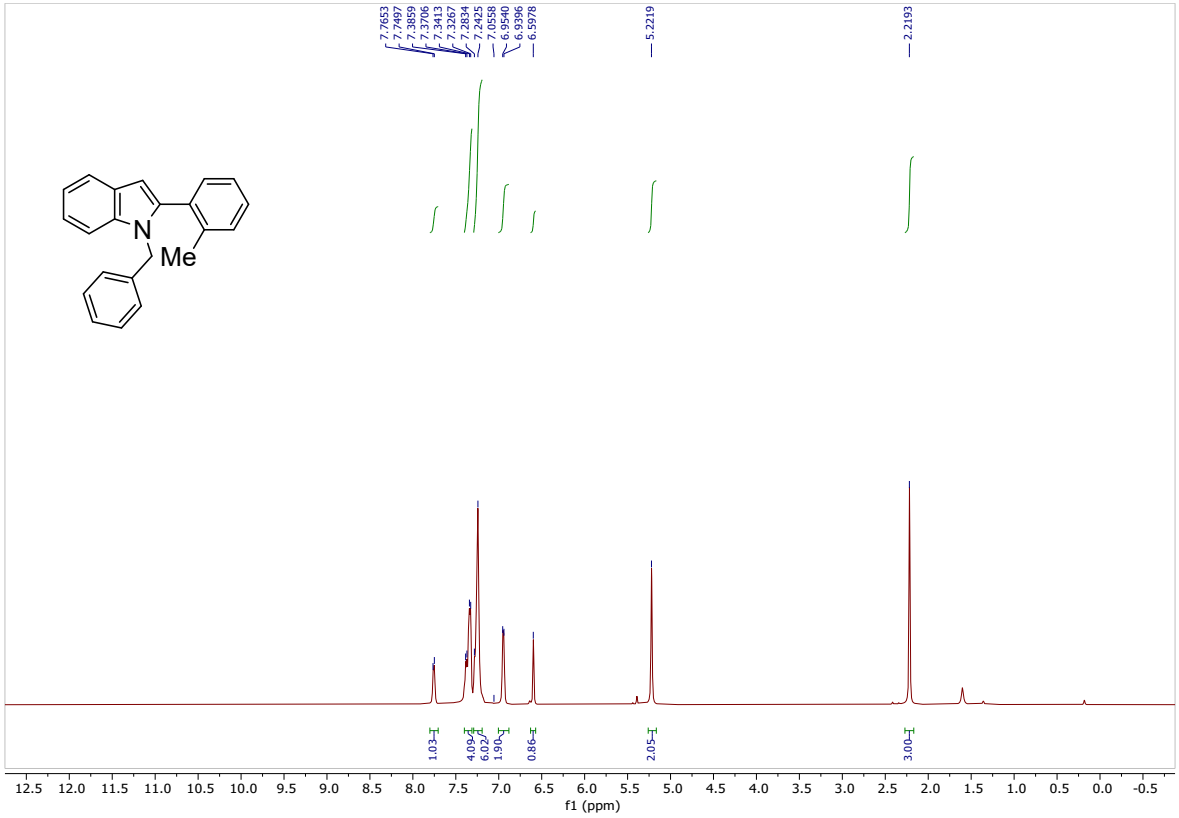
^{1}H NMR spectrum of compound **3q**, ($CDCl_3$, 500 MHz).



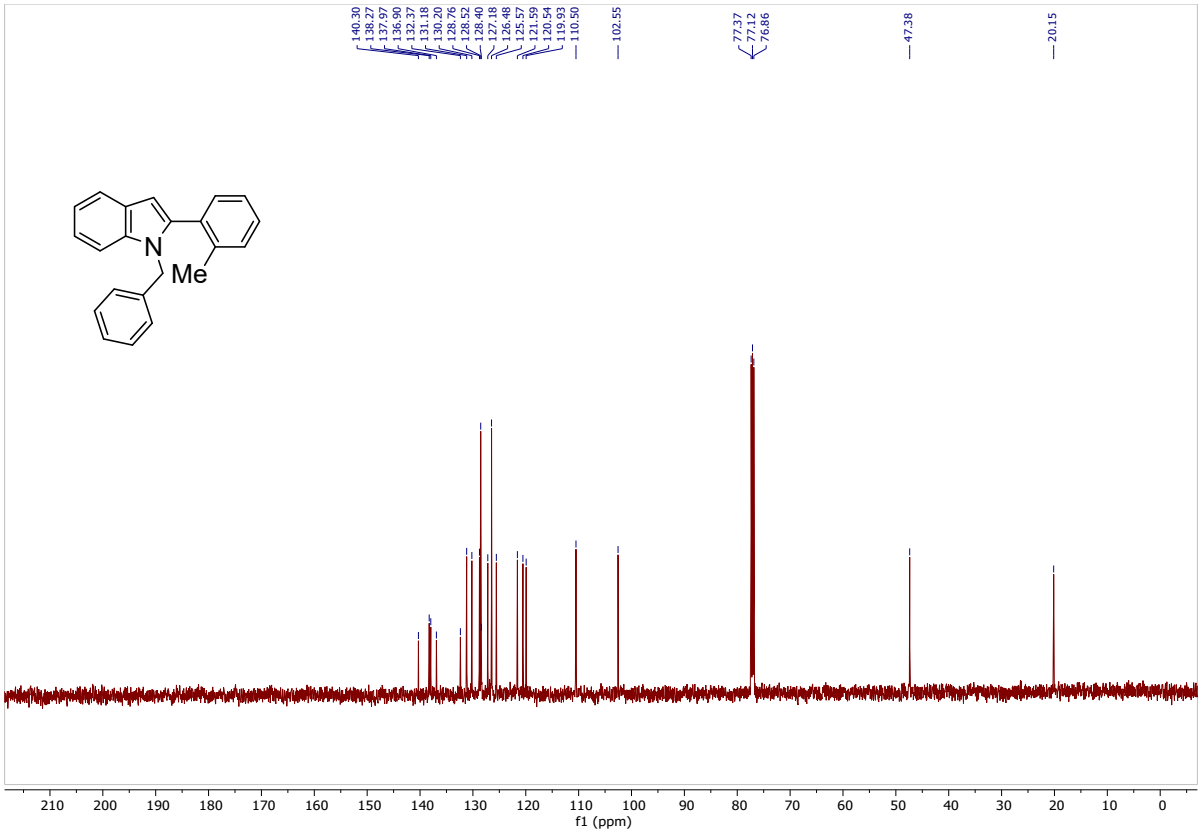
^{13}C NMR spectrum of compound **3q**, ($CDCl_3$, 125 MHz).



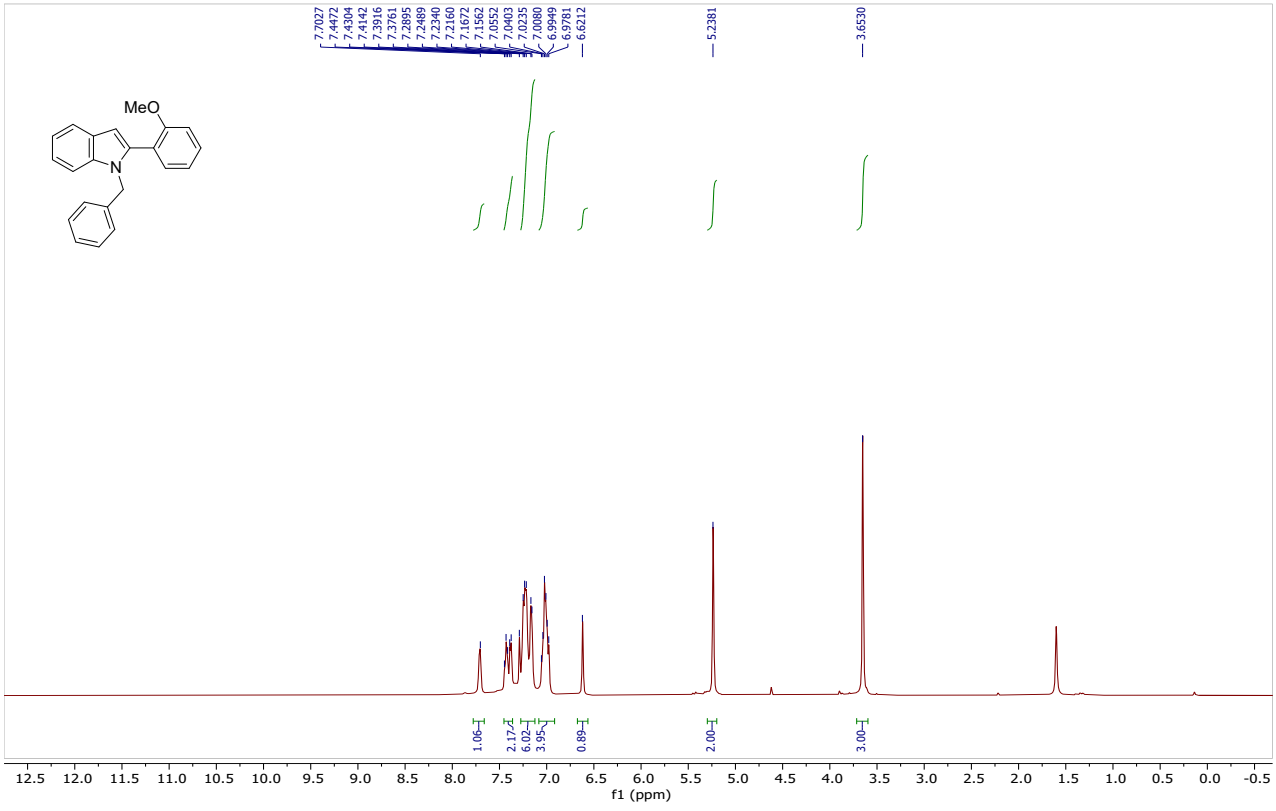
^{1}H NMR spectrum of compound **3r**, ($CDCl_3$, 500 MHz).



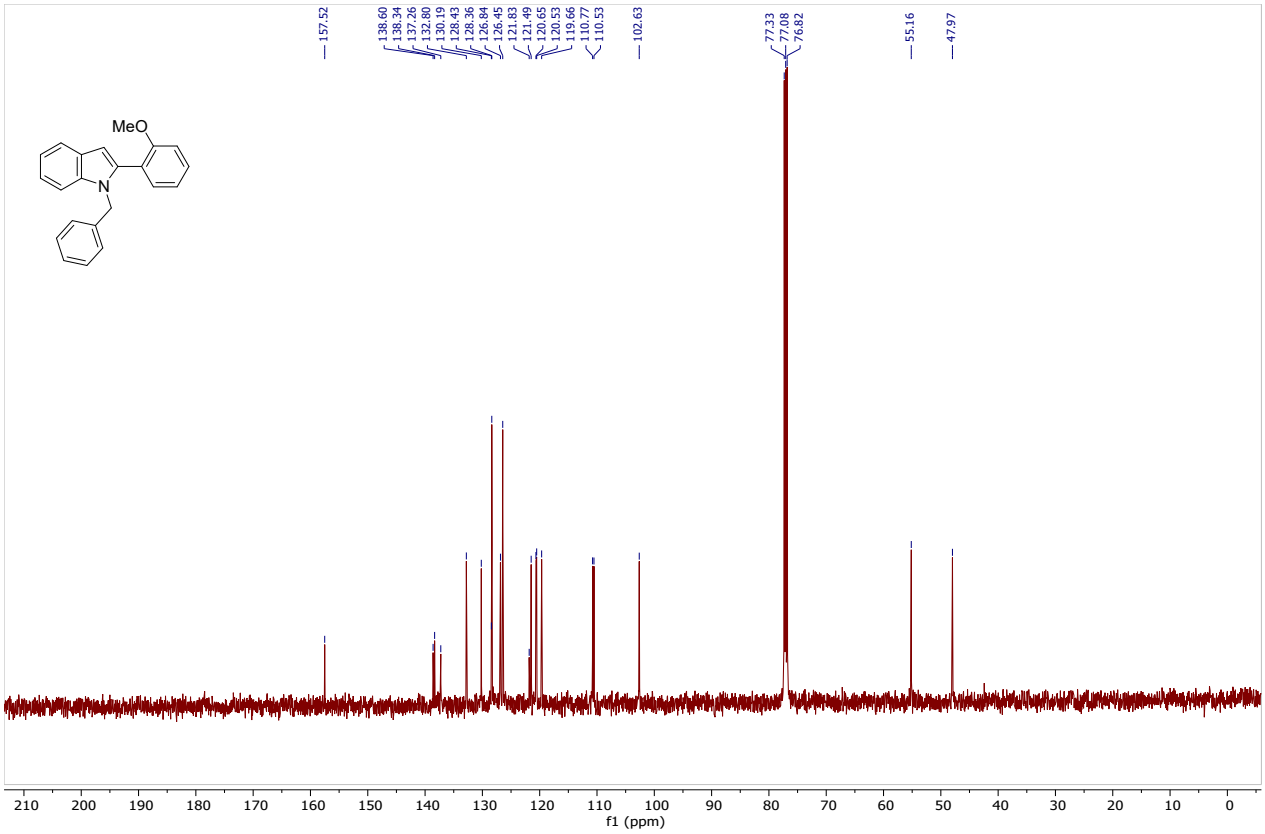
^{13}C NMR spectrum of compound **3r**, ($CDCl_3$, 125 MHz).



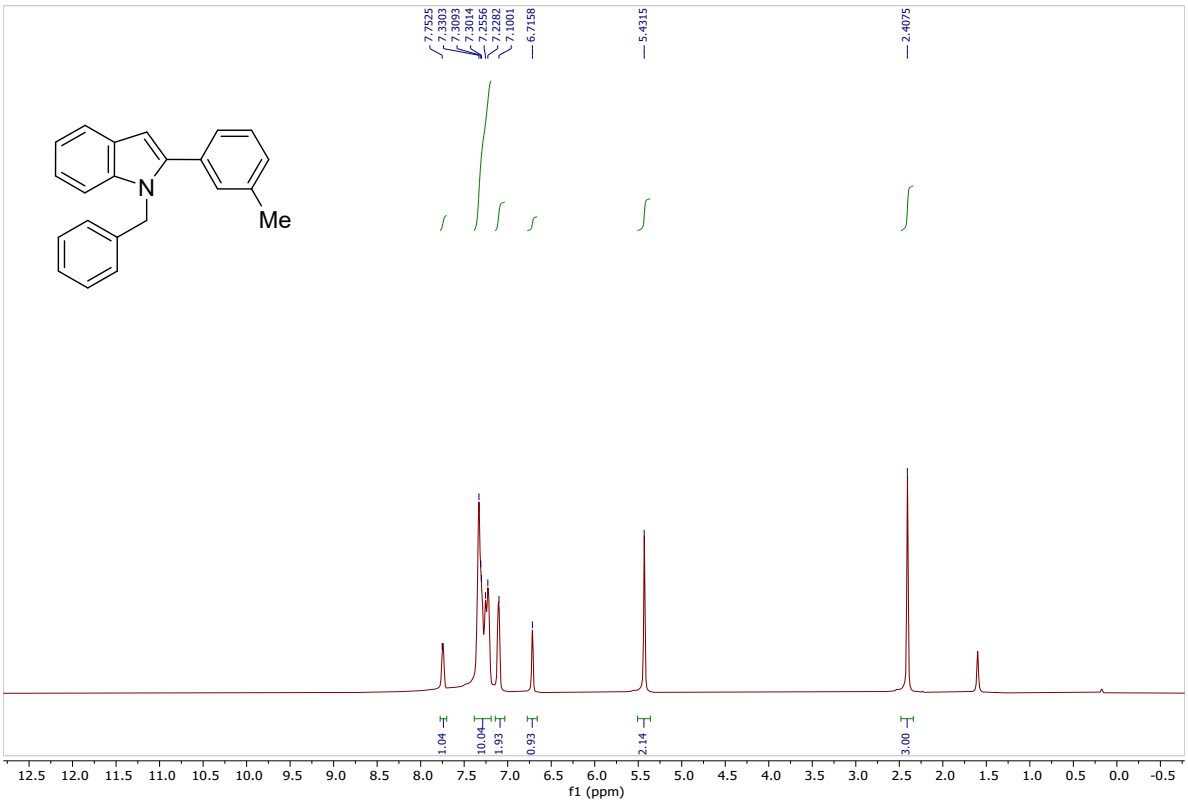
^{1}H NMR spectrum of compound **3s**, ($CDCl_3$, 500 MHz).



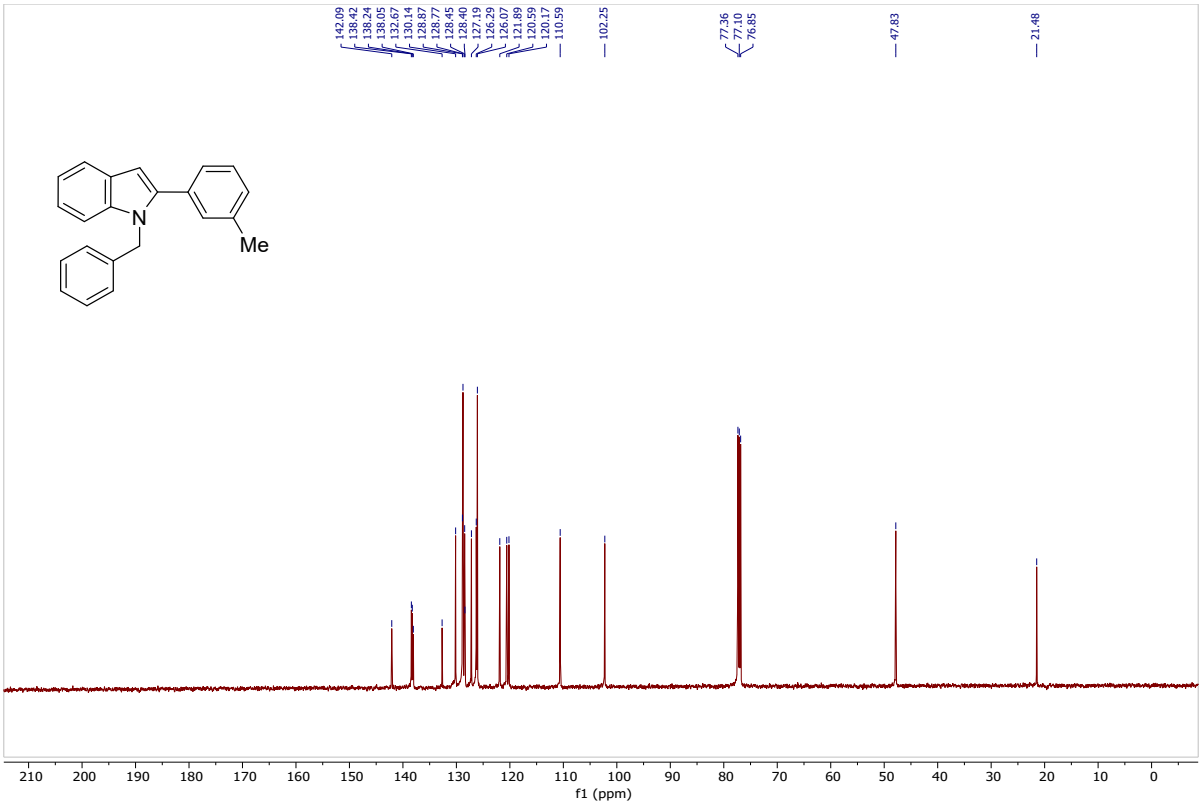
^{13}C NMR spectrum of compound **3s**, ($CDCl_3$, 125 MHz).



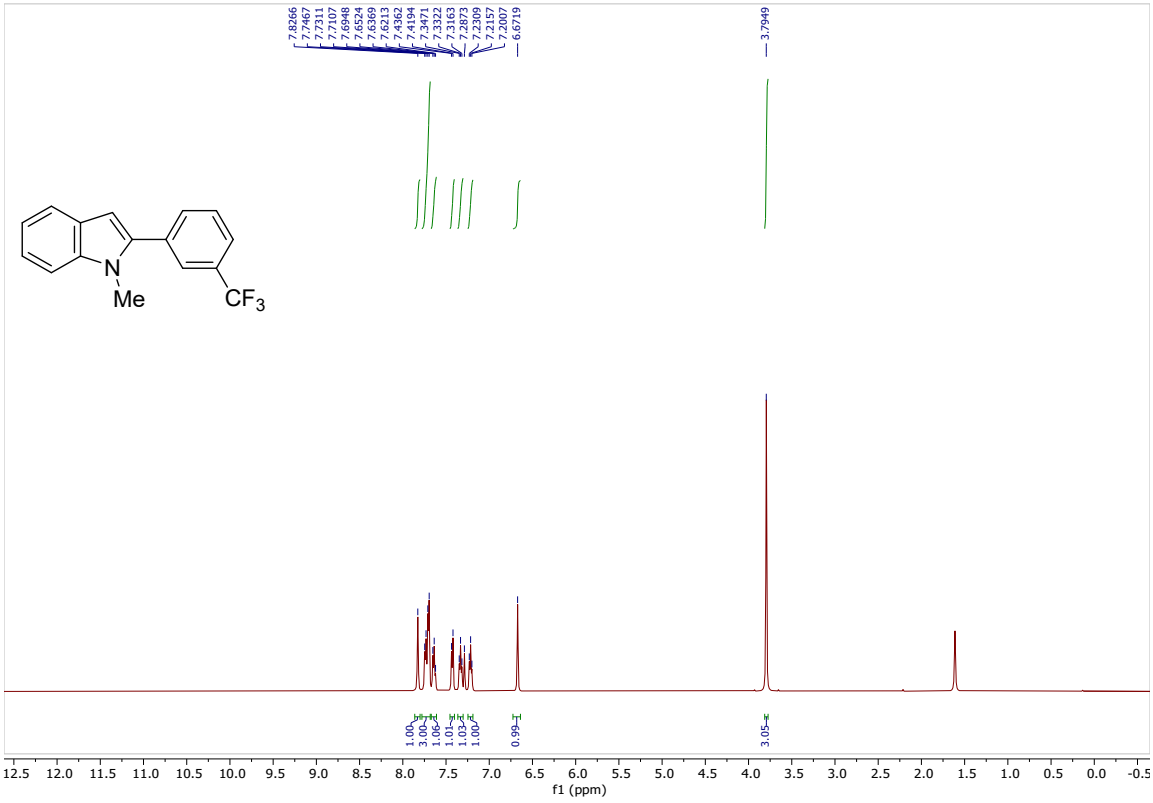
^{1}H NMR spectrum of compound **3t**, ($CDCl_3$, 500 MHz)



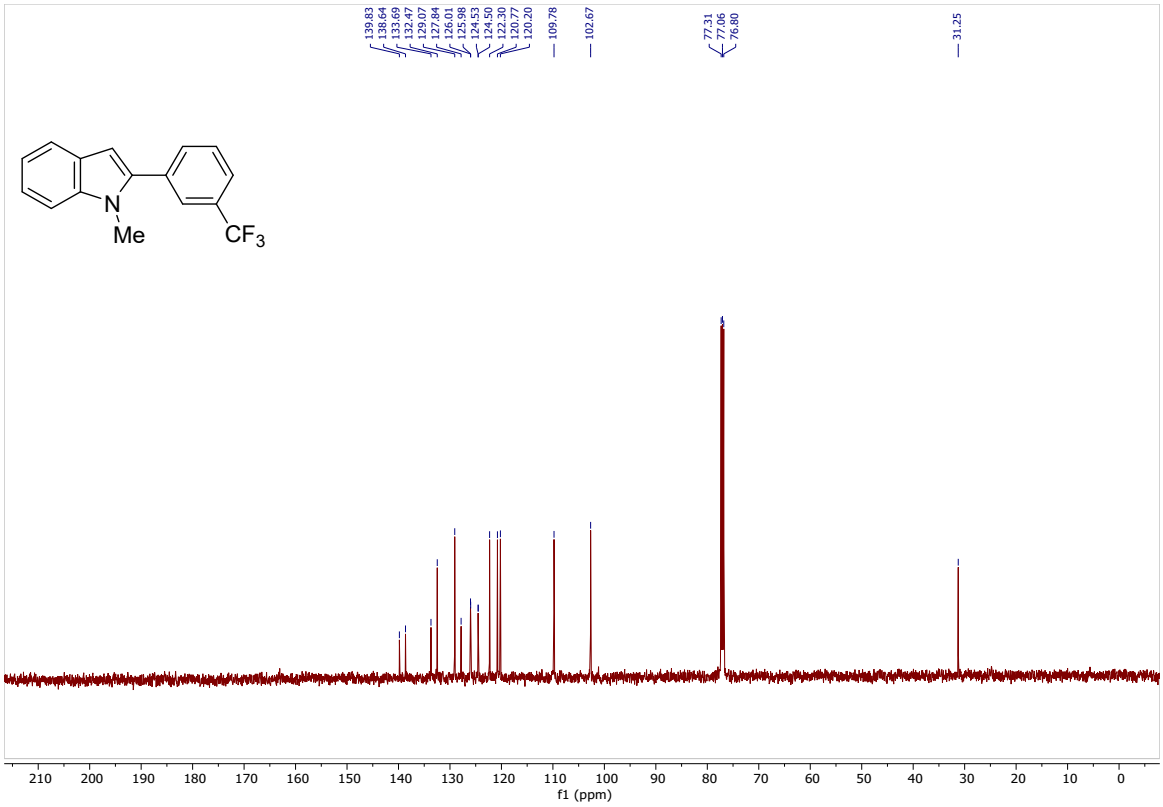
^{13}C NMR spectrum of compound **3t**, ($CDCl_3$, 125 MHz).



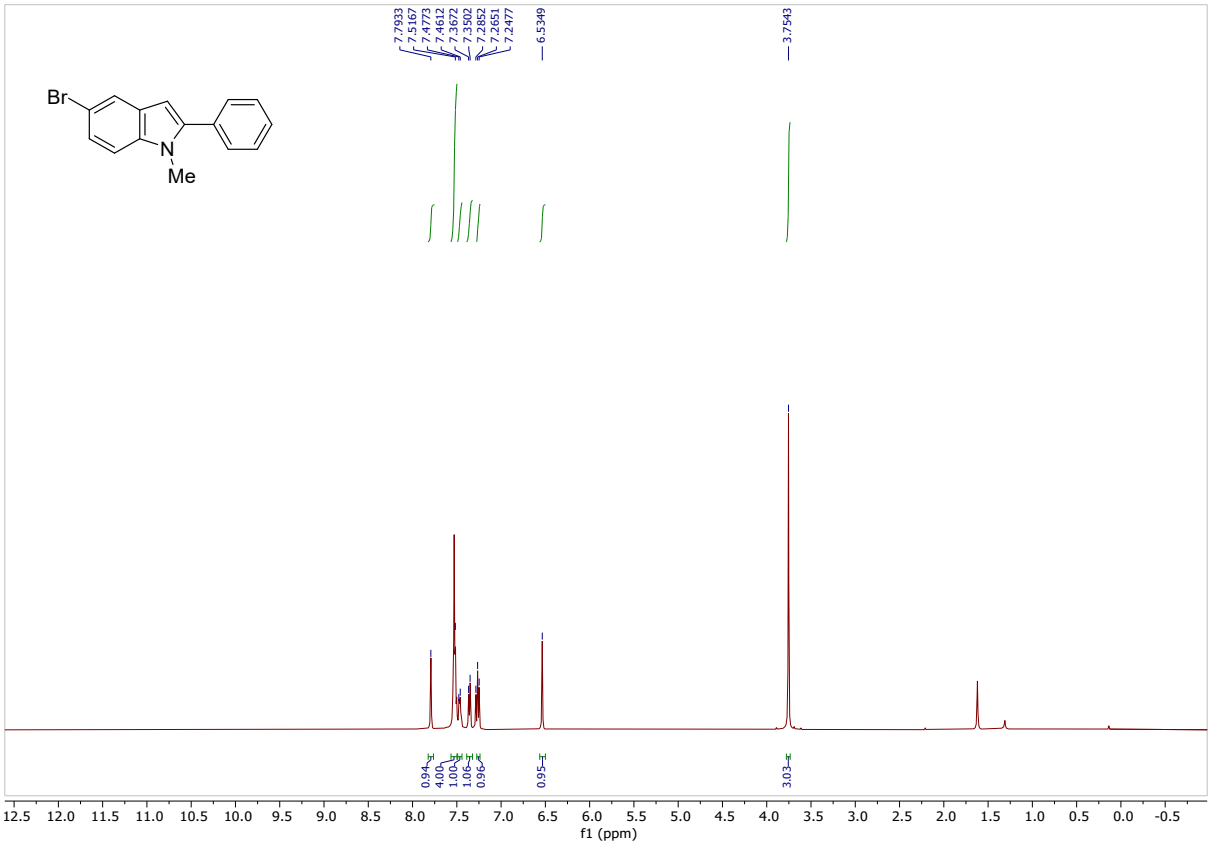
^{1}H NMR spectrum of compound **3u**, ($CDCl_3$, 500 MHz)



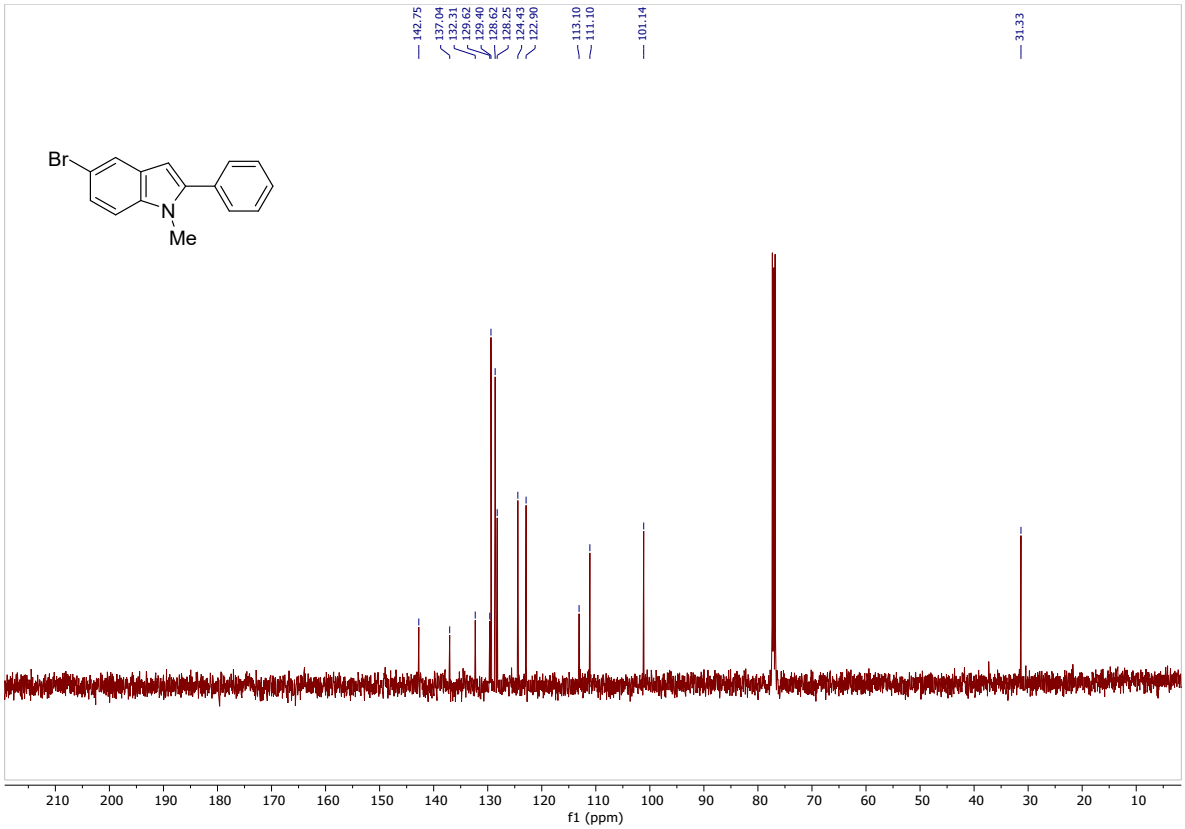
^{13}C NMR spectrum of compound **3u**, ($CDCl_3$, 125 MHz).



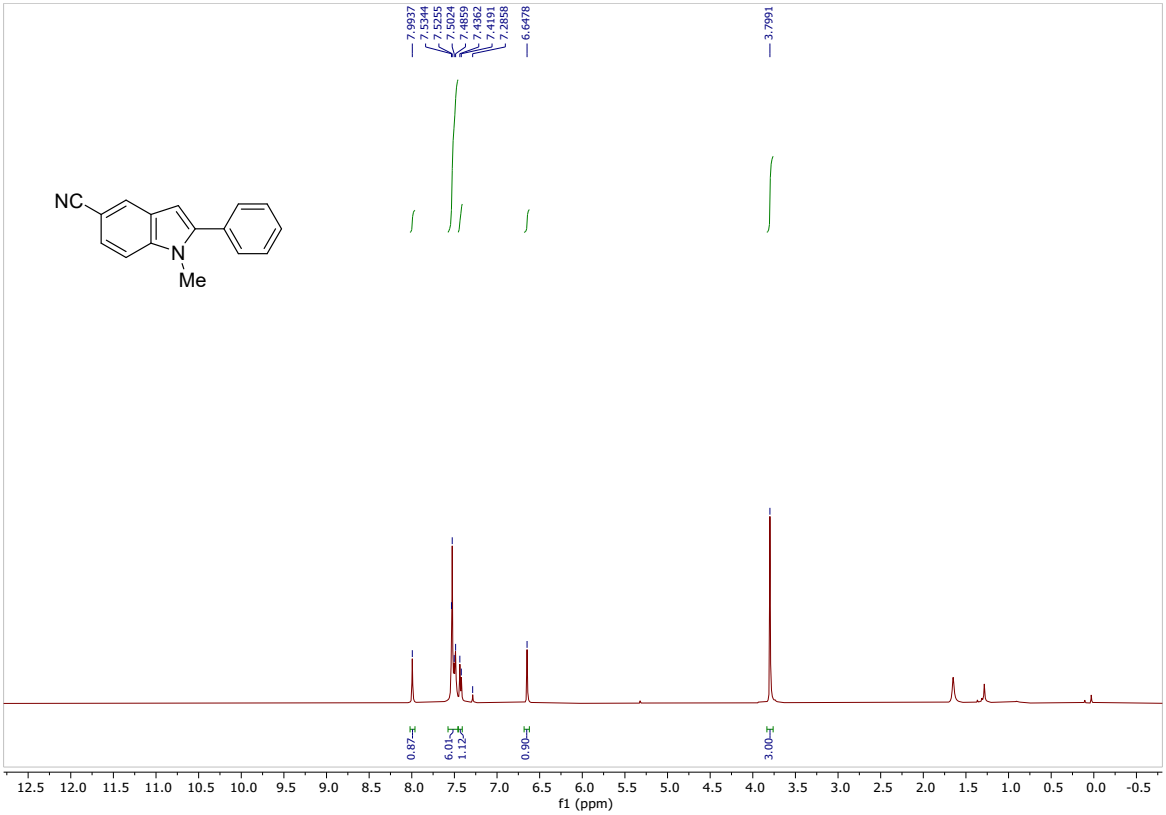
^{1}H NMR spectrum of compound **3v**, ($CDCl_3$, 500 MHz)



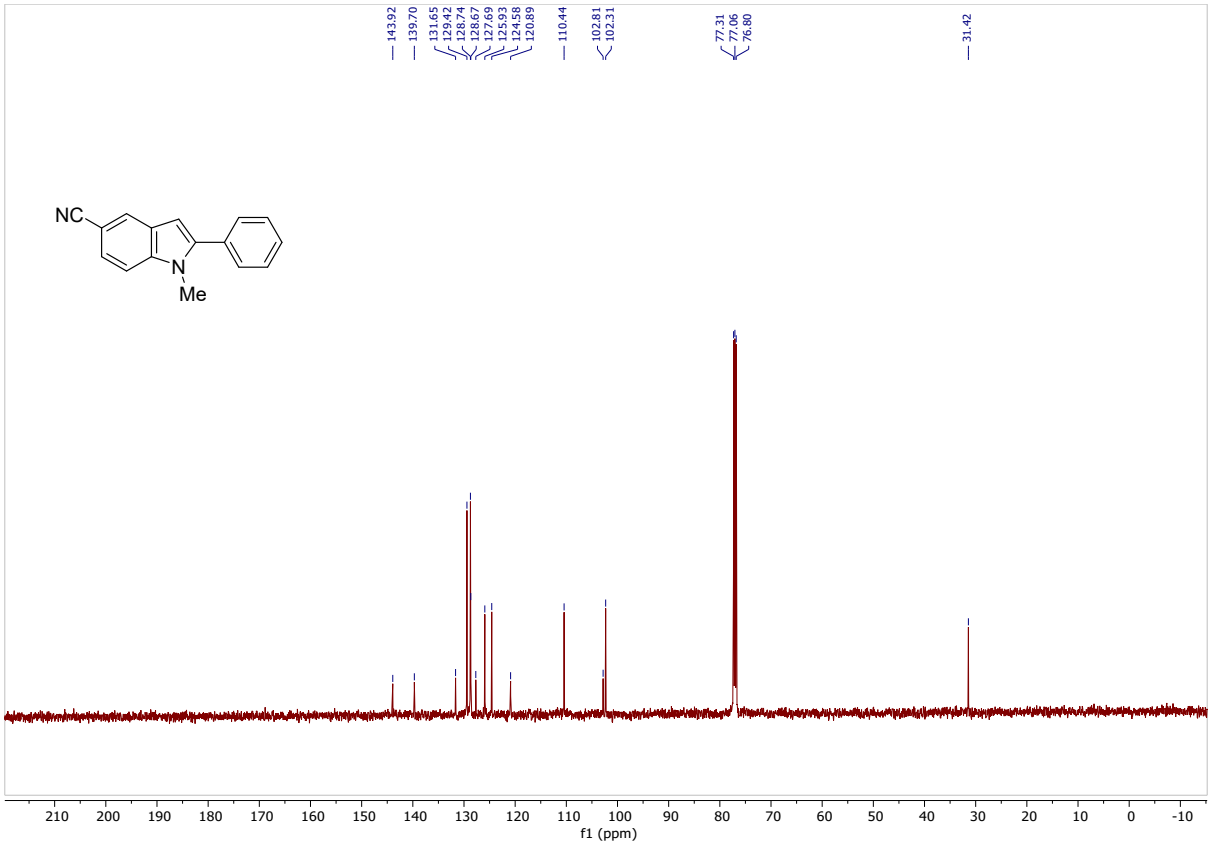
^{13}C NMR spectrum of compound **3v**, ($CDCl_3$, 125 MHz).



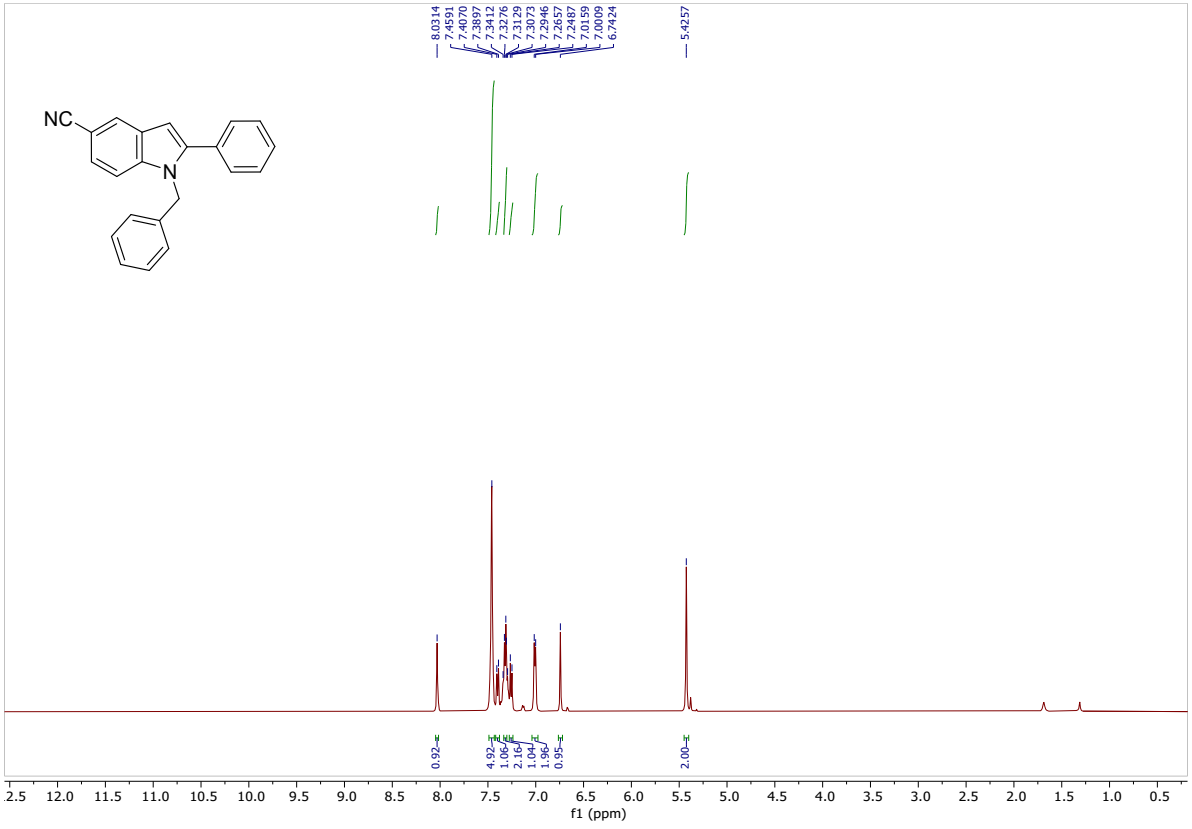
^{1}H NMR spectrum of compound **3w**, ($CDCl_3$, 500 MHz).



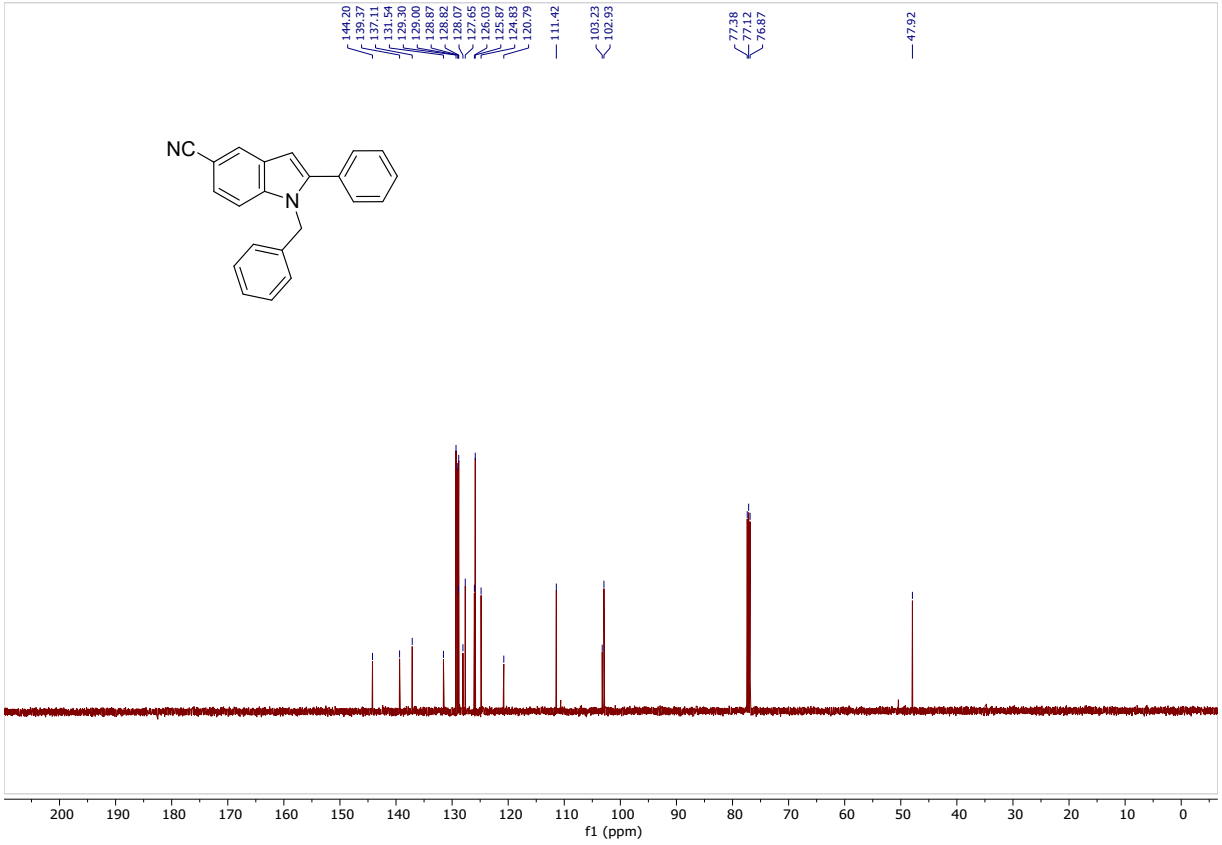
^{13}C NMR spectrum of compound **3w**, ($CDCl_3$, 125 MHz).



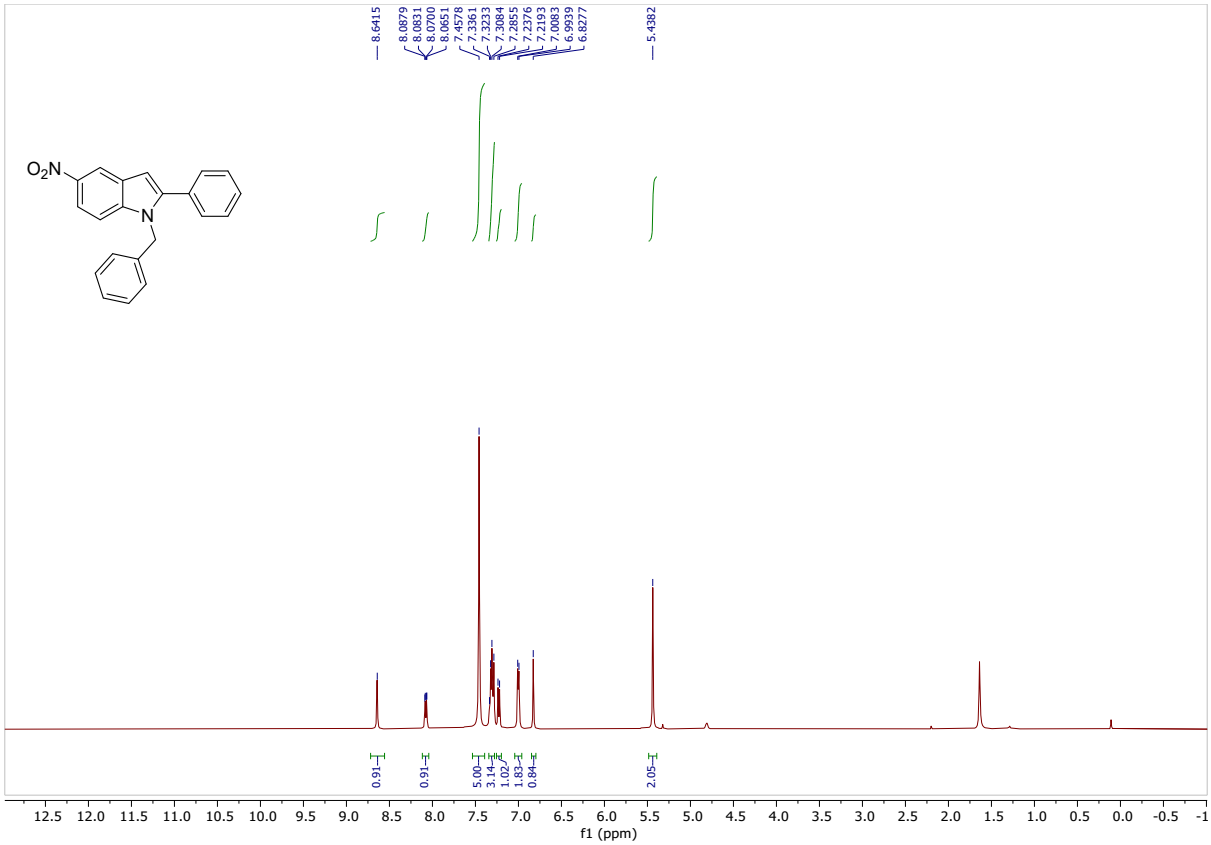
^{1}H NMR spectrum of compound **3x**, ($CDCl_3$, 500 MHz).



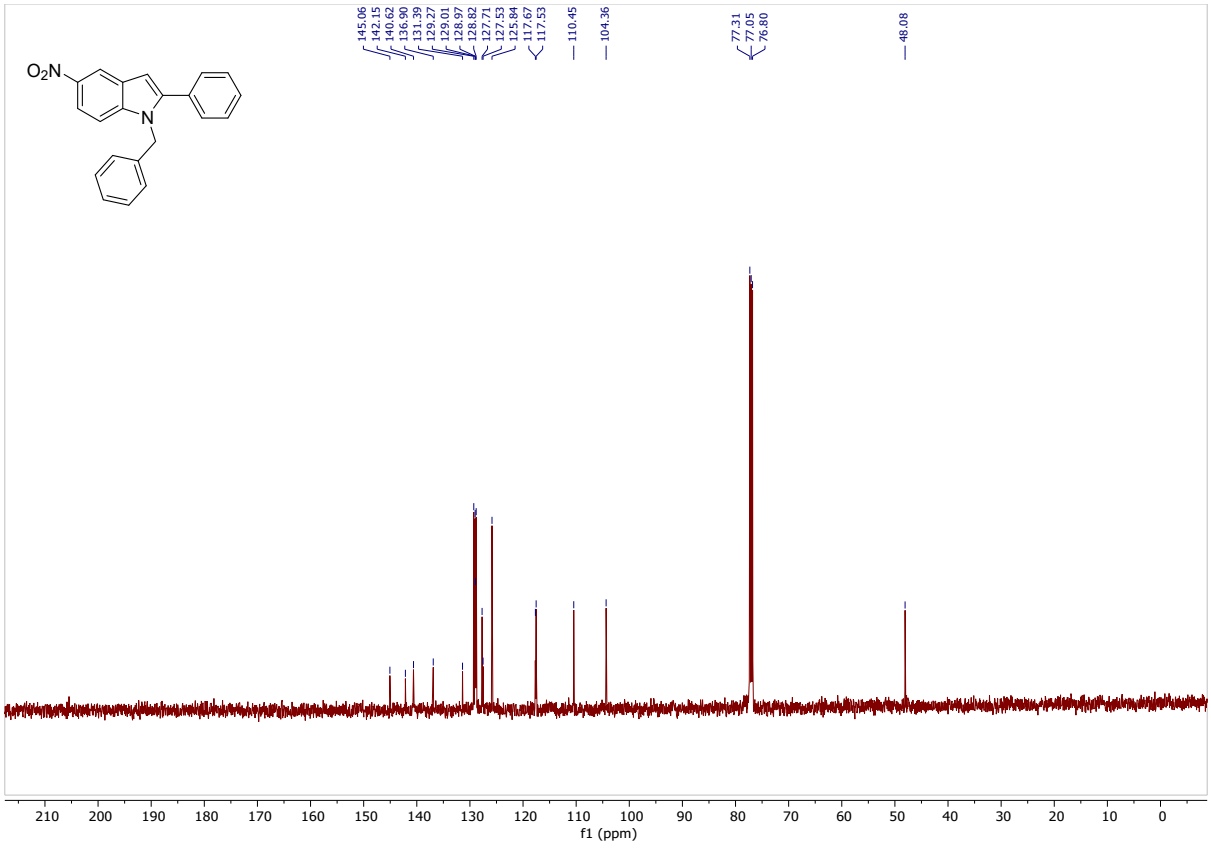
^{13}C NMR spectrum of compound **3x**, ($CDCl_3$, 125 MHz).



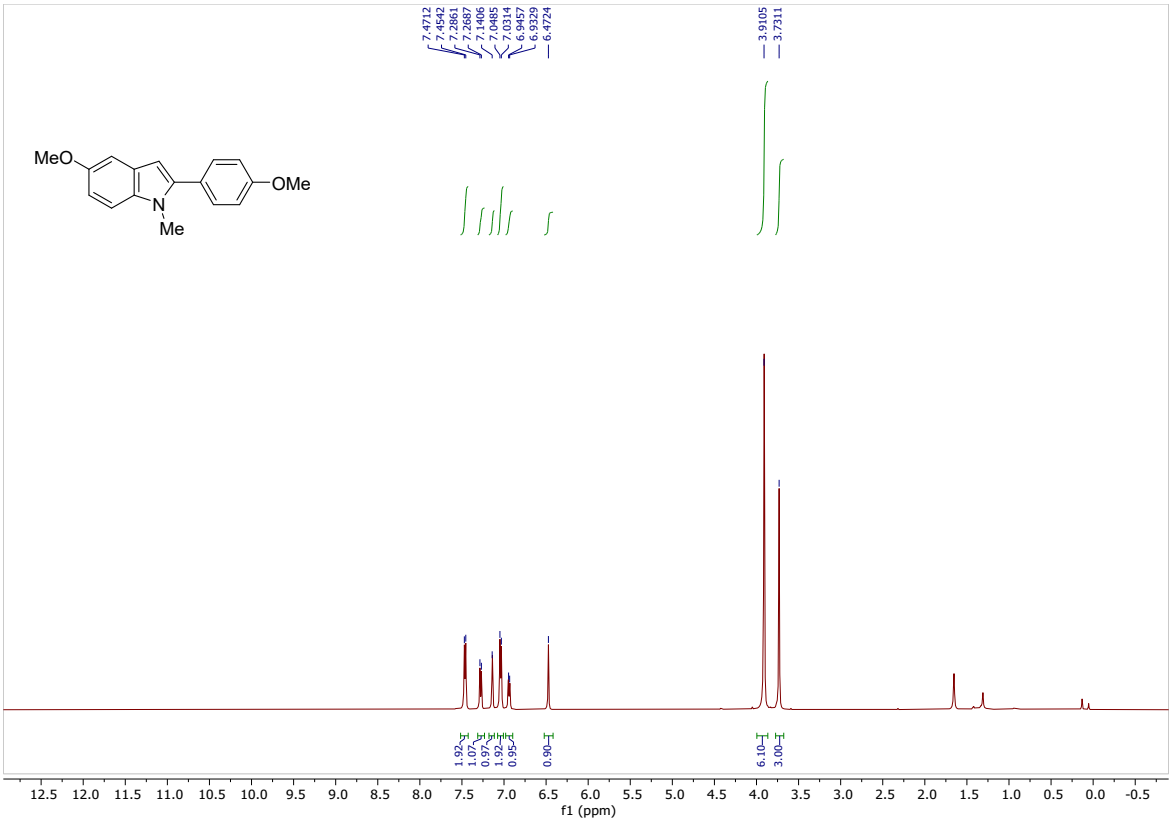
^{1}H NMR spectrum of compound **3y**, ($CDCl_3$, 500 MHz).



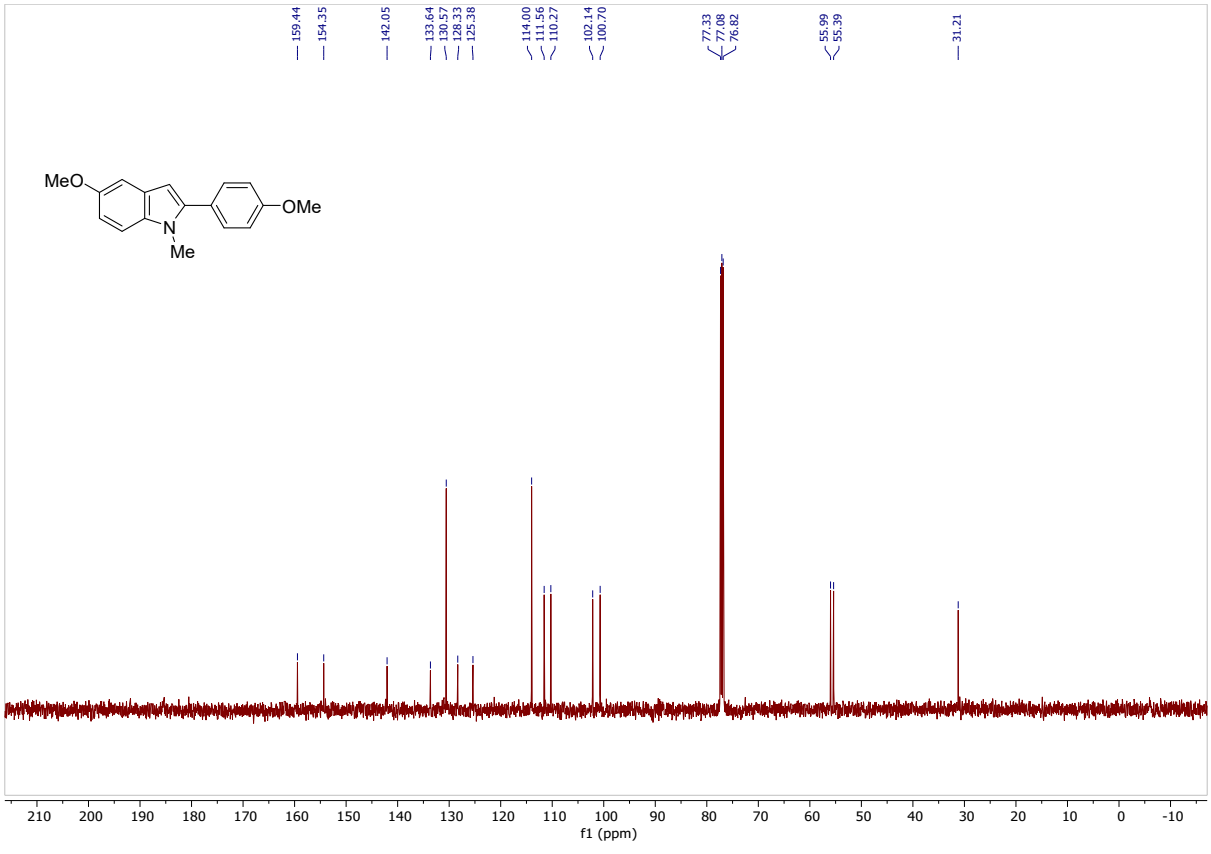
^{13}C NMR spectrum of compound **3y**, ($CDCl_3$, 125 MHz).



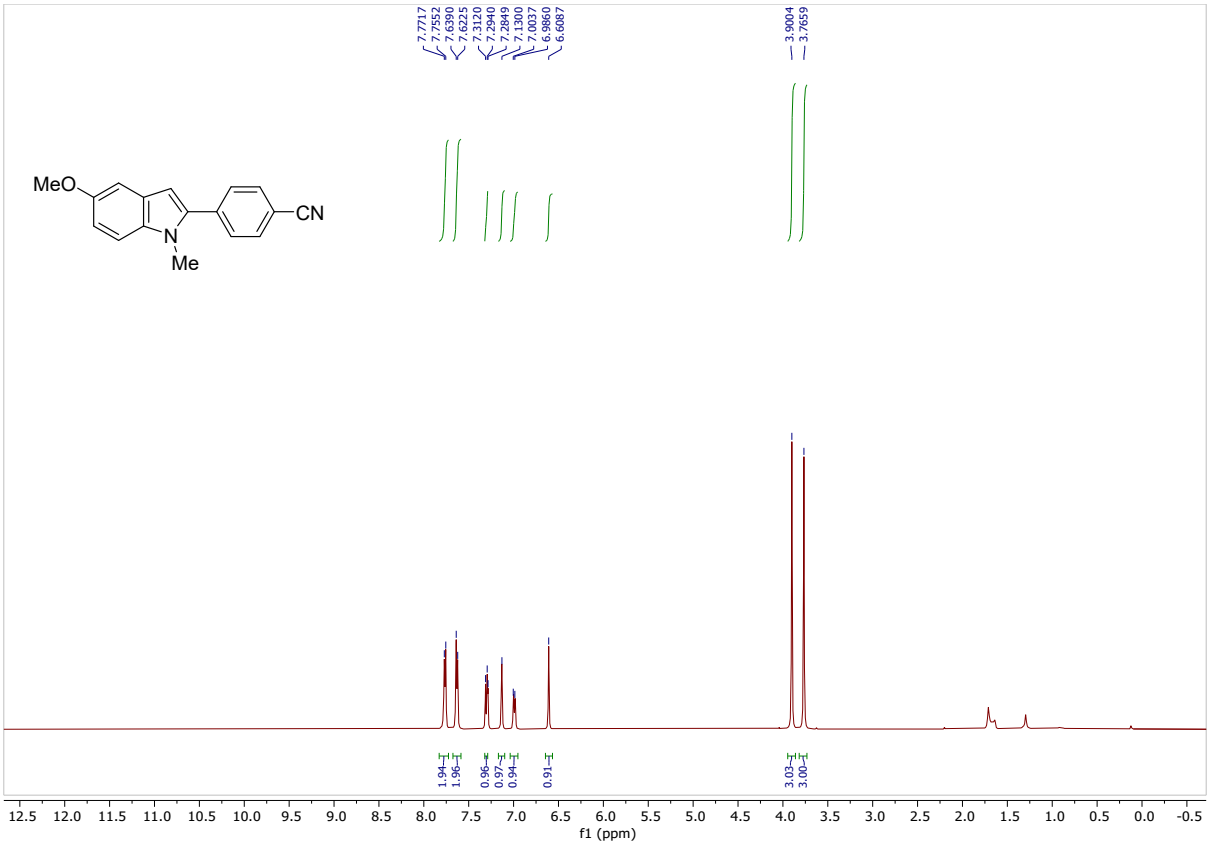
^{1}H NMR spectrum of compound **3z**, ($CDCl_3$, 500 MHz).



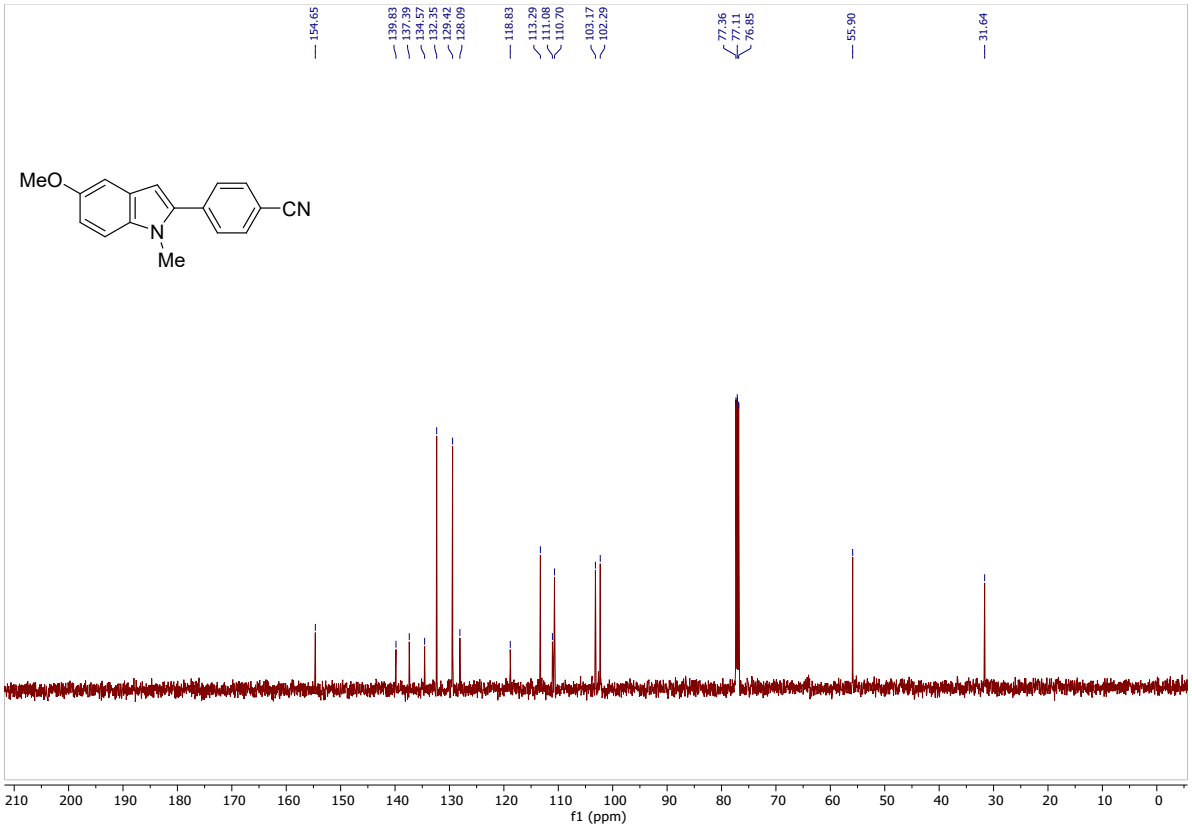
^{13}C NMR spectrum of compound **3z**, ($CDCl_3$, 125 MHz).



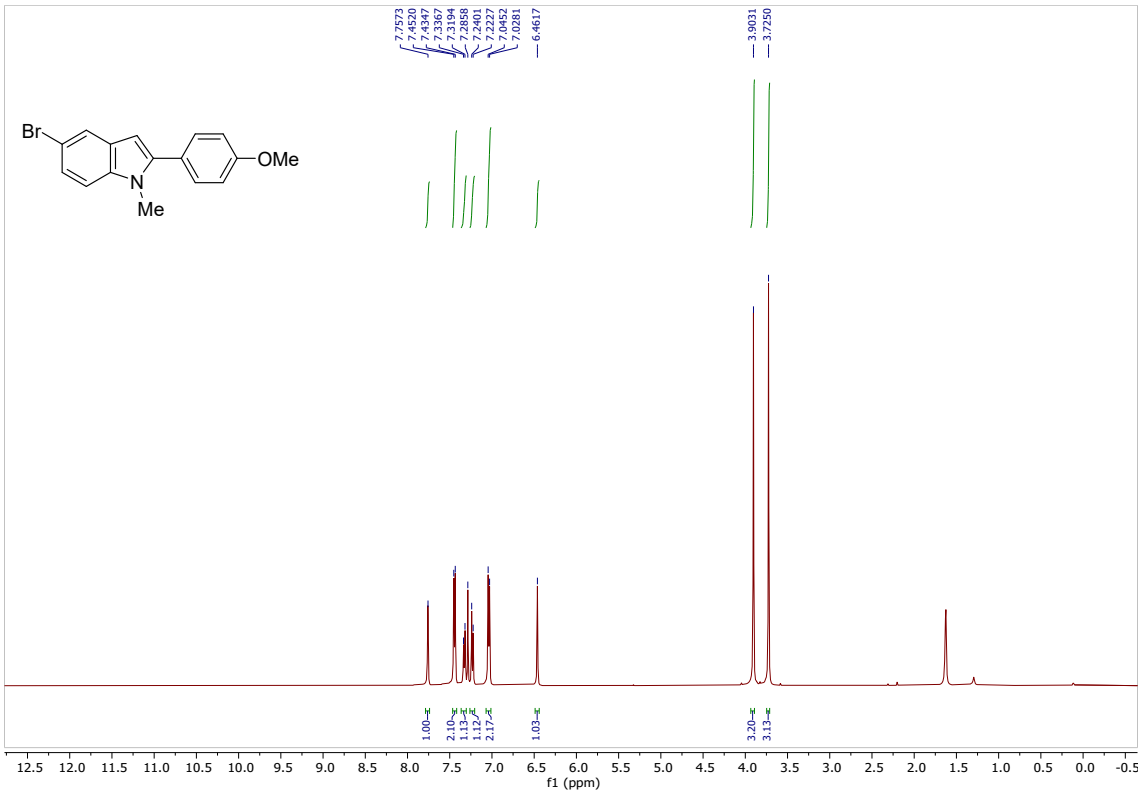
^{1}H NMR spectrum of compound **3aa**, ($CDCl_3$, 500 MHz).



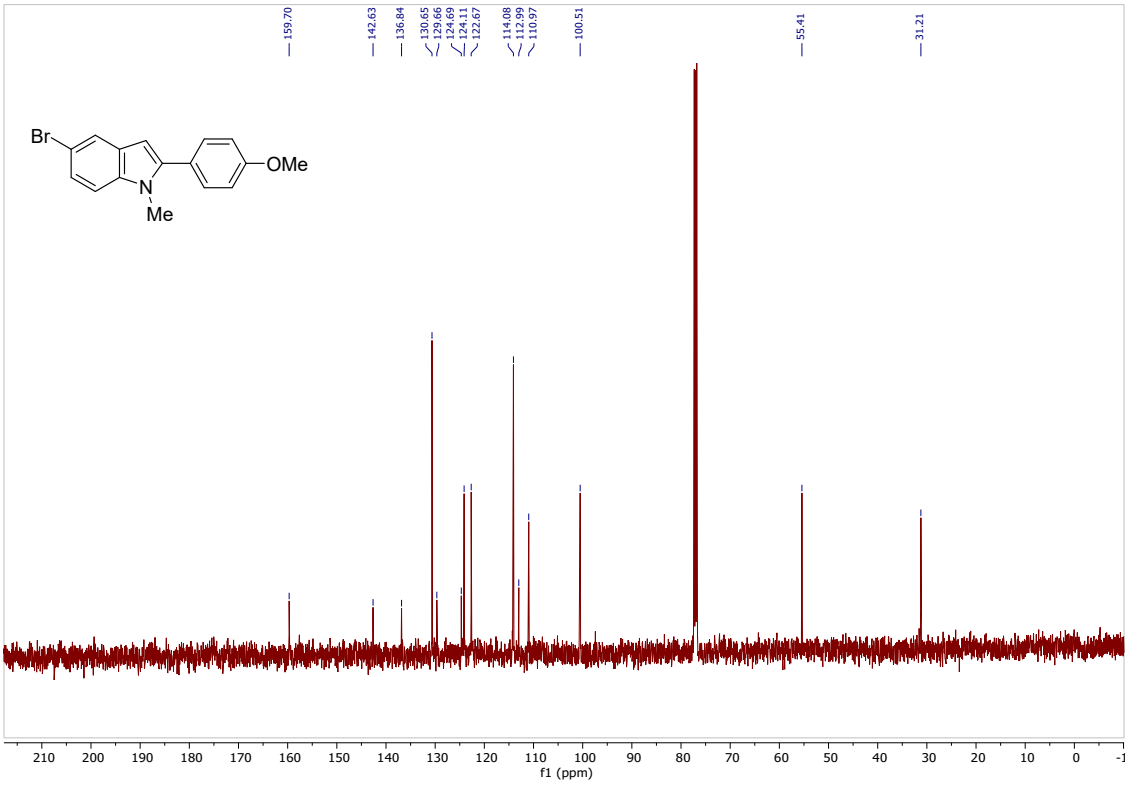
^{13}C NMR spectrum of compound **3aa**, ($CDCl_3$, 125 MHz).



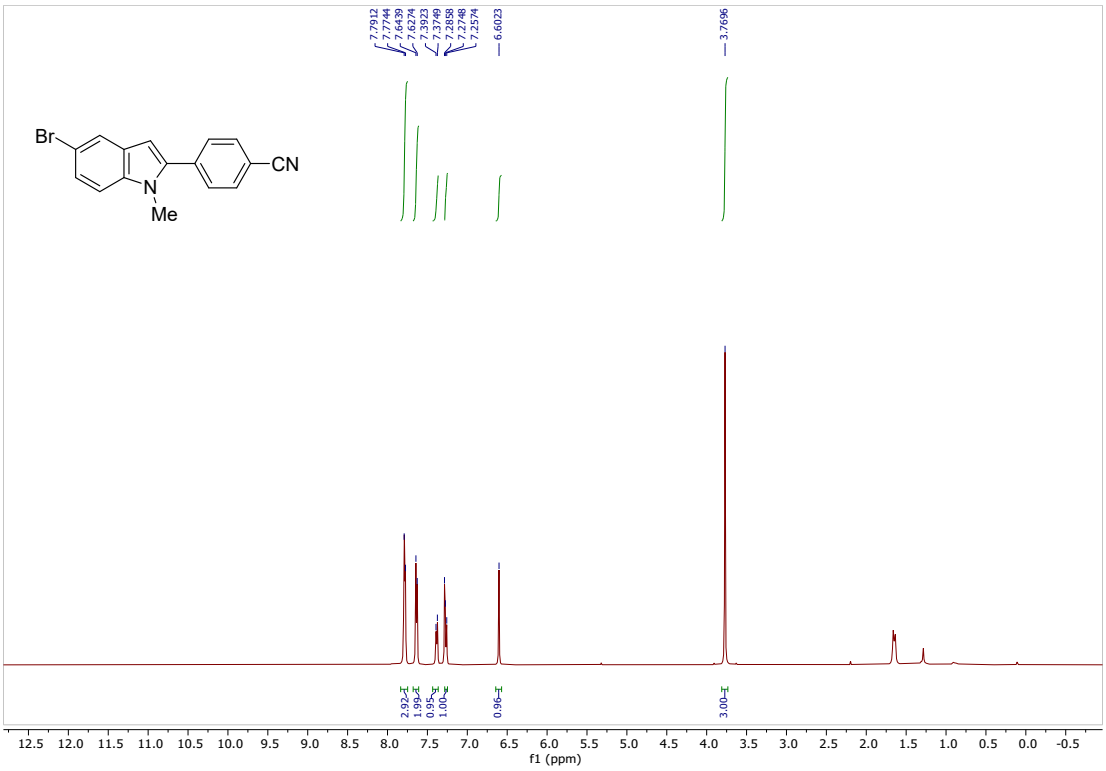
^{1}H NMR spectrum of compound **3ab**, ($CDCl_3$, 500 MHz).



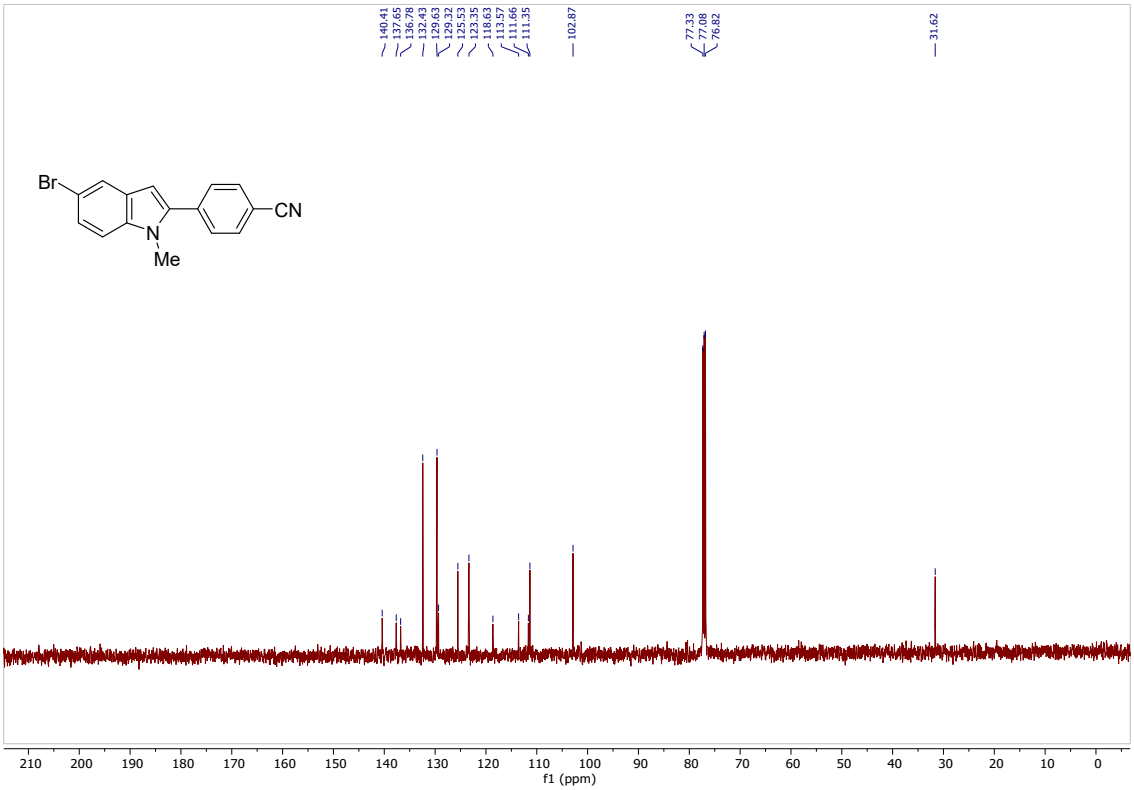
^{13}C NMR spectrum of compound **3ab**, ($CDCl_3$, 125 MHz).



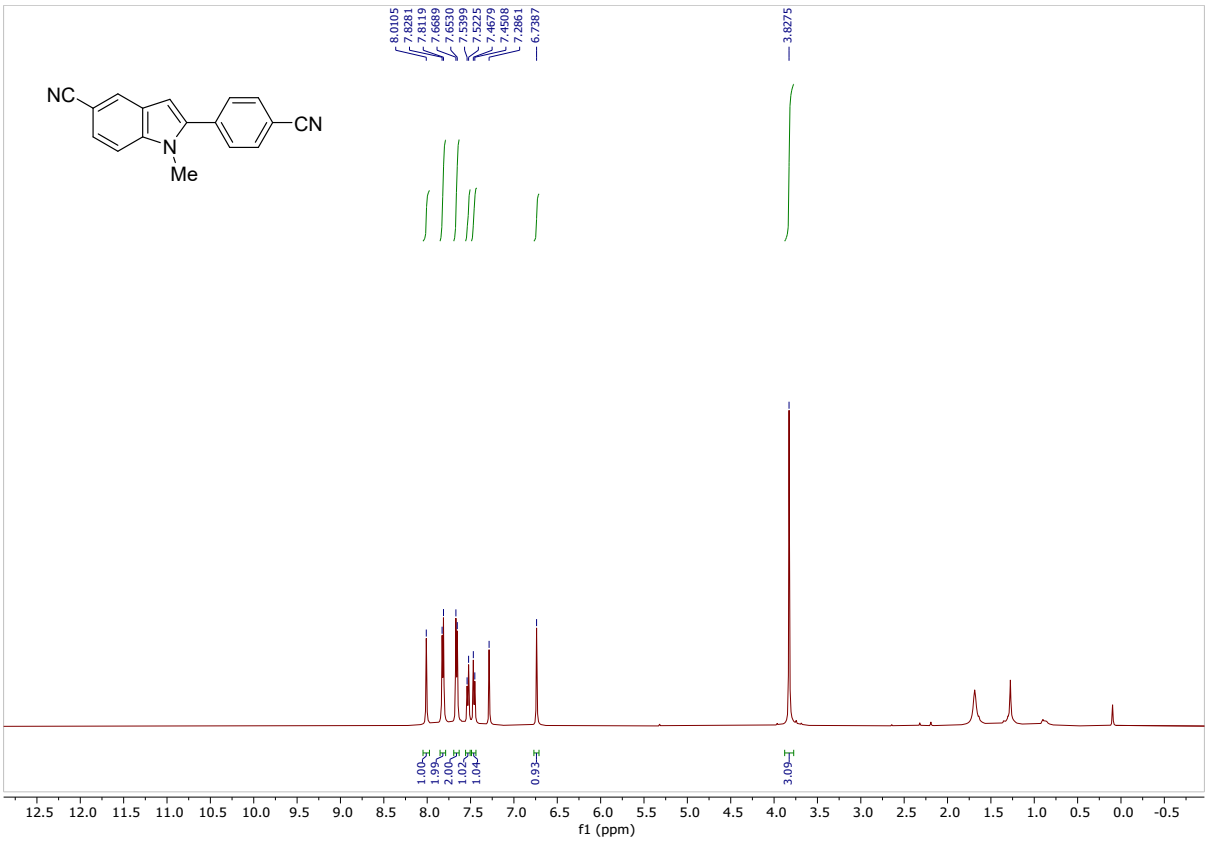
^{1}H NMR spectrum of compound **3ac**, ($CDCl_3$, 500 MHz).



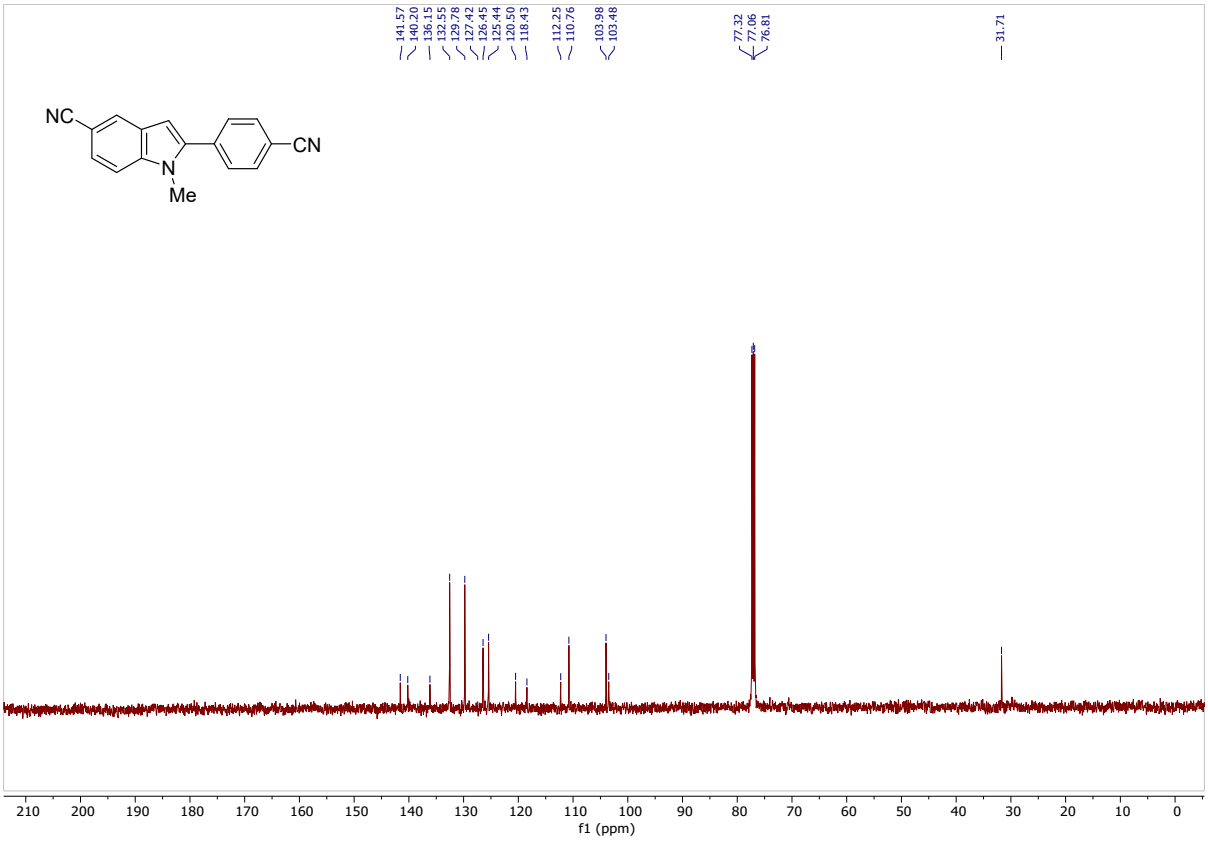
^{13}C NMR spectrum of compound **3ac**, ($CDCl_3$, 125 MHz).



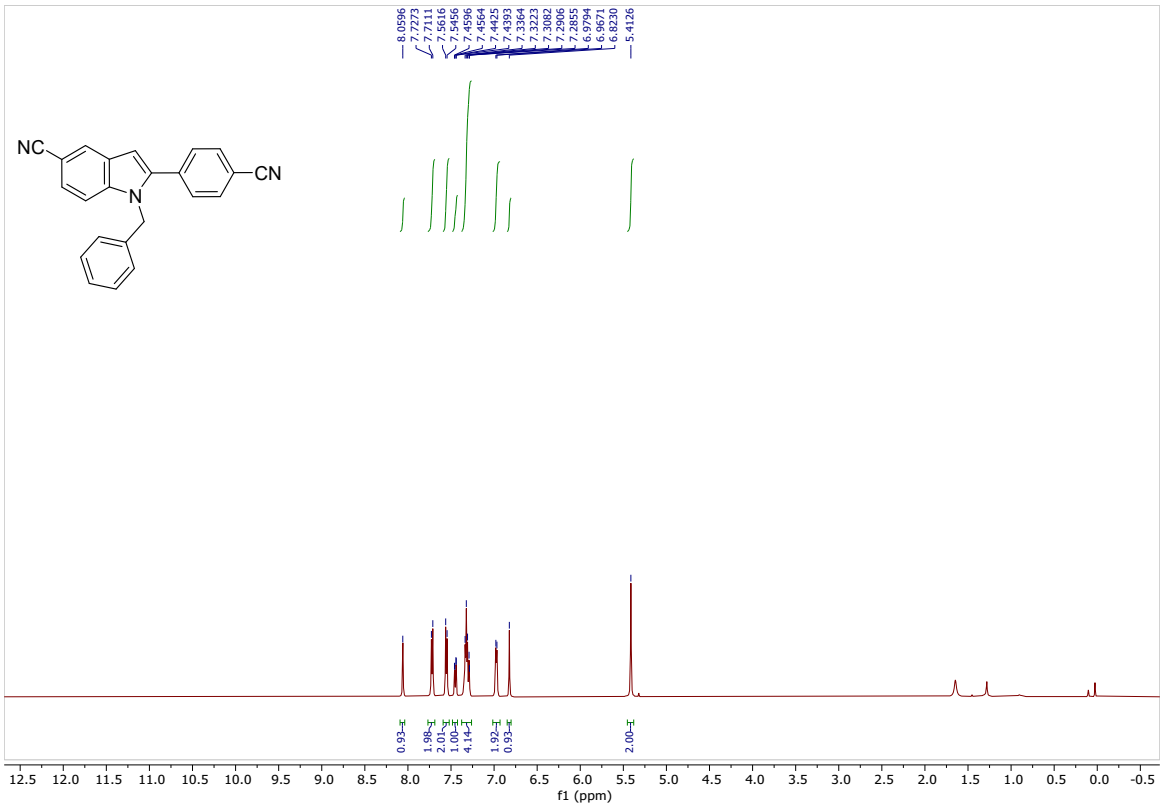
^{1}H NMR spectrum of compound **3ad**, ($CDCl_3$, 500 MHz).



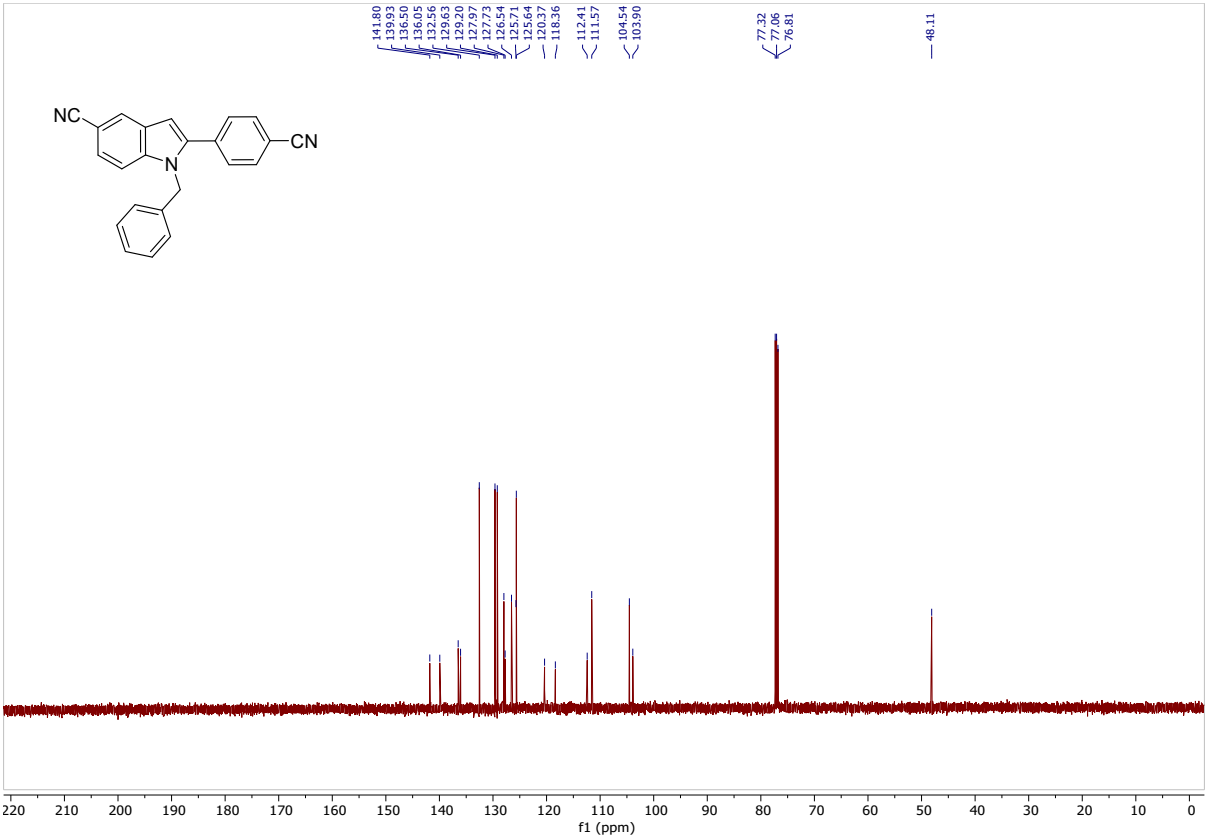
^{13}C NMR spectrum of compound **3ad**, ($CDCl_3$, 125 MHz).



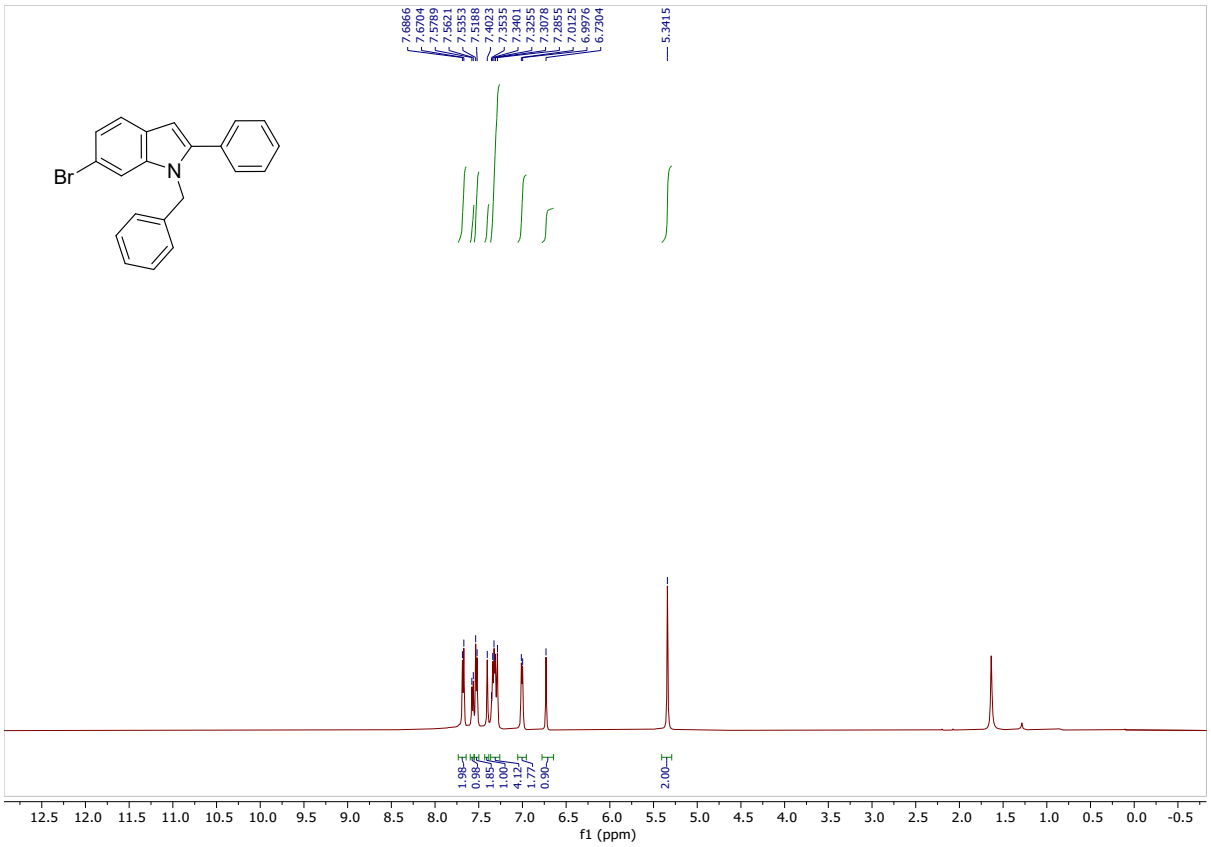
^{1}H NMR spectrum of compound **3ae**, ($CDCl_3$, 500 MHz).



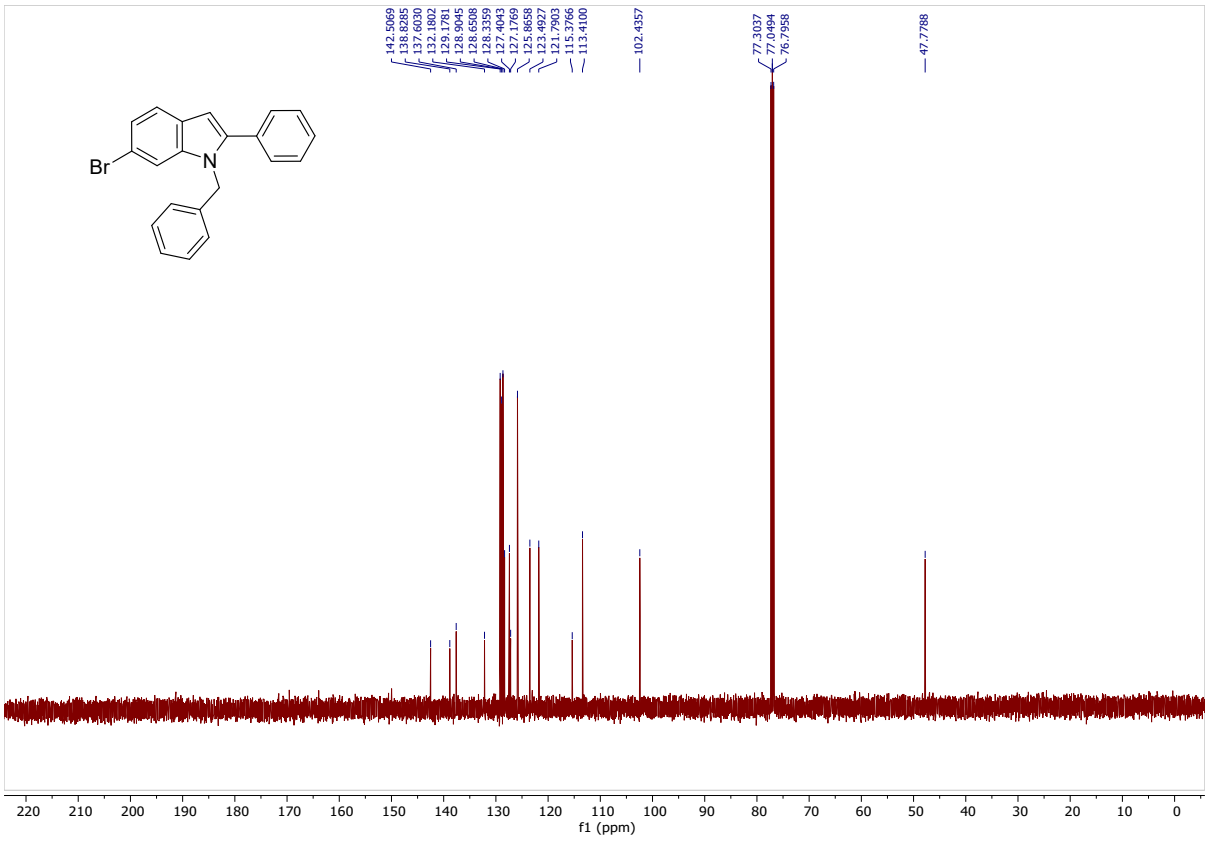
^{13}C NMR spectrum of compound **3ae**, ($CDCl_3$, 125 MHz).



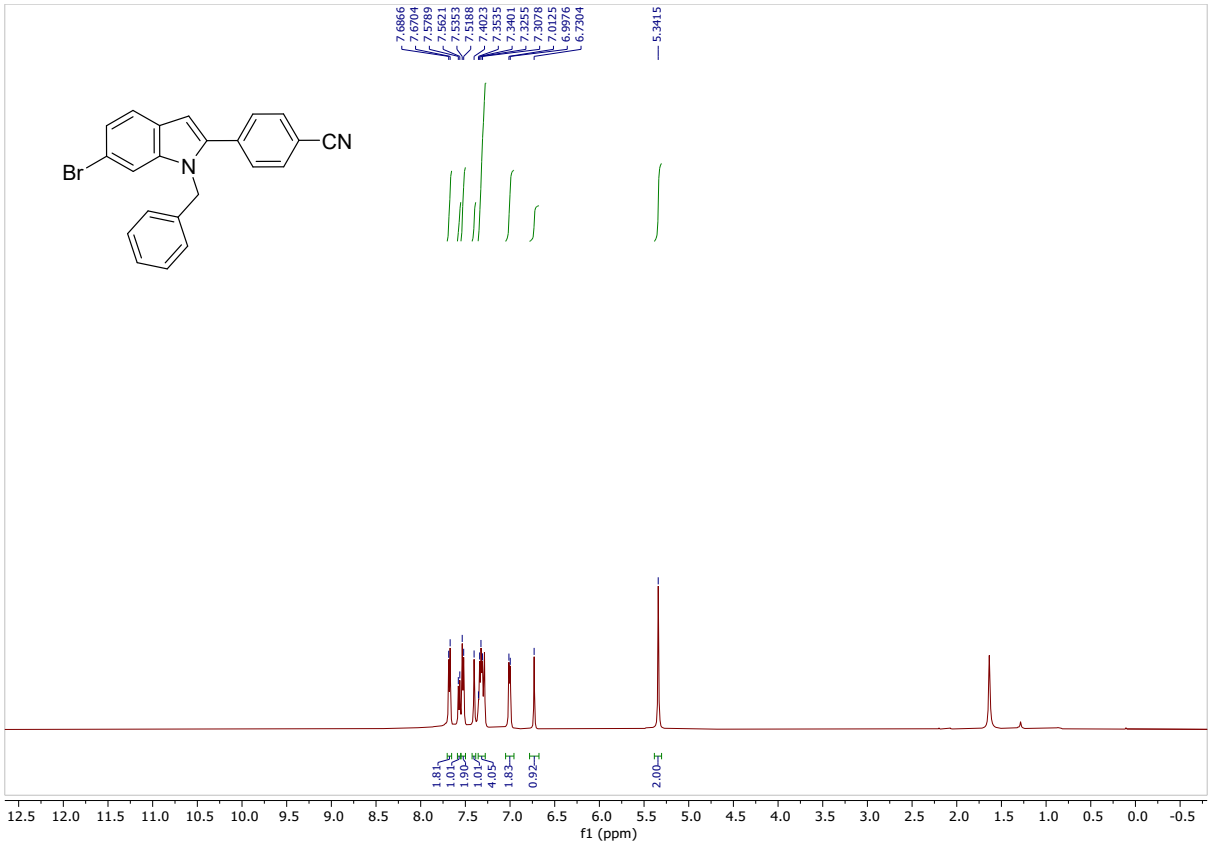
^{1}H NMR spectrum of compound **3af**, ($CDCl_3$, 500 MHz).



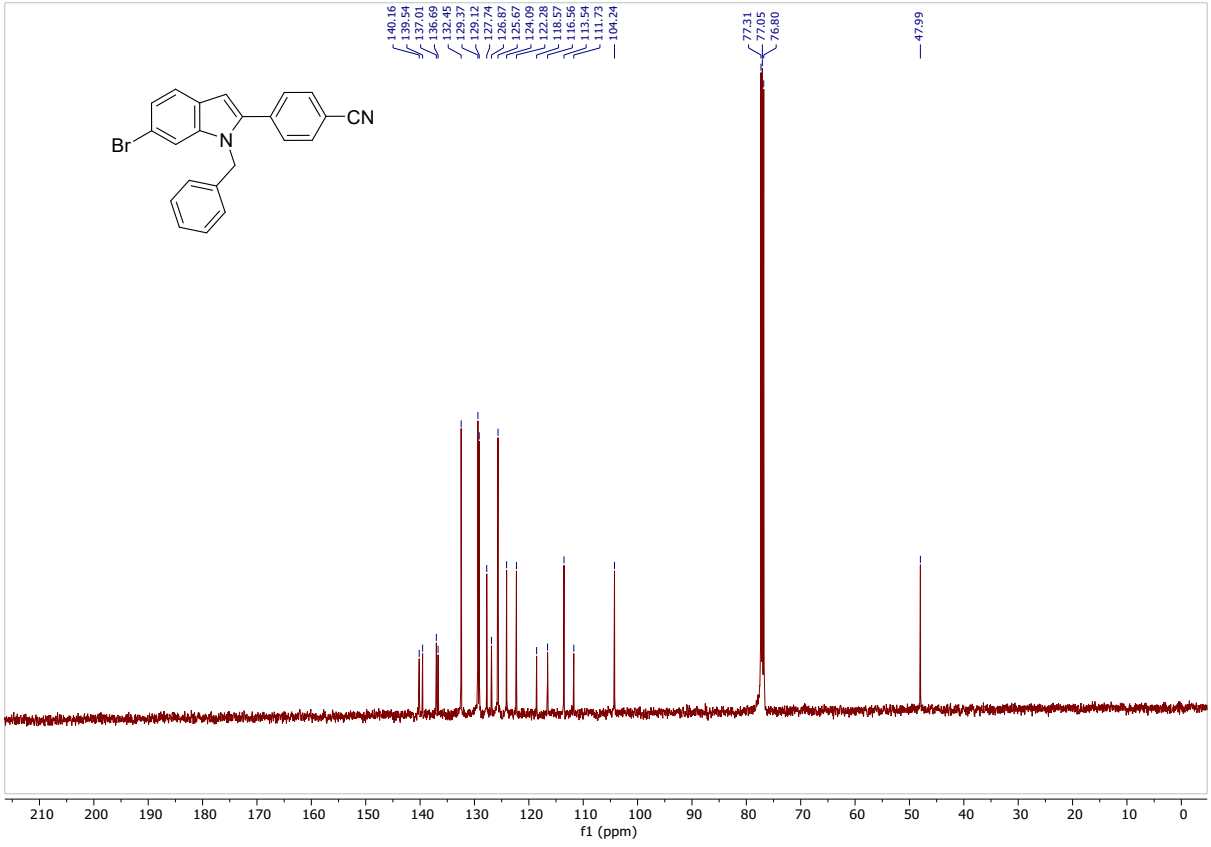
^{13}C NMR spectrum of compound **3af**, ($CDCl_3$, 125 MHz).



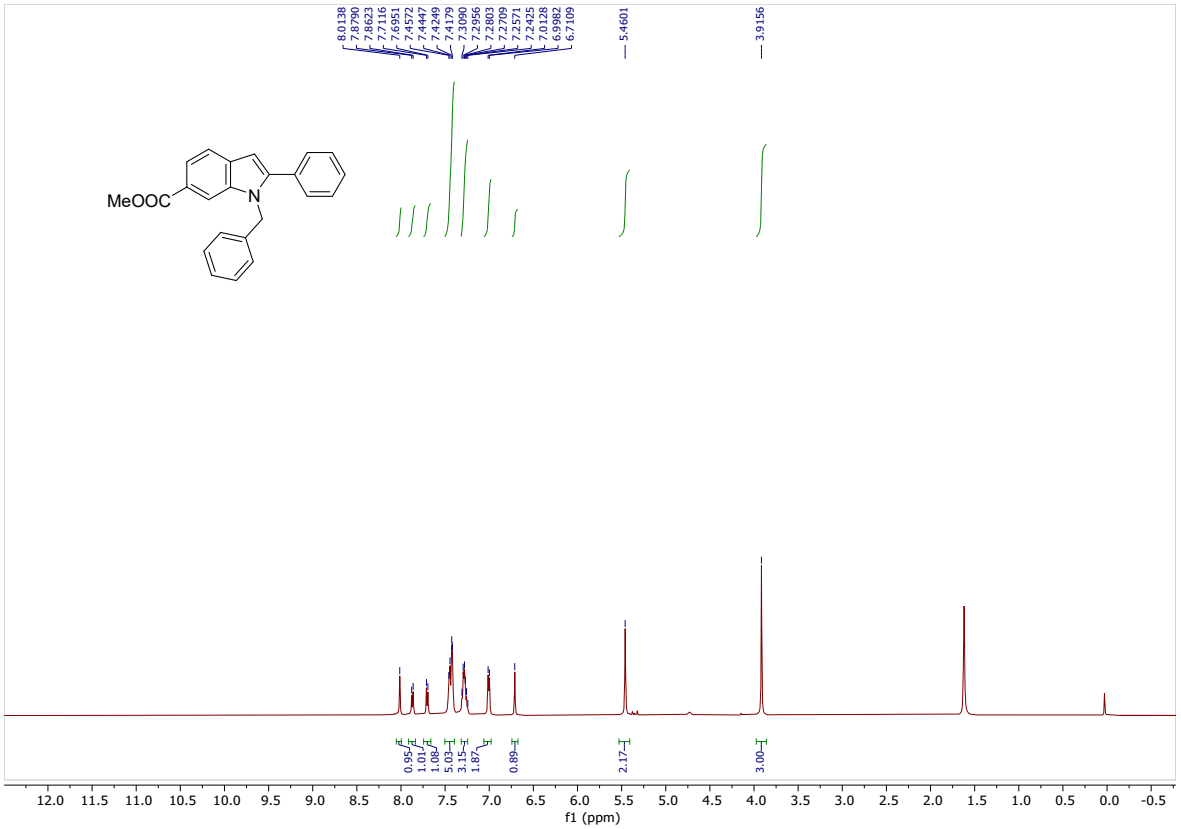
^{1}H NMR spectrum of compound **3ag**, ($CDCl_3$, 500 MHz).



^{13}C NMR spectrum of compound **3ag**, ($CDCl_3$, 125 MHz).



^{1}H NMR spectrum of compound **3ah**, ($CDCl_3$, 500 MHz).



^{13}C NMR spectrum of compound **3ah**, ($CDCl_3$, 125 MHz).