

Supporting Information

Oxindole Synthesis *via* Polar-Radical-Crossover of Ketene-derived Amide Enolates in a Formal [3+2] Cycloaddition

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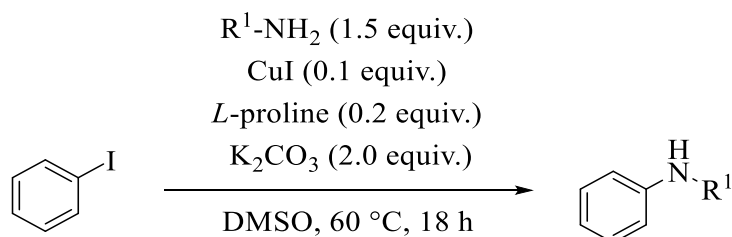
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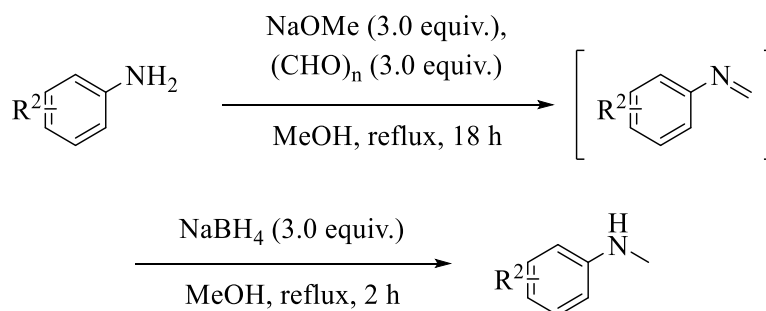
1. General information

Reactions with compounds sensitive to air or moisture were conducted in oven-dried glassware under an atmosphere of argon using standard Schlenk-technique. Anhydrous tetrahydrofuran (THF) was refluxed over sodium and freshly distilled from potassium prior to use. Anhydrous diethyl ether (Et₂O) was freshly distilled from Na/K-alloy. Anhydrous dichloromethane (CH₂Cl₂) was dried over P₄O₁₀ and also freshly distilled prior to use. Anhydrous methanol (MeOH) and dimethyl sulfoxide (DMSO) were purchased in extra-dry grade from *Acros Organics* and stored over molecular sieves. Unless stated otherwise, all reagents were purchased at *Sigma Aldrich*, *Acros Organics*, *Alfa Aesar*, *ABCR*, *TCl*, *Fluorochem* and *BLDPharm* and were used without further purification. Flash column chromatography (FC) was carried out on *Merck* silica gel (40-63 μm) with an excess compressed air pressure up to 0.5 bar. Solvents for chromatography and liquid-liquid extractions were purchased in technical grade and purified by distillation. For analytical thin layer chromatography (TLC) *Merck silica gel 60 F254*-plates were used and detection was carried out using UV-light (254 nm) or KMNO₄-stain (1.5 g in 250 mL water, 5 g NaHCO₃). Automatic flash-systems by *Reveleris IES* and *Büchi C-850 Flashprep* were used for medium pressure liquid chromatography (MPLC) using commercially available 4 g, 12 g or 40 g *Reveleris*-C₁₈-flash cartridges as the stationary phase. Preparative HPLC was conducted on a *Büchi C-850 Flashprep* device using an *Agilent Zorbax XDB-C18* column (21.2 x 150 mm, 5 μm particle size) as the stationary phase. As the mobile phase, water (*Milli-Q* grade), acetonitrile (HPLC grade) and methanol (technical grade, distilled prior to use) were used. Detection was performed by UV-absorption ($\lambda = 210$ nm, 230, 254, 320 nm) and electronic light scattering detection (ELSD) with isopropanol as carrier. Melting points were measured using a *Büchi Melting Point M-560* device and are uncorrected. Infrared spectra were recorded on a *Digilab 3100 FT-IR Excalibur Series* and a *Jasco FT/IR-4600* spectrometer. Absorption bands are given in wave numbers ν (cm⁻¹). HRMS spectra (ESI-MS) were recorded on a *Thermo Fisher Scientific Orbitrap Velos Pro* and *Thermo Fisher Scientific LTQ Orbitrap XL* spectrometer. ¹H NMR (300 MHz, 400 MHz, 500 MHz and 600 MHz), ¹³C NMR (75 MHz, 101 MHz, 126 MHz and 151 MHz) and ¹⁹F NMR (282 MHz) spectra were measured on a *Bruker Avance II 300*, *Bruker NEO 400*, *Agilent DD2 500* and *Agilent DD2 600* spectrometer. Chemical shifts (δ in ppm) were referenced to the solvent residual peak (CDCl₃: $\delta_{\text{H}} = 7.26$ ppm and $\delta_{\text{C}} = 77.0$ ppm; DMSO-*d*₆: $\delta_{\text{H}} = 2.50$ ppm and $\delta_{\text{C}} = 39.5$ ppm). The multiplets of the observed signals were given as s (singlet), bs (broad signal), d (doublet), t (triplet), q (quartet), hept (heptet), m (multiplet) and combination of the above.

2. General procedures

General Procedure (GP1) for the preparation of *N*-monosubstituted anilines (1g-ah):

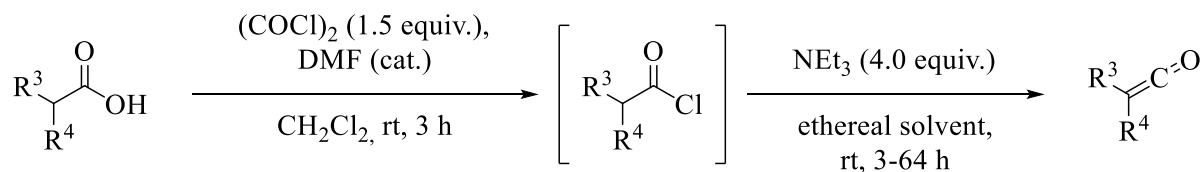
According to a procedure by *Ma et al.*¹, iodobenzene (1.0 equiv., 10.0 mmol), a primary amine (1.5 equiv.), copper iodide (0.1 equiv.), *L*-proline (0.2 equiv.) and potassium bicarbonate (2.0 equiv.) were dissolved in anhydrous DMSO (0.5 M) and heated to 60 °C for 18 hours. After cooling to room temperature, water and EtOAc were added and the phases were separated. The aqueous layer was extracted with EtOAc (3 x), the combined organic phases were dried over MgSO₄ and concentrated *in vacuo*. Purification by flash column chromatography (EtOAc/pentane) led to isolation of the desired *N*-monosubstituted anilines.

General Procedure (GP2) for the preparation of *N*-Methylanilines (1l-n and 1p-q):

According to a procedure by *Barluenga et al.*², an aniline (1.0 equiv., 5.00 mmol), NaOMe (3.0 equiv.) and paraformaldehyde (3.0 equiv.) were dissolved in anhydrous MeOH (0.4 M) and refluxed overnight. After cooling to room temperature, sodium borohydride (3.0 equiv.) was added in three portions over 15 minutes. The reaction mixture was refluxed for two hours, cooled to room temperature and quenched with NH₄Cl-solution (sat. aq.) and EtOAc. The phases were separated and the aqueous phase was extracted with EtOAc (3 x). The combined organic phases were dried over MgSO₄ and concentrated *in vacuo*. Purification by flash column chromatography (EtOAc/pentane) led to isolation of the desired *N*-methylanilines.

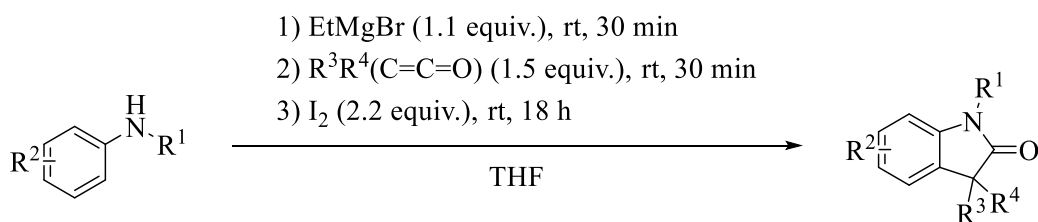
2. General procedures

General Procedure (GP3) for the preparation of Ketenes (2a-h):



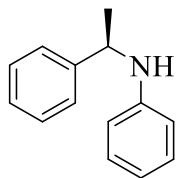
Following a representative procedure from the literature³, a carboxylic acid (1.0 equiv., between 10.0 mmol and 20.0 mmol) was dissolved in anhydrous CH_2Cl_2 (approx. 0.1 M). Oxalyl chloride (1.5 equiv.) and catalytic amounts of anhydrous DMF were added at room temperature. When gas formation ceased (approx. 3 h), the volatiles were removed *in vacuo* and the residue was dissolved in anhydrous ethereal solvent (THF or Et_2O , depending on the boiling point of the ketene). Triethylamine (4.0 equiv.) was added slowly at room temperature and the reaction mixture was stirred for 3 – 64 hours. Filtration under Argon atmosphere, concentration *in vacuo* and short-path distillation gave the desired ketenes as yellow oils.

General Procedure (GP4) for the preparation of Oxindoles (3aa-ha):



To a solution of a *N*-monosubstituted aniline (1.0 equiv., 0.20 mmol) in anhydrous THF (0.01 M) ethyl magnesium bromide (3.0 M solution in Et_2O , 1.1 equiv.) was added at room temperature and the reaction mixture was stirred for 30 minutes. Subsequently, the ketene (1.5 equiv.) was added dropwise and stirring was continued. After further 30 minutes, iodine (2.2 equiv.) was added and the reaction was stirred overnight at room temperature. Sodium sulfite (sat. aq. solution) was added until the brown colour disappeared and the phases were separated. The aqueous phase was extracted with EtOAc (3 x), the combined organic phases dried over MgSO_4 and concentrated *in vacuo*. Purification by *reversed-phase* MPLC ($\text{MeOH}/\text{H}_2\text{O}$ or $\text{MeCN}/\text{H}_2\text{O}$) led to isolation of the desired oxindoles.

3. Analytical Data of compounds

3.1 Synthesis of *N*-monosubstituted anilines**(*R*)-*N*-(1-Phenylethyl)aniline (1g):**

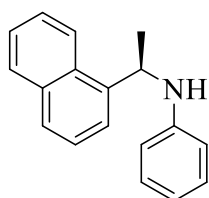
The title compound was prepared following the general procedure **GP1** using iodobenzene (1.12 mL, 10.0 mmol, 1.0 equiv.), (*R*)-1-phenylethan-1-amine (1.91 mL, 15.0 mmol, 1.5 equiv.), CuI (191 mg, 1.00 mmol, 0.1 equiv.), *L*-proline (230 mg, 2.00 mmol, 0.2 equiv.) and K₂CO₃ (2.76 g, 20.0 mmol, 2.0 equiv.) in DMSO (20 mL). Purification by flash column chromatography (EtOAc/pentane, *v/v* = 1:19) led to isolation of the title compound as a colourless solid (1.67 g, 8.48 mmol, 85%).

¹H NMR (300 MHz, CDCl₃, 300 K): δ_H (ppm) = 7.47 – 7.27 (m, 5H), 7.21 – 7.14 (m, 2H), 6.76 – 6.70 (m, 1H), 6.62 – 6.57 (m, 2H), 4.56 (q, *J* = 6.7 Hz, 1H), 4.23 (bs, 1H), 1.59 (d, *J* = 6.7 Hz, 3H).

¹³C NMR (75 MHz, CDCl₃, 300 K): δ_C (ppm) = 147.2 (C_q), 145.2 (C_q), 129.2 (CH), 128.7 (CH), 127.0 (CH), 126.0 (CH), 117.4 (CH), 113.5 (CH), 53.6 (CH), 25.1 (CH₃).

HRMS (ESI) *m/z* = 198.1277 calcd. for [C₁₄H₁₅NH]⁺ [M+H]⁺, found: 198.1277.

The analytical data are consistent with those reported in literature.⁴

(*R*)-*N*-(1-(Naphthalen-1-yl)ethyl)aniline (1h):

The title compound was prepared following the general procedure **GP1** using iodobenzene (1.12 mL, 10.0 mmol, 1.0 equiv.), (*R*)-1-(naphthalen-1-yl)ethan-1-amine (2.41 mL, 15.0 mmol, 1.5 equiv.), CuI (191 mg, 1.00 mmol, 0.1 equiv.), *L*-proline (230 mg, 2.00 mmol, 0.2 equiv.) and K₂CO₃ (2.76 g, 20.0 mmol, 2.0 equiv.) in DMSO (20 mL). Purification by flash column chromatography (EtOAc/pentane, *v/v* = 1:19) led to isolation of the title compound as a colourless solid (1.67 g, 8.48 mmol, 85%).

¹H NMR (300 MHz, CDCl₃, 300 K): δ_H (ppm) = 8.19 (d, *J* = 8.2 Hz, 1H), 7.95 – 7.92 (m, 1H), 7.77 (d, *J* = 8.2 Hz, 1H), 7.68 (d, *J* = 7.2 Hz, 1H), 7.61 – 7.51 (m, 2H), 7.45 – 7.40 (m, 1H), 7.11 – 7.06 (m, 2H), 6.68 – 6.63 (m, 1H), 6.52 – 6.49 (m, 2H), 5.31 (q, *J* = 6.7 Hz, 1H), 4.19 (s, 1H), 1.69 (d, *J* = 6.7 Hz, 3H).

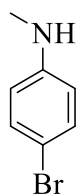
3. Analytical Data of compounds

¹³C NMR (75 MHz, CDCl₃, 300 K): δ_C (ppm) = 147.1 (C_q), 139.9 (C_q), 134.1 (C_q), 130.7 (C_q), 129.2 (CH), 127.5 (CH), 126.1 (CH), 125.9 (CH), 125.5 (CH), 122.6 (CH), 122.3 (CH), 117.2 (CH), 113.2 (CH), 49.5 (CH), 23.7 (CH₃).

HRMS (ESI) m/z = 248.1434 calcd. for [C₁₈H₁₇NH]⁺ [M+H]⁺, found: 248.1436.

The analytical data are consistent with those reported in literature.⁵

4-Bromo-*N*-methylaniline (1l):



The title compound was prepared following the general procedure **GP2** using 4-bromoaniline (860 mg, 5.00 mmol, 1.0 equiv.), NaOMe (810 mg, 15.0 mmol, 3.0 equiv.), paraformaldehyde (451 mg, 15.0 mmol, 3.0 equiv.) and NaBH₄ (568 mg, 15.0 mmol, 3.0 equiv.) in MeOH (12.5 mL). Purification by flash column chromatography (EtOAc/pentane, v/v = 1:9) led to isolation of the title compound as a brown oil (818 mg, 4.40 mmol, 88%).

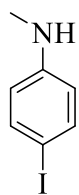
¹H NMR (300 MHz, CDCl₃, 300 K): δ_H (ppm) = 7.31 – 7.27 (m, 2H), 6.52 – 6.48 (m, 2H), 3.74 (s, 1H), 2.82 (s, 3H).

¹³C NMR (75 MHz, CDCl₃, 300 K): δ_C (ppm) = 148.3 (C_q), 131.9 (CH), 114.0 (CH), 108.7 (C_q), 30.7 (CH₃).

HRMS (ESI) m/z = 185.9913 calcd. for [C₇H₈NBrH]⁺ [M+H]⁺, found: 185.9912.

The analytical data are consistent with those reported in literature.⁶

4-Iodo-*N*-methylaniline (1m):



The title compound was prepared following the general procedure **GP2** using 4-iodoaniline (1.10 g, 5.00 mmol, 1.0 equiv.), NaOMe (810 mg, 15.0 mmol, 3.0 equiv.), paraformaldehyde (451 mg, 15.0 mmol, 3.0 equiv.) and NaBH₄ (568 mg, 15.0 mmol, 3.0 equiv.) in MeOH (12.5 mL). Purification by flash column chromatography (EtOAc/pentane, v/v = 1:9) led to isolation of the title compound as a brown oil (815 mg, 3.50 mmol, 70%).

¹H NMR (300 MHz, CDCl₃, 300 K): δ_H (ppm) = 7.46 – 7.42 (m, 2H), 6.43 – 6.38 (m, 2H), 3.97 (s, 1H), 2.81 (s, 3H).

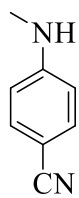
¹³C NMR (75 MHz, CDCl₃, 300 K): δ_C (ppm) = 148.8 (C_q), 137.7 (CH), 114.6 (CH), 77.8 (C_q), 30.6 (CH₃).

3. Analytical Data of compounds

HRMS (ESI) $m/z = 233.9774$ calcd. for $[C_7H_8NIH]^+ [M+H]^+$, found: 233.9773.

The analytical data are consistent with those reported in literature.⁷

4-(Methylamino)benzonitrile (**1n**):



The title compound was prepared following the general procedure **GP2** using 4-aminobenzonitrile (591 mg, 5.00 mmol, 1.0 equiv.), NaOMe (810 mg, 15.0 mmol, 3.0 equiv.), paraformaldehyde (451 mg, 15.0 mmol, 3.0 equiv.) and NaBH₄ (568 mg, 15.0 mmol, 3.0 equiv.) in MeOH (12.5 mL). Purification by flash column chromatography (EtOAc/pentane, $v/v = 3:7$) led to isolation of the title compound as a colourless solid (555 mg, 4.20 mmol, 84%).

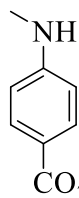
¹H NMR (300 MHz, CDCl₃, 300 K): δ_H (ppm) = 7.45 – 7.41 (m, 2H), 6.58 – 6.54 (m, 2H), 4.33 (s, 1H), 2.88 (d, $J = 5.0$ Hz, 3H).

¹³C NMR (75 MHz, CDCl₃, 300 K): δ_C (ppm) = 152.2 (C_q), 133.7 (CH), 120.6 (C_q), 111.8 (CH), 98.4 (C_q), 30.0 (CH₃).

HRMS (ESI) $m/z = 133.0760$ calcd. for $[C_8H_8N_2H]^+ [M+H]^+$, found: 133.0760.

The analytical data are consistent with those reported in literature.⁸

Methyl 4-(methylamino)benzoate (**1p**):



The title compound was prepared following the general procedure **GP2** using methyl 4-aminobenzoate (756 mg, 5.00 mmol, 1.0 equiv.), NaOMe (810 mg, 15.0 mmol, 3.0 equiv.), paraformaldehyde (451 mg, 15.0 mmol, 3.0 equiv.) and NaBH₄ (568 mg, 15.0 mmol, 3.0 equiv.) in MeOH (12.5 mL). Purification by flash column chromatography (EtOAc/pentane, $v/v = 1:4$) led to isolation of the title compound as a colourless solid (653 mg, 3.95 mmol, 79%).

¹H NMR (300 MHz, CDCl₃, 300 K): δ_H (ppm) = 7.90 – 7.85 (m, 2H), 6.57 – 6.52 (m, 2H), 4.31 (s, 1H), 3.87 (s, 3H), 2.87 (s, 3H).

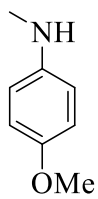
¹³C NMR (75 MHz, CDCl₃, 300 K): δ_C (ppm) = 167.5 (C_q), 152.9 (C_q), 131.5 (CH), 118.1 (C_q), 111.1 (CH), 51.5 (CH₃), 30.1 (CH₃).

HRMS (ESI) $m/z = 188.0682$ calcd. for $[C_9H_{11}NO_2Na]^+ [M+Na]^+$, found: 188.0679.

The analytical data are consistent with those reported in literature.⁸

3. Analytical Data of compounds

4-Methoxy-*N*-methylaniline (1q):



The title compound was prepared following the general procedure **GP2** using 4-methoxyaniline (616 mg, 5.00 mmol, 1.0 equiv.), NaOMe (810 mg, 15.0 mmol, 3.0 equiv.), paraformaldehyde (451 mg, 15.0 mmol, 3.0 equiv.) and NaBH₄ (568 mg, 15.0 mmol, 3.0 equiv.) in MeOH (12.5 mL). Purification by flash column chromatography (EtOAc/pentane, *v/v* = 1:4) led to isolation of the title compound as a colourless solid (594 mg, 4.33 mmol, 87%).

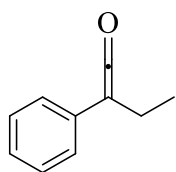
¹H NMR (300 MHz, CDCl₃, 300 K): δ_H (ppm) = 6.88 – 6.82 (m, 2H), 6.65 – 6.60 (m, 2H), 3.79 (s, 3H), 3.47 (s, 1H), 2.83 (s, 3H).

¹³C NMR (75 MHz, CDCl₃, 300 K): δ_C (ppm) = 152.1 (C_q), 143.8 (C_q), 114.9 (CH), 113.7 (CH), 55.9 (CH₃), 31.6 (CH₃).

HRMS (ESI) m/z = 138.0913 calcd. for [C₈H₁₁NOH]⁺ [M+H]⁺, found: 138.0910.

The analytical data are consistent with those reported in literature.⁹

3.2 Synthesis of Ketenes

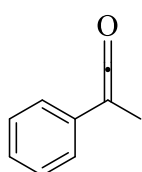
Ethylphenylketene (**2a**):

Ethylphenylketene **2a** was prepared following general procedure **GP3** using 2-phenylbutanoic acid (3.28 g, 20.0 mmol, 1.0 equiv.), oxalyl chloride (3.43 mL, 40.0 mmol, 2.0 equiv.) and NEt₃ (11.1 mL, 80.0 mmol, 4.0 equiv.) in CH₂Cl₂ (35 mL) and THF (30 mL). Purification by short-path vacuum distillation (high-vacuum, 70 °C) gave the title compound as a deep yellow oil (2.45 g, 16.7 mmol, 84%) which can be stored in the fridge for months.

¹H NMR (300 MHz, CDCl₃, 300 K): δ_H (ppm) = 7.55 – 7.50 (m, 2H), 7.31 – 7.24 (m, 3H), 2.65 (q, J = 7.4 Hz, 2H), 1.45 (t, J = 7.4 Hz, 3H).

¹³C NMR (75 MHz, CDCl₃, 300 K): δ_C (ppm) = 205.4 (C_q), 132.9 (C_q), 129.0 (CH), 124.2 (CH), 124.0 (CH), 41.9 (C_q), 17.0 (CH₂), 12.9 (CH₃).

The analytical data are consistent with those reported in the literature.¹⁰

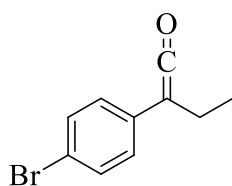
Methylphenylketene (**2b**):

Methylphenylketene **2b** was prepared following general procedure **GP3** using 2-phenylpropanoic acid (1.37 mL, 10.0 mmol, 1.0 equiv.), oxalyl chloride (1.29 mL, 15.0 mmol, 1.5 equiv.) and NEt₃ (5.55 mL, 40.0 mmol, 4.0 equiv.) in CH₂Cl₂ (10 mL) and Et₂O (15 mL). Purification by short-path vacuum distillation (70 °C, 0.47 mbar) gave the title compound as a deep yellow oil (768 mg, 5.81 mmol, 58%).

¹H NMR (300 MHz, CDCl₃, 300 K): δ_H (ppm) = 7.23 – 7.17 (m, 2H), 6.99 – 6.88 (m, 3H), 1.87 (s, 3H).

¹³C NMR (75 MHz, CDCl₃, 300 K): δ_C (ppm) = 205.6 (C_q), 133.4 (C_q), 129.0 (CH), 124.2 (CH), 123.7 (CH), 123.6 (CH), 33.8 (C_q), 8.6 (CH₃).

The analytical data are consistent with those reported in the literature.¹¹

2-(4-Bromophenyl)but-1-en-1-one (**2c**):

Following a modified procedure from the literature¹², diisopropylamine (8.43 mL, 60.0 mmol, 3.0 equiv.) was dissolved in anhydrous THF (25 mL). *n*-BuLi (1.6 M in hexanes, 31.3 mL, 50.0 mmol, 2.5 equiv.) was added slowly at 0 °C and the mixture was stirred at room temperature for 30 minutes. After cooling to 0 °C, a solution of 4-bromophenylacetic acid (4.30 g, 20.0 mmol,

3. Analytical Data of compounds

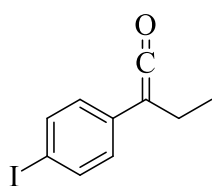
1.0 equiv.) in THF (20) was added slowly. The suspension was stirred for one hour at 0 °C, then ethyliodide (2.41 mL, 30.0 mmol, 1.5 equiv.) was added slowly. The reaction mixture was allowed to reach room temperature overnight and then adjusted to pH 1 by addition of hydrochloric acid (2 N aqueous solution, 7 mL). EtOAc (50 mL) was added and the phases were separated. The aqueous phase was extracted with EtOAc (3 x 50 mL), the combined organic phases were washed with brine (100 mL), dried over MgSO₄ and concentrated *in vacuo*. Purification by RP-MPLC (MeOH/water, gradient from 5% to 90%) gave 2-(4-bromophenyl)butanoic acid as a colourless solid (3.09 g, 12.7 mmol, 64%). The acid (3.10 g, 12.7 mmol, 1.0 equiv.) was then transformed to the desired ketene following general procedure **GP2** using oxalyl chloride (1.64 mL, 19.1 mmol, 1.5 equiv.) and NEt₃ (7.06 mL, 50.9 mmol, 4.0 equiv.) in CH₂Cl₂ (20 mL) and Et₂O (20 mL). Purification by Kugelrohr distillation (100 °C, 0.28 mbar) gave the title compound as a slightly yellow oil (982 mg, 4.36 mmol, 34%) which has been used immediately after preparation.

¹H NMR (300 MHz, CDCl₃, 300 K): δ_H (ppm) = 7.30 – 7.25 (m, 2H), 6.78 – 6.73 (m, 2H), 2.27 (q, J = 7.4 Hz, 2H), 1.09 (t, J = 7.4 Hz, 3H).

¹³C NMR (75 MHz, CDCl₃, 300 K): δ_C (ppm) = 204.3 (C_q), 132.0 (C_q and CH), 125.5 (CH), 117.2 (C_q), 41.8 (C_q), 17.0 (CH₂), 12.8 (CH₃).

The analytical data are consistent with those reported in the literature.¹¹

2-(4-Iodophenyl)but-1-en-1-one (2d):



Following a modified procedure from the literature¹², diisopropylamine (6.32 mL, 45.0 mmol, 3.0 equiv.) was dissolved in anhydrous THF (20 mL). *n*-BuLi (1.6 M in hexanes, 23.4 mL, 37.5 mmol, 2.5 equiv.) was added slowly at 0 °C and the mixture was stirred at room temperature for 30 minutes. After cooling to 0 °C, a solution of 4-iodophenylacetic acid (3.93 g, 15.0 mmol, 1.0 equiv.) in THF (15) was added slowly. The suspension was stirred for one hour at 0 °C, then ethyliodide (1.81 mL, 22.5 mmol, 1.5 equiv.) was added slowly. The reaction mixture was allowed to reach room temperature overnight and then adjusted to pH 1 by addition of hydrochloric acid (2 N aqueous solution, 5 mL). EtOAc (50 mL) was added and the phases were separated. The aqueous phase was extracted with EtOAc (3 x 50 mL), the combined organic phases were washed with brine (100 mL), dried over MgSO₄ and concentrated *in vacuo*. Purification by RP-MPLC (MeOH/water, gradient from 5% to 90%) gave 2-(4-iodophenyl)butanoic acid as a colourless solid (2.07 g, 7.03 mmol, 47%). The acid (2.03 g,

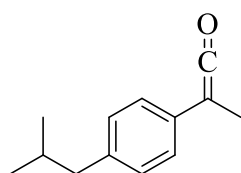
3. Analytical Data of compounds

7.00 mmol, 1.0 equiv.) was then transformed to the desired ketene following general procedure **GP2** using oxalyl chloride (952 μ L, 10.5 mmol, 1.5 equiv.) and NEt_3 (3.88 mL, 28.0 mmol, 4.0 equiv.) in CH_2Cl_2 (20 mL) and Et_2O (20 mL). Purification by Kugelrohr distillation (125 $^\circ\text{C}$, 0.40 mbar) gave the title compound as a slightly yellow oil (331 mg, 1.22 mmol, 17%) which has been used immediately after preparation.

$^1\text{H NMR}$ (300 MHz, CDCl_3 , 300 K): δ_{H} (ppm) = 7.28 (d, J = 8.2 Hz, 2H), 6.46 (d, J = 8.2 Hz, 2H), 2.08 (q, J = 7.4 Hz, 2H), 0.91 (t, J = 7.4 Hz, 3H).

$^{13}\text{C NMR}$ (75 MHz, CDCl_3 , 300 K): δ_{C} (ppm) = 204.1 (C_q), 137.8 (CH), 132.7 (C_q), 125.8 (CH), 87.8 (C_q), 41.9 (C_q), 16.9 (CH_2), 12.8 (CH_3).

2-(4-Isobutylphenyl)prop-1-en-1-one (**2e**):



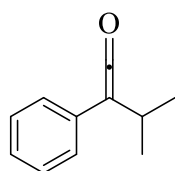
Ibuprofeneketene **2e** was prepared following general procedure **GP3** using ibuprofene (2.06 g, 10.0 mmol, 1.0 equiv.), oxalyl chloride (1.72 mL, 20.0 mmol, 2.0 equiv.) and NEt_3 (5.54 mL, 40.0 mmol, 4.0 equiv.) in CH_2Cl_2 (15 mL) and Et_2O (15 mL). Purification by short-path vacuum distillation (150 $^\circ\text{C}$, 0.28 mbar) gave the title compound as a deep yellow oil (862 mg, 4.58 mmol, 46%).

$^1\text{H NMR}$ (300 MHz, CDCl_3 , 300 K): δ_{H} (ppm) = 7.18 – 7.14 (m, 2H), 7.01 – 6.97 (m, 2H), 2.50 (d, J = 7.2 Hz, 2H), 2.04 (s, 3H), 1.97 – 1.81 (m, 1H), 0.96 (d, J = 6.6 Hz, 6H).

$^{13}\text{C NMR}$ (75 MHz, CDCl_3 , 300 K): δ_{C} (ppm) = 206.8 (C_q), 137.7 (C_q), 130.3 (C_q), 129.8 (CH), 123.4 (CH), 45.0 (CH_2), 33.4 (C_q), 30.4 (CH), 22.4 (CH_3), 8.7 (CH_3).

The analytical data are consistent with those reported in the literature.¹³

Isopropylphenylketene (**2f**):

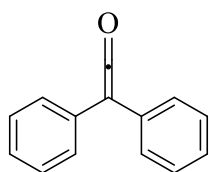


Isopropylphenylketene **2f** was prepared following general procedure **GP3** using 3-methyl-2-phenylbutanoic acid (1.78 g, 10.0 mmol, 1.0 equiv.), oxalyl chloride (1.29 mL, 15.0 mmol, 1.5 equiv.) and NEt_3 (5.55 mL, 40.0 mmol, 4.0 equiv.) in CH_2Cl_2 (10 mL) and Et_2O (15 mL). Purification by Kugelrohr distillation (100 $^\circ\text{C}$, 0.30 mbar) gave the title compound as an inseparable 11.5:1-mixture with residual acid chloride (NMR yield **2f**: 861 mg, 5.38 mmol, 54%).¹ This mixture was used for the oxindole synthesis without further purification and analysis.

¹ Determined by $^1\text{H-NMR}$ spectroscopy. Ketene **2f** was identified by comparison with spectra from the literature.¹¹

3. Analytical Data of compounds

Diphenylketene (**2g**):



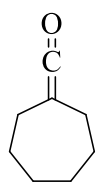
Diphenylketene **2g** was prepared following general procedure **GP3** using 2,2-diphenylacetic acid (2.12 g, 10.0 mmol, 1.0 equiv.), oxalyl chloride (1.72 mL, 20.0 mmol, 2.0 equiv.) and NEt_3 (5.54 mL, 40.0 mmol, 4.0 equiv.) in CH_2Cl_2 (15 mL) and Et_2O (15 mL). Purification by short-path vacuum distillation (150 °C, 0.24 mbar) gave the title compound as a deep yellow oil (1.34 g, 6.88 mmol, 69%).

$^1\text{H NMR}$ (300 MHz, CDCl_3 , 300 K): δ_{H} (ppm) = 7.34 – 7.28 (m, 4H), 7.19 – 7.13 (m, 6H).

$^{13}\text{C NMR}$ (75 MHz, CDCl_3 , 300 K): δ_{C} (ppm) = 200.0 (C_q), 129.7 (C_q), 128.2 (CH), 126.6 (CH), 125.1 (CH), 45.8 (C_q).

The analytical data are consistent with those reported in the literature.¹⁴

Cycloheptylidene methane (**2h**):



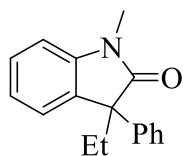
Ketene **2h** was prepared following general procedure **GP3** using Cycloheptanecarboxylic acid (2.40 mL, 20.0 mmol, 1.0 equiv.), Oxalyl chloride (3.41 mL, 40.0 mmol, 2.0 equiv.) and NEt_3 (11.1 mL, 80.0 mmol, 4.0 equiv.) in CH_2Cl_2 (20 mL) and Et_2O (25 mL). Purification by short-path vacuum distillation (70 °C, 0.8 mbar) gave the title compound as a yellow oil (412 mg, 3.32 mmol, 17%) which has been used immediately after distillation due to rapid decomposition.

$^1\text{H NMR}$ (300 MHz, CDCl_3 , 300 K): δ_{H} (ppm) = 2.25 – 2.21 (m, 4H), 1.70 – 1.61 (m, 4H), 1.59 – 1.51 (m, 4H).

The analytical data are consistent with those reported in the literature.¹⁴

3.3 Synthesis of Oxindoles

3-Ethyl-1-methyl-3-phenylindolin-2-one (3aa)



The title compound was prepared following the general procedure **GP4** using *N*-methylaniline **1a** (22 μ L, 0.20 mmol, 1.0 equiv.), EtMgBr (3.0 M solution in Et₂O, 73 μ L, 0.22 mmol, 1.1 equiv.), ketene **2a** (39 μ L, 0.30 mmol, 1.5 equiv.) and iodine (112 mg, 0.440 mmol, 2.2 equiv.) in THF (20 mL). Purification by RP-MPLC (MeOH/H₂O, gradient from 5% to 90%) gave the title compound as a colourless solid (41.2 mg, 0.164 mmol, 82%).

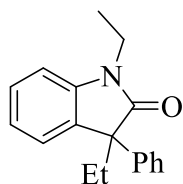
¹H NMR (300 MHz, CDCl₃, 300 K): δ_H (ppm) = 7.30 – 7.11 (m, 7H), 7.06 – 7.01 (m, 1H), 6.84 – 6.81 (m, 1H), 3.14 (s, 3H), 2.41 – 2.29 (m, 1H), 2.21 – 2.09 (m, 1H), 0.60 (t, J = 7.4 Hz, 3H).

¹³C NMR (75 MHz, CDCl₃, 300 K): δ_C (ppm) = 178.6 (C_q), 144.1 (C_q), 140.2 (C_q), 132.1 (C_q), 128.5 (CH), 128.1 (CH), 127.2 (CH), 127.0 (CH), 124.8 (CH), 122.6 (CH), 108.2 (CH), 57.3 (C_q), 30.9 (CH₂), 26.4 (CH₃), 9.1 (CH₃).

HRMS (ESI) m/z = 274.1202 calcd. for [C₁₇H₁₇NONa]⁺ [M+Na]⁺, found: 274.1203.

The analytical data are consistent with those reported in literature.¹⁵

1,3-Diethyl-3-phenylindolin-2-one (3ab)



The title compound was prepared following the general procedure **GP4** using *N*-ethylaniline **1b** (25 μ L, 0.20 mmol, 1.0 equiv.), EtMgBr (3.0 M solution in Et₂O, 73 μ L, 0.22 mmol, 1.1 equiv.), ketene **2a** (39 μ L, 0.30 mmol, 1.5 equiv.) and iodine (112 mg, 0.440 mmol, 2.2 equiv.) in THF (20 mL). Purification by RP-MPLC (MeOH/H₂O, gradient from 5% to 90%) gave the title compound as a colourless oil (26.0 mg, 98.0 μ mol, 49%).

¹H NMR (300 MHz, CDCl₃, 300 K): δ_H (ppm) = 7.38 – 7.21 (m, 7H), 7.13 – 7.08 (m, 1H), 6.95 – 6.92 (m, 1H), 3.91 – 3.69 (m, 2H), 2.46 (dq, J = 13.3, 7.4 Hz, 1H), 2.24 (dq, J = 13.3, 7.4 Hz, 1H), 1.28 (t, J = 7.2 Hz, 3H), 0.69 (t, J = 7.3 Hz, 3H).

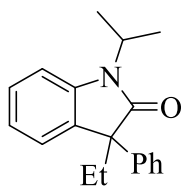
¹³C NMR (75 MHz, CDCl₃, 300 K): δ_C (ppm) = 178.2 (C_q), 143.2 (C_q), 140.5 (C_q), 132.5 (C_q), 128.5 (CH), 128.0 (CH), 127.1 (CH), 126.9 (CH), 124.9 (CH), 122.4 (CH), 108.3 (CH), 57.1 (C_q), 34.8 (CH₂), 30.8 (CH₂), 12.7 (CH₃), 8.9 (CH₃).

HRMS (ESI) m/z = 288.1359 calcd. for [C₁₈H₁₉NONa]⁺ [M+Na]⁺, found: 288.1358.

The analytical data are consistent to those reported in the literature.¹⁶

3. Analytical Data of compounds

3-Ethyl-1-isopropyl-3-phenylindolin-2-one (3ac)



The title compound was prepared following the general procedure **GP4** using *N*-isopropylaniline **1c** (29 μ L, 0.20 mmol, 1.0 equiv.), EtMgBr (3.0 M solution in Et₂O, 73 μ L, 0.22 mmol, 1.1 equiv.), ketene **2a** (39 μ L, 0.30 mmol, 1.5 equiv.) and iodine (112 mg, 0.440 mmol, 2.2 equiv.) in THF (20 mL).

Purification by RP-MPLC (MeOH/H₂O, gradient from 5% to 90%) gave the title compound as a colourless oil (19.6 mg, 70.0 μ mol, 35%).

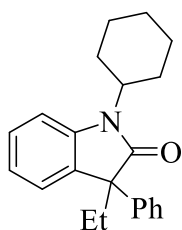
FT-IR (neat): ν (cm⁻¹) = 3062, 2970, 2935, 2878, 1708, 1608, 1484, 1465, 1399, 1352, 1311, 1296, 1244, 1211, 1137, 1080, 1027, 918, 749, 726, 696, 625.

¹H NMR (300 MHz, CDCl₃, 300 K): δ_H (ppm) = 7.36 – 7.07 (m, 9H), 4.70 (hept, J = 7.1 Hz, 1H), 2.54 – 2.42 (m, 1H), 2.28 – 2.17 (m, 1H), 1.52 (d, J = 7.1 Hz, 6H), 0.68 (t, J = 7.3 Hz, 3H).

¹³C NMR (75 MHz, CDCl₃, 300 K): δ_C (ppm) = 178.3 (C_q), 142.8 (C_q), 140.7 (C_q), 132.9 (C_q), 128.5 (CH), 127.7 (CH), 127.1 (CH), 126.8 (CH), 124.8 (CH), 122.1 (CH), 109.9 (CH), 56.9 (C_q), 43.9 (CH), 30.7 (CH₂), 19.5 (2 x CH₃), 8.8 (CH₃).

HRMS (ESI) m/z = 302.1521 calcd. for [C₁₉H₂₁NONa]⁺ [M+Na]⁺, found: 302.1514.

1-Cyclohexyl-3-ethyl-3-phenylindolin-2-one (3ad)



The title compound was prepared following the general procedure **GP4** using *N*-cyclohexylaniline **1d** (35 μ L, 0.20 mmol, 1.0 equiv.), EtMgBr (3.0 M solution in Et₂O, 73 μ L, 0.22 mmol, 1.1 equiv.), ketene **2a** (39 μ L, 0.30 mmol, 1.5 equiv.) and iodine (112 mg, 0.440 mmol, 2.2 equiv.) in THF (20 mL).

Purification by RP-MPLC (MeOH/H₂O, gradient from 5% to 90%) gave the title compound as a colourless oil (31.4 mg, 98.0 μ mol, 49%).

FT-IR (neat): ν (cm⁻¹) = 3053, 2934, 2858, 2009, 1706, 1609, 1483, 1484, 1369, 1346, 1306, 1256, 1236, 1202, 1112, 1080, 1034, 907, 749, 728, 696, 672, 648, 611.

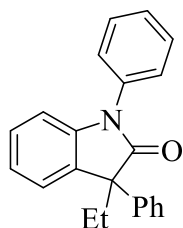
¹H NMR (600 MHz, CDCl₃, 300 K): δ_H (ppm) = 7.34 – 7.32 (m, 2H), 7.30 – 7.27 (m, 3H), 7.24 – 7.21 (m, 1H), 7.17 (dd, J = 7.4, 1.4 Hz, 1H), 7.13 (d, J = 7.9 Hz, 1H), 7.08 – 7.05 (m, 1H), 4.23 – 4.18 (m, 1H), 2.50 – 2.43 (m, 1H), 2.26 – 2.16 (m, 2H), 1.91 – 1.88 (m, 2H), 1.76 – 1.75 (m, 3H), 1.48 – 1.36 (m, 2H), 1.31 – 1.22 (m, 2H), 0.67 (t, J = 7.3 Hz, 3H).

3. Analytical Data of compounds

¹³C NMR (151 MHz, CDCl₃, 300 K): δ_C (ppm) = 178.4 (C_q), 143.2 (C_q), 140.9 (C_q), 132.9 (C_q), 128.5 (CH), 127.7 (CH), 127.1 (CH), 126.8 (CH), 124.8 (CH), 122.0 (CH), 110.0 (CH), 56.8 (C_q), 52.3 (CH), 30.7 (CH₂), 29.3 (CH₂), 29.2 (CH₂), 26.0 (2 x CH₂), 25.4 (CH₂), 8.8 (CH₃).

HRMS (ESI) m/z = 342.1834 calcd. for [C₂₂H₂₅NONa]⁺ [M+Na]⁺, found: 342.1827.

3-Ethyl-1,3-diphenylindolin-2-one (3ae)



The title compound was prepared following the general procedure **GP4** using diphenylamin **1e** (33.8 mg, 0.200 mmol, 1.0 equiv.), EtMgBr (3.0 M-solution in Et₂O, 73 μ L, 0.22 mmol, 1.1 equiv.), ketene **2a** (39 μ L, 0.30 mmol, 1.5 equiv.) and iodine (112 mg, 0.440 mmol, 2.2 equiv.) in THF (20 mL). Purification by RP-MPLC (MeOH/H₂O, gradient from 5% to 90%) gave the title compound as a colourless solid (34.9 mg, 0.111 mmol, 56%).

MP: 117-119 °C.

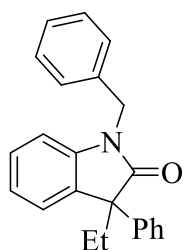
FT-IR (neat): ν (cm⁻¹) = 3058, 2965, 2925, 2876, 1715, 1608, 1583, 1496, 1480, 1463, 1333, 1319, 1280, 1207, 1173, 1108, 913, 748, 723, 694, 640, 608.

¹H NMR (300 MHz, CDCl₃, 300 K): δ_H (ppm) = 7.53 – 7.11 (m, 13H), 6.90 – 6.87 (m, 1H), 2.62 – 2.50 (m, 1H), 2.37 – 2.25 (m, 1H), 0.81 (t, J = 7.3 Hz, 3H).

¹³C NMR (75 MHz, CDCl₃, 300 K): δ_C (ppm) = 178.1 (C_q), 144.1 (C_q), 140.4 (C_q), 134.6 (C_q), 132.0 (C_q), 129.6 (CH), 128.6 (CH), 128.0 (2 x CH), 127.3 (CH), 127.0 (CH), 126.7 (CH), 125.0 (CH), 123.1 (CH), 109.5 (CH), 57.4 (C_q), 31.3 (CH₂), 9.1 (CH₃).

HRMS (ESI) m/z = 336.1359 calcd. for [C₂₂H₁₉NONa]⁺ [M+Na]⁺, found: 336.1359.

1-Benzyl-3-ethyl-3-phenylindolin-2-one (3af)



The title compound was prepared following the general procedure **GP4** using *N*-benzylaniline **1f** (36.7 mg, 0.200 mmol, 1.0 equiv.), EtMgBr (3.0 M solution in Et₂O, 73 μ L, 0.22 mmol, 1.1 equiv.), ketene **2a** (39 μ L, 0.30 mmol, 1.5 equiv.) and iodine (112 mg, 0.440 mmol, 2.2 equiv.) in THF (20 mL). Purification by RP-MPLC (MeOH/H₂O, gradient from 5% to 90%) gave the title compound as a colourless oil (35.1 mg, 0.107 mmol, 54%).

¹H NMR (300 MHz, CDCl₃, 300 K): δ_H (ppm) = 7.39 – 7.17 (m, 12H), 7.09 – 7.04 (m, 1H), 6.80 – 6.77 (m, 1H), 4.92 (dd, J = 15.7, 6.9 Hz, 2H), 2.51 (dq, J = 13.4, 7.3 Hz, 1H), 2.28 (dq, J = 13.4, 7.3 Hz, 1H), 0.73 (t, J = 7.3 Hz, 3H).

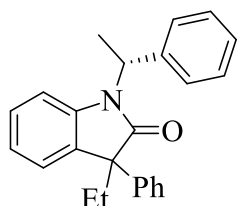
3. Analytical Data of compounds

¹³C NMR (75 MHz, CDCl₃, 300 K): δ_C (ppm) = 178.7 (C_q), 143.3 (C_q), 140.4 (C_q), 136.1 (C_q), 132.2 (C_q), 128.8 (CH), 128.6 (CH), 128.0 (CH), 127.6 (CH), 127.4 (CH), 127.3 (CH), 127.0 (CH), 124.8 (CH), 122.6 (CH), 109.3 (CH), 57.3 (C_q), 44.0 (CH₂), 30.8 (CH₂), 9.2 (CH₃).

HRMS (ESI) m/z = 350.1521 calcd. for [C₂₃H₂₁NONa]⁺ [M+Na]⁺, found: 350.1513.

The analytical data are consistent with those reported in literature.¹⁷

3-Ethyl-3-phenyl-1-((*R*)-1-phenylethyl)indolin-2-one (**3ag**)



The title compound was prepared following the general procedure **GP4** using (*R*)-*N*-(1-phenylethyl)aniline **1g** (39.5 mg, 0.200 mmol, 1.0 equiv.), EtMgBr (3.0 M solution in Et₂O, 73 μ L, 0.22 mmol, 1.1 equiv.), ketene **2a** (39 μ L, 0.30 mmol, 1.5 equiv.) and iodine (112 mg, 0.440 mmol, 2.2 equiv.) in THF (20 mL). Deprotonation time and stirring time after ketene addition were extended to one hour each. Purification by RP-MPLC (MeOH/H₂O, gradient from 5% to 90%) and preparative HPLC (MeCN/H₂O, gradient from 5% to 70%) gave the title compound as a colourless oil (49.7 mg, 0.146 mmol, 73%, 1.9:1 d.r.²).

FT-IR (neat): ν (cm⁻¹) = 3059, 2967, 2923, 1704, 1607, 1483, 1465, 1347, 1197, 1077, 1026, 909, 748, 727, 695, 670, 633.

¹H NMR (600 MHz, CDCl₃, 300 K): δ_H (ppm) = 7.39 – 7.25 (m, 18H, both diastereoisomers), 7.19 – 7.17 (m, 2H, both diastereoisomers), 7.09 – 7.01 (m, 4H, both diastereoisomers), 6.58 – 6.54 (m, 2H, both diastereoisomers), 5.94 – 5.86 (m, 2H, both diastereoisomers), 2.58 – 2.52 (m, 2H, both diastereoisomers), 2.34 – 2.25 (m, 2H, both diastereoisomers), 1.84 (d, J = 7.2 Hz, 3H, minor diastereoisomer), 1.82 (d, J = 7.2 Hz, 3H, major diastereoisomer), 0.81 (t, J = 7.3 Hz, 3H, major diastereoisomer), 0.72 (t, J = 7.3 Hz, 3H, minor diastereoisomer).

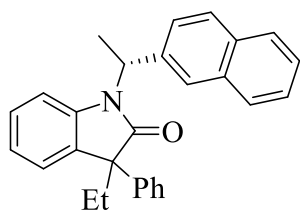
¹³C NMR (151 MHz, CDCl₃, 300 K): δ_C (ppm) = 178.6 (C_q), 142.0 (2 x C_q), 140.8 (C_q), 140.7 (C_q), 139.3 (C_q), 132.7 (2 x C_q), 128.6 (3 x CH), 127.5 (CH), 127.3 (2 x CH), 127.2 (2 x CH), 126.9 (CH), 126.7 (CH), 126.6 (CH), 124.7 (CH), 124.6 (CH), 122.3 (CH), 122.2 (CH), 111.0 (2 x CH), 57.0 (C_q), 49.0 (2 x CH), 30.7 (CH₂), 30.5 (CH₂), 16.3 (2 x CH₃), 9.3 (CH₃), 9.0 (CH₃).

HRMS (ESI) m/z = 364.1677 calcd. for [C₂₄H₂₃NONa]⁺ [M+Na]⁺, found: 364.1668.

² Determined by ¹H-NMR spectroscopy of the crude product prior to purification.

3. Analytical Data of compounds

3-Ethyl-1-((*R*)-1-(naphthalen-2-yl)ethyl)-3-phenylindolin-2-one (**3ah**)



The title compound was prepared following the general procedure **GP4** using (*R*)-*N*-(1-(naphthalen-2-yl)ethyl)aniline **1h** (49.5 mg, 0.200 mmol, 1.0 equiv.), EtMgBr (3.0 M solution in Et₂O, 73 μL, 0.22 mmol, 1.1 equiv.), ketene **2a** (39 μL, 0.30 mmol, 1.5 equiv.) and iodine (112 mg, 0.440 mmol, 2.2 equiv.) in THF (20 mL). Deprotonation time and stirring time after ketene addition were extended to one hour each. Purification by RP-MPLC (MeOH/H₂O, gradient from 5% to 90%) and preparative HPLC (MeCN/H₂O, gradient from 5% to 70%) gave the title compound as a colourless oil (61.9 mg, 0.158 mmol, 79%, 1.5:1 d.r.³).

FT-IR (neat): ν (cm⁻¹) = 3059, 2968, 2924, 1708, 1607, 1483, 1465, 1197, 1077, 1027, 913, 749, 696, 634.

¹H NMR (600 MHz, CDCl₃, 300 K): δ_H (ppm) = 7.38 – 7.28 (m, 18H, both diastereoisomers), 7.25 – 7.24 (m, 2H, both diastereoisomers), 7.27 – 7.16 (m, 2H, both diastereoisomers), 7.08 – 7.00 (m, 4H, both diastereoisomers), 6.57 – 6.54 (m, 2H, both diastereoisomers), 5.92 – 5.86 (m, 2H, both diastereoisomers), 2.57 – 2.54 (m, 2H, both diastereoisomers), 2.33 – 2.25 (m, 2H, both diastereoisomers), 1.84 (d, J = 7.2 Hz, 3, minor diastereoisomer), 1.81 (d, J = 7.2 Hz, 3H, major diastereoisomer), 0.80 (t, J = 7.3 Hz, 3H, major diastereoisomer), 0.72 (t, J = 7.3 Hz, 3H, minor diastereoisomer).

¹³C NMR (151 MHz, CDCl₃, 300 K): δ_C (ppm) = 178.6 (C_q), 142.0 (2 x C_q), 140.8 (C_q), 140.7 (C_q), 139.3 (C_q), 132.7 (C_q), 128.6 (2 x CH), 128.5 (CH), 127.5 (CH), 127.3 (2 x CH), 127.2 (2 x CH), 126.9 (CH), 126.7 (CH), 126.6 (CH), 124.7 (CH), 124.6 (CH), 122.2 (2 x CH), 111.0 (CH), 110.9 (CH), 57.0 (C_q), 56.9 (C_q), 49.0 (2 x CH), 30.7 (CH₂), 30.5 (CH₂), 16.3 (2 x CH₃), 9.3 (CH₃), 9.0 (CH₃).⁴

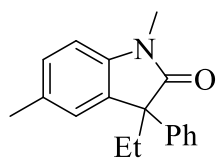
HRMS (ESI) m/z = 414.1834 calcd. for [C₂₈H₂₅NONa]⁺ [M+Na]⁺, found: 414.1825.

³ Determined by ¹H-NMR spectroscopy of the crude product prior to purification.

⁴ Some aromatic signals of the diastereoisomers are superimposed and therefore not resolved.

3. Analytical Data of compounds

3-Ethyl-1,5-dimethyl-3-phenylindolin-2-one (3ai)



The title compound was prepared following the general procedure **GP4** using *N*,4-dimethylaniline **1i** (25 μ L, 0.20 mmol, 1.0 equiv.), EtMgBr (3.0 M solution in Et₂O, 73 μ L, 0.22 mmol, 1.1 equiv.), ketene **2a** (39 μ L, 0.30 mmol, 1.5 equiv.) and iodine (112 mg, 0.440 mmol, 2.2 equiv.) in THF (20 mL). Purification by RP-MPLC (MeOH/H₂O, gradient from 20% to 90%) to give the title compound as a colourless oil (40.5 mg, 0.153 mmol, 76%).

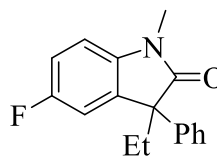
FT-IR (neat): ν (cm⁻¹) = 3022, 2966, 2933, 2876, 2359, 1704, 1618, 1601, 1497, 1457, 1323, 1348, 1262, 1146, 1113, 1070, 806, 774, 695, 638.

¹H NMR (300 MHz, CDCl₃, 300 K): δ_H (ppm) = 7.40 – 7.22 (m, 5H), 7.16 – 7.13 (m, 1H), 7.06 – 7.05 (m, 1H), 6.82 (d, *J* = 7.9 Hz, 1H), 3.24 (s, 3H), 2.52 – 2.39 (m, 4H), 2.30 – 2.18 (m, 1H), 0.71 (t, *J* = 7.3 Hz, 3H).

¹³C NMR (75 MHz, CDCl₃, 300 K): δ_C (ppm) = 178.6 (C_q), 141.8 (C_q), 140.5 (C_q), 132.2 (C_q), 132.1 (C_q), 128.5 (CH), 128.4 (CH), 127.1 (CH), 127.0 (CH), 125.5 (CH), 107.9 (CH), 57.4 (C_q), 30.7 (CH₂), 26.3 (CH₃), 21.3 (CH₃), 9.1 (CH₃).

HRMS (ESI) m/z = 288.1364 calcd. for [C₁₈H₁₉NONa]⁺ [M+Na]⁺, found: 288.1355.

3-Ethyl-5-fluoro-1-methyl-3-phenylindolin-2-one (3aj)



The title compound was prepared following the general procedure **GP4** using 4-fluoro-*N*-methylaniline **1j** (24 μ L, 0.20 mmol, 1.0 equiv.), EtMgBr (3.0 M-solution in Et₂O, 73 μ L, 0.22 mmol, 1.1 equiv.), ketene **2a** (39 μ L, 0.30 mmol, 1.5 equiv.) and iodine (112 mg, 0.440 mmol, 2.2 equiv.) in THF (20 mL). Purification by RP-MPLC (MeOH/H₂O, gradient from 20% to 90%) to give the title compound as a colourless oil (38.7 mg, 0.144 mmol, 72%).

FT-IR (neat): ν (cm⁻¹) = 3060, 2968, 2934, 2878, 1710, 1618, 1493, 1452, 1350, 1262, 1112, 856, 811, 741, 723, 697, 561.

¹H NMR (600 MHz, CDCl₃, 300 K): δ_H (ppm) = 7.36 – 7.29 (m, 4H), 7.27 – 7.24 (m, 1H), 7.05 (dd, *J* = 8.5, 2.6 Hz, 1H), 6.98 (d, *J* = 2.6 Hz, 1H), 6.84 (d, *J* = 8.5 Hz, 1H), 3.23 (s, 3H), 2.45 (dq, *J* = 13.4, 7.3 Hz, 1H), 2.22 (dq, *J* = 13.4, 7.3 Hz, 1H), 0.70 (t, *J* = 7.3 Hz, 3H).

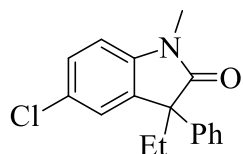
3. Analytical Data of compounds

$^{13}\text{C}\{^1\text{H},^{19}\text{F}\}$ NMR (151 MHz, CDCl_3 , 300 K): δ_{C} (ppm) = 178.3 (C_q), 159.3 (C_q), 140.1 (C_q), 139.6 (C_q), 133.8 (C_q), 128.6 (CH), 127.4 (CH), 126.8 (CH), 114.4 (CH), 112.8 (CH), 108.5 (CH), 57.8 (C_q), 30.7 (CH_2), 26.4 (CH_3), 8.9 (CH_3).

$^{19}\text{F}\{^1\text{H},^{13}\text{C}\}$ NMR (282 MHz, CDCl_3 , 300 K): δ_{F} (ppm) = -120.4.

HRMS (ESI) m/z = 292.1114 calcd. for $[\text{C}_{17}\text{H}_{16}\text{NOFNa}]^+ [\text{M}+\text{Na}]^+$, found: 292.1106.

5-Chloro-3-ethyl-1-methyl-3-phenylindolin-2-one (3ak)



The title compound was prepared following the general procedure **GP4** using 4-chloro-*N*-methylaniline **1k** (24 μL , 0.20 mmol, 1.0 equiv.), EtMgBr (3.0 M-solution in Et_2O , 73 μL , 0.22 mmol, 1.1 equiv.), ketene **2a** (39 μL , 0.30 mmol, 1.5 equiv.) and iodine (112 mg, 0.440 mmol, 2.2 equiv.) in THF (20 mL). Purification by RP-MPLC (MeOH/ H_2O , gradient from 20% to 90%) to give the title compound as a colourless oil (30.3 mg, 0.106 mmol, 53%).

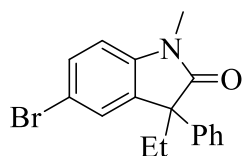
^1H NMR (300 MHz, CDCl_3 , 300 K): δ_{H} (ppm) = 7.37 – 7.21 (m, 7H), 6.85 (d, J = 8.3 Hz, 1H), 3.24 (s, 3H), 2.45 (dq, J = 13.4, 7.3 Hz, 1H), 2.24 (dq, J = 13.4, 7.3 Hz, 1H), 0.71 (t, J = 7.3 Hz, 3H).

^{13}C NMR (75 MHz, CDCl_3 , 300 K): δ_{C} (ppm) = 178.1 (C_q), 142.7 (C_q), 139.6 (C_q), 134.0 (C_q), 128.7 (CH), 128.1 (CH), 128.0 (C_q), 127.5 (CH), 126.8 (CH), 125.1 (CH), 109.1 (CH), 57.6 (C_q), 30.7 (CH_2), 26.4 (CH_3), 9.0 (CH_3).

HRMS (ESI) m/z = 308.0813 calcd. for $[\text{C}_{17}\text{H}_{16}\text{NOCINa}]^+ [\text{M}+\text{Na}]^+$, found: 308.0811.

The analytical data are consistent with those reported in the literature.¹⁵

5-Bromo-3-ethyl-1-methyl-3-phenylindolin-2-one (3al)



The title compound was prepared following the general procedure **GP4** using 4-bromo-*N*-methylaniline **1l** (37.2 mg, 0.200 mmol, 1.0 equiv.), EtMgBr (3.0 M-solution in Et_2O , 73 μL , 0.22 mmol, 1.1 equiv.), ketene **2a** (39 μL , 0.30 mmol, 1.5 equiv.) and iodine (112 mg, 0.440 mmol, 2.2 equiv.) in THF (20 mL). Purification by RP-MPLC (MeOH/ H_2O , gradient from 20% to 90%) to give the title compound as a colourless oil (45.3 mg, 0.137 mmol, 69%).

^1H NMR (300 MHz, CDCl_3 , 300 K): δ_{H} (ppm) = 7.42 – 7.39 (m, 1H), 7.28 – 7.18 (m, 5H), 6.75 – 6.72 (m, 1H), 3.16 (d, 3H), 2.44 – 2.32 (m, 1H), 2.22 – 2.10 (m, 1H), 0.64 (t, J = 7.3 Hz, 3H).

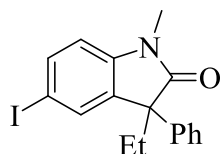
3. Analytical Data of compounds

¹³C NMR (75 MHz, CDCl₃, 300 K): δ_C (ppm) = 178.0 (C_q), 143.2 (C_q), 139.5 (C_q), 134.4 (C_q), 131.0 (CH), 128.7 (CH), 127.8 (CH), 127.5 (CH), 126.8 (CH), 115.4 (C_q), 109.6 (CH), 57.6 (C_q), 30.7 (CH₂), 26.4 (CH₃), 9.0 (CH₃).

HRMS (ESI) m/z = 352.0308 calcd. for [C₁₇H₁₆NOBrNa]⁺ [M+Na]⁺, found: 352.0309.

The analytical data are consistent with those reported in the literature.¹⁵

5-Iodo-3-ethyl-1-methyl-3-phenylindolin-2-one (3am)



The title compound was prepared following the general procedure **GP4** using 4-iodo-*N*-methylaniline **1m** (46.6 mg, 0.200 mmol, 1.0 equiv.), EtMgBr (3.0 M-solution in Et₂O, 73 μ L, 0.22 mmol, 1.1 equiv.), ketene **2a** (39 μ L, 0.30 mmol, 1.5 equiv.) and iodine (112 mg, 0.440 mmol, 2.2 equiv.) in THF (20 mL). Purification by RP-MPLC (MeOH/H₂O, gradient from 20% to 90%) to give the title compound as a colourless oil (65.6 mg, 0.174 mmol, 87%).

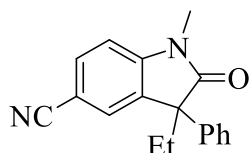
FT-IR (neat): ν (cm⁻¹) = 3058, 2966, 2932, 2875, 1710, 1601, 1484, 1457, 1361, 1341, 1320, 1111, 1077, 807, 726, 696, 627.

¹H NMR (300 MHz, CDCl₃, 300 K): δ_H (ppm) = 7.68 – 7.64 (m, 1H), 7.50 (d, J = 1.7 Hz, 1H), 7.33 – 7.22 (m, 5H), 6.70 (d, J = 8.1 Hz, 1H), 3.22 (s, 3H), 2.49 – 2.38 (m, 1H), 2.28 – 2.16 (m, 1H), 0.70 (t, J = 7.1 Hz, 3H).

¹³C NMR (75 MHz, CDCl₃, 300 K): δ_C (ppm) = 177.9 (C_q), 143.9 (C_q), 139.6 (C_q), 137.0 (CH), 134.7 (C_q), 133.3 (CH), 128.7 (CH), 127.5 (CH), 126.8 (CH), 110.2 (CH), 85.2 (C_q), 57.4 (C_q), 30.7 (CH₂), 26.4 (CH₃), 9.0 (CH₃).

HRMS (ESI) m/z = 400.0169 calcd. for [C₁₇H₁₆NOINa]⁺ [M+Na]⁺, found: 400.0167.

3-Ethyl-1-methyl-2-oxo-3-phenylindoline-5-carbonitrile (3an)



The title compound was prepared following the general procedure **GP4** using 4-cyano-*N*-methylaniline **1n** (26.4 mg, 0.200 mmol, 1.0 equiv.), EtMgBr (3.0 M-solution in Et₂O, 73 μ L, 0.22 mmol, 1.1 equiv.), ketene **2a** (39 μ L, 0.30 mmol, 1.5 equiv.) and iodine (112 mg, 0.440 mmol, 2.2 equiv.) in THF (20 mL). Purification by RP-MPLC (MeOH/H₂O, gradient from 20% to 90%) to give the title compound as a colourless oil (50.8 mg, 0.184 mmol, 92%).

FT-IR (neat): ν (cm⁻¹) = 2972, 2252, 2224, 1718, 1613, 1496, 1343, 1259, 1069, 904, 821, 695, 647, 610.

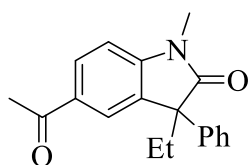
3. Analytical Data of compounds

¹H NMR (300 MHz, CDCl₃, 300 K): δ_H (ppm) = 7.71 – 7.67 (m, 1H), 7.50 (d, J = 1.1 Hz, 1H), 7.37 – 7.26 (m, 5H), 7.02 – 6.99 (m, 1H), 3.28 (s, 3H), 2.53 – 2.34 (m, 1H), 2.31 – 2.22 (m, 1H), 0.71 (t, J = 7.3 Hz, 3H).

¹³C NMR (75 MHz, CDCl₃, 300 K): δ_C (ppm) = 178.3 (C_q), 147.9 (C_q), 138.7 (C_q), 133.5 (CH), 133.3 (C_q), 128.8 (CH), 128.0 (CH), 127.8 (CH), 126.7 (CH), 119.2 (C_q), 108.7 (CH), 105.8 (C_q), 57.1 (C_q), 30.8 (CH₂), 26.6 (CH₃), 9.0 (CH₃).

HRMS (ESI) m/z = 299.1155 calcd. for [C₁₈H₁₆N₂ONa]⁺ [M+Na]⁺, found: 299.1157.

5-Acetyl-3-ethyl-1-methyl-3-phenylindolin-2-one (3ao)



The title compound was prepared following the general procedure **GP4** using 1-(4-(methylamino)phenyl)ethan-1-one **1o** (29.8 mg, 0.200 mmol, 1.0 equiv.), EtMgBr (3.0 M-solution in Et₂O, 73 μ L, 0.22 mmol, 1.1 equiv.), ketene **2a** (39 μ L, 0.30 mmol, 1.5 equiv.) and iodine (112 mg,

0.440 mmol, 2.2 equiv.) in THF (20 mL). Purification by RP-MPLC (MeOH/H₂O, gradient from 20% to 90%) to give the title compound as a colourless oil (17.6 mg, 0.060 mmol, 30%).

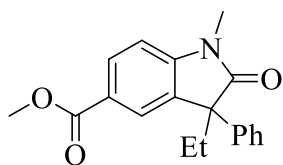
FT-IR (neat): ν (cm⁻¹) = 2968, 1719, 1674, 1607, 1497, 1441, 1372, 1346, 1270, 1221, 1056, 747, 698, 614.

¹H NMR (600 MHz, CDCl₃, 300 K): δ_H (ppm) = 8.02 (dd, J = 8.2, 1.8 Hz, 1H), 7.88 (dd, J = 1.8, 0.5 Hz, 1H), 7.37 – 7.24 (m, 5H), 6.97 (d, J = 8.2 Hz, 1H), 3.29 (s, 3H), 2.61 (s, 3H), 2.47 (dq, J = 13.4, 7.3 Hz, 1H), 2.30 (dq, J = 13.4, 7.3 Hz, 1H), 0.70 (t, J = 7.3 Hz, 3H).

¹³C NMR (151 MHz, CDCl₃, 300 K): δ_C (ppm) = 196.9 (C_q), 178.9 (C_q), 148.4 (C_q), 139.5 (C_q), 132.5 (C_q), 132.2 (C_q), 130.2 (CH), 128.7 (CH), 127.5 (CH), 126.8 (CH), 124.6 (CH), 107.6 (CH), 57.2 (C_q), 30.8 (CH₂), 26.6 (CH₃), 26.4 (CH₃), 9.0 (CH₃).

HRMS (ESI) m/z = 316.1308 calcd. for [C₁₉H₁₉NO₂Na]⁺ [M+Na]⁺, found: 316.1310.

Methyl 3-ethyl-1-methyl-2-oxo-3-phenylindoline-5-carboxylate (3ap)



The title compound was prepared following the general procedure **GP4** using methyl 4-(methylamino)benzoate **1p** (33.0 mg, 0.200 mmol, 1.0 equiv.), EtMgBr (3.0 M-solution in Et₂O, 73 μ L, 0.22 mmol, 1.1 equiv.), ketene **2a** (39 μ L, 0.30 mmol, 1.5 equiv.) and iodine

(112 mg, 0.440 mmol, 2.2 equiv.) in THF (20 mL). Purification by RP-MPLC (MeOH/H₂O,

3. Analytical Data of compounds

gradient from 5% to 60%) to give the title compound as a colourless oil (51.0 mg, 0.165 mmol, 82%).

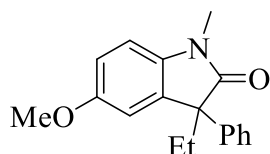
FT-IR (neat): ν (cm⁻¹) = 2950, 2878, 1709, 1613, 1498, 1442, 1345, 1273, 1224, 1103, 1064, 913, 768, 728, 631.

¹H NMR (300 MHz, CDCl₃, 300 K): δ_H (ppm) = 8.12 – 8.09 (m, 1H), 7.92 (d, J = 1.7 Hz, 1H), 7.38 – 7.25 (m, 5H), 6.96 (d, J = 8.2 Hz, 1H), 3.91 (s, 3H), 3.27 (s, 3H), 2.52 – 2.41 (m, 1H), 2.35 – 2.23 (m, 1H), 0.69 (t, J = 7.3 Hz, 3H).

¹³C NMR (75 MHz, CDCl₃, 300 K): δ_C (ppm) = 178.9 (C_q), 167.0 (C_q), 148.2 (C_q), 139.5 (C_q), 132.1 (C_q), 130.9 (CH), 128.7 (CH), 127.5 (CH), 126.9 (CH), 126.0 (CH), 124.6 (C_q), 107.8 (CH), 57.2 (C_q), 52.1 (CH₃), 30.9 (CH₂), 26.5 (CH₃), 9.0 (CH₃).

HRMS (ESI) m/z = 332.1257 calcd. for [C₁₉H₁₉NO₃Na]⁺ [M+Na]⁺, found: 332.1257.

3-Ethyl-5-methoxy-1-methyl-3-phenylindolin-2-one (3aq)



The title compound was prepared following the general procedure **GP4** using 4-(methoxy)-*N*-methylaniline **1q** (27.4 mg, 0.200 mmol, 1.0 equiv.), EtMgBr (3.0 M-solution in Et₂O, 73 μ L, 0.22 mmol, 1.1 equiv.), ketene **2a** (39 μ L, 0.30 mmol, 1.5 equiv.) and iodine (112 mg, 0.440 mmol, 2.2 equiv.) in THF (20 mL). Purification by RP-MPLC (MeOH/H₂O, gradient from 20% to 90%) to give the title compound as a colourless oil (40.0 mg, 0.142 mmol, 71%).

FT-IR (neat): ν (cm⁻¹) = 2935, 1706, 1600, 1497, 1459, 1288, 1041, 807, 698.

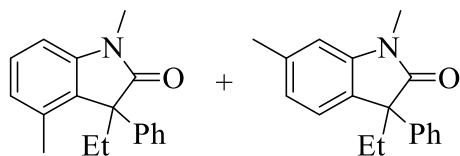
¹H NMR (300 MHz, CDCl₃, 300 K): δ_H (ppm) = 7.39 – 7.22 (m, 5H), 6.90 – 6.81 (m, 3H), 3.82 (m, 3H), 3.23 – 3.22 (m, 3H), 2.52 – 2.40 (m, 1H), 2.28 – 2.16 (m, 1H), 0.73 – 0.68 (m, 3H).

¹³C NMR (75 MHz, CDCl₃, 300 K): δ_C (ppm) = 178.3 (C_q), 156.0 (C_q), 140.3 (C_q), 137.7 (C_q), 133.5 (C_q), 128.5 (CH), 127.2 (CH), 126.9 (CH), 112.3 (CH), 112.2 (CH), 108.4 (CH), 57.8 (C_q), 55.8 (CH₃), 30.7 (CH₂), 26.4 (CH₃), 9.0 (CH₃).

HRMS (ESI) m/z = 304.1308 calcd. for [C₁₈H₁₉NO₂Na]⁺ [M+Na]⁺, found: 304.1308.

3. Analytical Data of compounds

3-Ethyl-1,4-dimethyl-3-phenylindolin-2-one (**3ar**) and 3-Ethyl-1,6-dimethyl-3-phenylindolin-2-one (**3ar'**):



The title compound was prepared following the general procedure **GP4** using *N*,3-dimethylaniline **1r** (25 μ L, 0.20 mmol, 1.0 equiv.), EtMgBr (3.0 M-solution in Et₂O, 73 μ L, 0.22 mmol, 1.1 equiv.), ketene **2a** (39 μ L, 0.30 mmol, 1.5 equiv.) and iodine (112 mg, 0.440 mmol, 2.2 equiv.) in THF (20 mL). Purification by RP-MPLC (MeOH/H₂O, gradient from 20% to 90%) to give the title compound as a colourless oil. (40.3 mg, 0.152 mmol, 76%, 1.8:1 r.r.). Purification by preparative HPLC (MeCN/H₂O, gradient from 5% to 50%) gave analytically pure samples of both regioisomers.

3-Ethyl-1,4-dimethyl-3-phenylindolin-2-one (major regioisomer, **3ar**):

FT-IR (neat): ν (cm⁻¹) = 2967, 2934, 1713, 1600, 1471, 1365, 1346, 1243, 1054, 959, 913, 771, 741, 697, 667, 596.

¹H NMR (300 MHz, CDCl₃, 300 K): δ_H (ppm) = 7.31 – 7.19 (m, 6H), 6.89 (d, J = 7.8 Hz, 1H), 6.78 (d, J = 7.7 Hz, 1H), 3.22 (s, 3H), 2.71 (dq, J = 13.3, 7.3 Hz, 1H), 2.34 (dq, J = 13.3, 7.3 Hz, 1H), 2.03 (s, 3H), 0.61 (t, J = 7.3 Hz, 3H).

¹³C NMR (151 MHz, CDCl₃, 300 K): δ_C (ppm) = 178.6 (C_q), 144.6 (C_q), 139.6 (C_q), 135.1 (C_q), 129.7 (C_q), 128.5 (CH), 128.1 (CH), 127.2 (CH), 126.7 (CH), 125.0 (CH), 105.7 (CH), 57.8 (C_q), 27.1 (CH₂), 26.4 (CH₃), 18.2 (CH₃), 9.0 (CH₃).

HRMS (ESI) m/z = 288.1357 calcd. for [C₁₈H₁₉NONa]⁺ [M+Na]⁺, found: 288.1354.

3-Ethyl-1,6-dimethyl-3-phenylindolin-2-one (minor regioisomer, **3ar'**):

FT-IR (neat): ν (cm⁻¹) = 3025, 2968, 2934, 1707, 1619, 1496, 1469, 1456, 1372, 1315, 1276, 1257, 1075, 1038, 957, 910, 730, 697, 602.

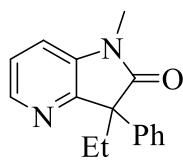
¹H NMR (300 MHz, CDCl₃, 300 K): δ_H (ppm) = 7.40 – 7.36 (m, 2H), 7.32 – 7.20 (m, 3H), 7.12 (d, J = 7.5 Hz, 1H), 6.96 – 6.93 (m, 1H), 6.74 (s, 1H), 3.22 (s, 3H), 2.47 – 2.32 (m, 4H), 2.22 (dq, J = 13.4, 7.4 Hz, 1H), 0.69 (t, J = 7.4 Hz, 3H).

¹³C NMR (151 MHz, CDCl₃, 300 K): δ_C (ppm) = 178.9 (C_q), 144.2 (C_q), 140.4 (C_q), 138.2 (C_q), 129.0 (C_q), 128.4 (CH), 127.1 (CH), 127.0 (CH), 124.5 (CH), 123.1 (CH), 109.1 (CH), 57.1 (C_q), 30.9 (CH₂), 26.3 (CH₃), 21.8 (CH₃), 9.1 (CH₃).

HRMS (ESI) m/z = 288.1357 calcd. for [C₁₈H₁₉NONa]⁺ [M+Na]⁺, found: 288.1359.

3. Analytical Data of compounds

3-Ethyl-1-methyl-3-phenyl-1,3-dihydro-2H-pyrrolo[3,2-b]pyridin-2-one (3as)



The title compound was prepared following the general procedure **GP4** using *N*-methylpyridin-3-amine **1s** (21 μ L, 0.20 mmol, 1.0 equiv.), EtMgBr (3.0 M-solution in Et₂O, 73 μ L, 0.22 mmol, 1.1 equiv.), ketene **2a** (39 μ L, 0.30 mmol, 1.5 equiv.) and iodine (112 mg, 0.440 mmol, 2.2 equiv.) in THF (20 mL). Purification by RP-MPLC (MeOH/H₂O, gradient from 20% to 90%) to give the title compound as a colourless oil (19.7 mg, 0.078 mmol, 39%).

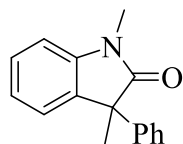
¹H NMR (300 MHz, CDCl₃, 300 K): δ_H (ppm) = 8.27 – 8.25 (m, 1H), 7.52 – 7.49 (m, 1H), 7.39 – 7.29 (m, 5H), 7.06 – 7.02 (m, 1H), 3.33 (s, 3H), 2.45 – 2.21 (m, 2H), 0.74 (t, $J = 7.4$ Hz, 3H).

¹³C NMR (75 MHz, CDCl₃, 300 K): δ_C (ppm) = 178.2 (C_q), 157.5 (C_q), 147.1 (CH), 138.9 (C_q), 132.1 (CH), 128.7 (CH), 127.6 (CH), 126.8 (CH), 126.6 (C_q), 118.1 (CH), 57.0 (C_q), 30.9 (CH₂), 25.5 (CH₃), 9.1 (CH₃).

HRMS (ESI) $m/z = 275.1160$ calcd. for [C₁₆H₁₆N₂ONa]⁺ [M+Na]⁺, found: 275.1153.

The analytical data are consistent with those reported in the literature.¹⁸

1,3-Dimethyl-3-phenylindolin-2-one (3ba)



The title compound was prepared following the general procedure **GP4** using *N*-methylaniline **1a** (22 μ L, 0.20 mmol, 1.0 equiv.), EtMgBr (3.0 M-solution in Et₂O, 73 μ L, 0.22 mmol, 1.1 equiv.), ketene **2b** (39.6 mg, 0.300 mmol, 1.5 equiv.) and iodine (112 mg, 0.440 mmol, 2.2 equiv.) in THF (20 mL). Purification by RP-MPLC (MeOH/H₂O, gradient from 20% to 90%) to give the title compound as a colourless oil (27.6 mg, 0.116 mmol, 58%).

¹H NMR (300 MHz, CDCl₃, 300 K): δ_H (ppm) = 7.37 – 7.19 (m, 7H), 7.13 – 7.08 (m, 1H), 6.94 – 6.92 (m, 1H), 3.26 (s, 3H), 1.80 (s, 3H).

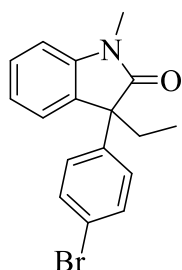
¹³C NMR (75 MHz, CDCl₃, 300 K): δ_C (ppm) = 179.5 (C_q), 143.3 (C_q), 140.8 (C_q), 134.9 (C_q), 128.5 (CH), 128.1 (CH), 127.2 (CH), 126.7 (CH), 124.2 (CH), 122.8 (CH), 108.3 (CH), 52.2 (C_q), 26.5 (CH₃), 23.8 (CH₃).

HRMS (ESI) $m/z = 260.1046$ calcd. for [C₁₆H₁₅NONa]⁺ [M+Na]⁺, found: 260.1046.

The analytical data are consistent with those reported in the literature.¹⁹

3. Analytical Data of compounds

3-(4-Bromophenyl)-3-ethyl-1-methylindolin-2-one (3ca)



The title compound was prepared following the general procedure **GP4** using *N*-methylaniline **1a** (22 μ L, 0.20 mmol, 1.0 equiv.), EtMgBr (3.0 M-solution in Et₂O, 73 μ L, 0.22 mmol, 1.1 equiv.), ketene **2c** (67.5 mg, 0.300 mmol, 1.5 equiv.) and iodine (112 mg, 0.440 mmol, 2.2 equiv.) in THF (20 mL). Purification by RP-MPLC (MeOH/H₂O, gradient from 20% to 90%) to give the title compound as a colourless oil (46.1 mg, 0.140 mmol, 70%).

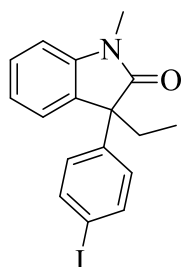
FT-IR (neat): ν (cm⁻¹) = 3055, 2966, 2932, 2877, 2247, 1705, 1609, 1489, 1469, 1370, 1347, 1254, 1098, 1074, 909, 814, 744, 731, 699, 570.

¹H NMR (300 MHz, CDCl₃, 300 K): δ_H (ppm) = 7.43 – 7.11 (m, 7H), 6.94 – 6.91 (m, 1H), 3.23 (s, 3H), 2.38 (dq, *J* = 13.3, 7.3 Hz, 1H), 2.20 (dq, *J* = 13.3, 7.3 Hz, 1H), 0.68 (t, *J* = 7.3 Hz, 3H).

¹³C NMR (75 MHz, CDCl₃, 300 K): δ_C (ppm) = 178.1 (C_q), 144.1 (C_q), 139.3 (C_q), 131.5 (CH), 131.4 (C_q), 128.9 (CH), 128.4 (CH), 124.8 (CH), 122.7 (CH), 121.4 (C_q), 108.4 (CH), 56.9 (C_q), 31.0 (CH₂), 26.4 (CH₃), 9.0 (CH₃).

HRMS (ESI) m/z = 352.0309 calcd. for [C₁₇H₁₆NOBrNa]⁺ [M+Na]⁺, found: 352.0308.

3-(4-Iodophenyl)-3-ethyl-1-methylindolin-2-one (3da)



The title compound was prepared following the general procedure **GP4** using *N*-methylaniline **1a** (22 μ L, 0.20 mmol, 1.0 equiv.), EtMgBr (3.0 M-solution in Et₂O, 73 μ L, 0.22 mmol, 1.1 equiv.), ketene **2d** (81.6 mg, 0.300 mmol, 1.5 equiv.) and iodine (112 mg, 0.440 mmol, 2.2 equiv.) in THF (20 mL). Purification by RP-MPLC (MeOH/H₂O, gradient from 20% to 90%) to give the title compound as a colourless oil (57.1 mg, 0.151 mmol, 76%).

FT-IR (neat): ν (cm⁻¹) = 3054, 2966, 2932, 2876, 1709, 1610, 1486, 1469, 1371, 1348, 1255, 1090, 1075, 1005, 911, 813, 750, 698, 570.

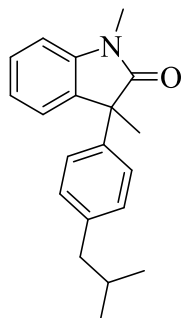
¹H NMR (300 MHz, CDCl₃, 300 K): δ_H (ppm) = 7.64 – 7.59 (m, 2H), 7.39 – 7.33 (m, 1H), 7.23 – 7.10 (m, 4H), 6.94 – 6.91 (m, 1H), 3.23 (s, 3H), 2.44 – 2.32 (m, 1H), 2.25 – 2.13 (m, 1H), 0.68 (t, *J* = 7.3 Hz, 3H).

¹³C NMR (75 MHz, CDCl₃, 300 K): δ_C (ppm) = 178.1 (C_q), 144.1 (C_q), 140.0 (C_q), 137.5 (CH), 131.3 (C_q), 129.1 (CH), 128.4 (CH), 124.7 (CH), 122.7 (CH), 108.4 (CH), 93.1 (C_q), 57.0 (C_q), 30.9 (CH₂), 26.4 (CH₃), 9.0 (CH₃).

3. Analytical Data of compounds

HRMS (ESI) $m/z = 400.0169$ calcd. for $[C_{17}H_{xx}NOINa]^+ [M+Na]^+$, found: 400.0169.

3-(4-Isobutylphenyl)-1,3-dimethylindolin-2-one (3ea)



The title compound was prepared following the general procedure **GP4** using *N*-methylaniline **1a** (22 μ L, 0.20 mmol, 1.0 equiv.), EtMgBr (3.0 M-solution in Et₂O, 73 μ L, 0.22 mmol, 1.1 equiv.), ketene **2e** (56.5 mg, 0.300 mmol, 1.5 equiv.) and iodine (112 mg, 0.440 mmol, 2.2 equiv.) in THF (20 mL). Purification by RP-MPLC (MeOH/H₂O, gradient from 20% to 90%) to give the title compound as a colourless oil (23.6 mg, 80.4 μ mol, 40%).

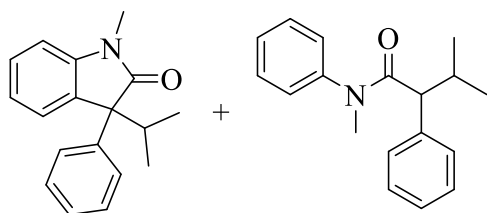
¹H NMR (300 MHz, CDCl₃, 300 K): δ_H (ppm) = 7.35 – 7.30 (m, 1H), 7.22 – 7.19 (m, 3H), 7.13 – 7.05 (m, 3H), 6.93 – 6.90 (m, 1H), 3.25 (s, 3H), 2.42 (d, $J = 7.2$ Hz, 2H), 1.87 – 1.78 (m, 4H), 0.89 – 0.87 (m, 6H).

¹³C NMR (75 MHz, CDCl₃, 300 K): δ_C (ppm) = 179.7 (C_q), 143.3 (C_q), 140.7 (C_q), 138.0 (C_q), 135.0 (C_q), 129.3 (CH), 128.0 (CH), 126.3 (CH), 124.2 (CH), 122.7 (CH), 108.2 (CH), 51.9 (C_q), 45.0 (CH₂), 30.1 (CH), 26.5 (CH₃), 23.8 (CH₃), 22.4 (2 x CH₃).

HRMS (ESI) $m/z = 316.1672$ calcd. for $[C_{20}H_{23}NONa]^+ [M+Na]^+$, found: 316.1672.

The analytical data are consistent with those reported in the literature.²⁰

3-Isopropyl-1-methyl-3-phenylindolin-2-one (3fa) and *N*,3-Dimethyl-*N*,2-diphenylbutanamide (4fa)



The title compounds were prepared following the general procedure **GP4** using *N*-methylaniline **1a** (22 μ L, 0.20 mmol, 1.0 equiv.), EtMgBr (3.0 M-solution in Et₂O, 73 μ L, 0.22 mmol, 1.1 equiv.), ketene **2f** (48.1 mg, 0.300 mmol, 1.5 equiv.) and iodine (112 mg, 0.440 mmol, 2.2 equiv.) in THF (20 mL). Purification by RP-MPLC (MeOH/H₂O, gradient from 5% to 60%) and preparative HPLC (MeCN/H₂O, gradient from 5% to 50%) to give the title compounds as a colourless oil and inseparable mixture (1:1.4 mixture, combined yield: 29.5 mg, 0.111 mmol, 56%).

¹H NMR (300 MHz, CDCl₃, 300 K): δ_H (ppm) = 7.49 – 6.90 (m, 10H from **4fa** and 9H from **3fa**), 3.24 (s, 3H from **4fa**), 3.20 (s, 3H from **3fa**), 3.01 (d, $J = 10.5$ Hz, 1H from **4fa**), 2.96 – 2.87 (m, 1H from **4fa**), 2.46 – 2.36 (m, 1H from **3fa**), 1.02 (d, $J = 6.5$ Hz, 3H from **4fa**), 0.96

3. Analytical Data of compounds

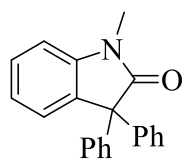
(d, $J = 7.0$ Hz, 3H from **3fa**), 0.69 (d, $J = 6.7$ Hz, 3H from **3fa**), 0.50 (d, $J = 6.7$ Hz, 3H from **4fa**).

^{13}C NMR (75 MHz, CDCl_3 , 300 K): δ_{C} (ppm) = 178.4 (C_q from **3fa**), 173.4 (C_q from **4fa**), 144.4 (C_q from **3fa**), 144.0 (C_q from **4fa**), 139.5 (C_q from **4fa**), 139.1 (C_q from **3fa**), 129.6, 129.5 (C_q from **3fa**), 128.7 (CH from **4fa**), 128.4 (CH from **4fa**), 128.3 (CH from **4fa**), 128.2 (CH from **3fa**), 127.9 (CH from **4fa**), 127.5 (CH from **4fa**), 127.1 (CH from **3fa**), 126.7 (CH from **4fa**), 126.2 (CH from **3fa**), 122.0 (CH from **3fa**), 108.2 (CH from **3fa**), 60.8 (C_q from **3fa**), 56.9 (CH from **4fa**), 37.6 (CH_3 from **4fa**), 36.1 (CH from **3fa**), 33.0 (CH from **4fa**), 26.2 (CH_3 from **3fa**), 21.9 (CH_3 from **4fa**), 20.2 (CH_3 from **4fa**), 17.6 (CH_3 from **3fa**), 17.5 (CH_3 from **3fa**).

HRMS (ESI) $m/z = 288.1359$ calcd. for $[\text{C}_{18}\text{H}_{19}\text{NONa}]^+ [\text{M}(\mathbf{3fa})+\text{Na}]^+$, found: 288.1360; 290.1515 calcd. for $[\text{C}_{18}\text{H}_{21}\text{NONa}]^+ [\text{M}(\mathbf{4fa})+\text{Na}]^+$, found: 290.1515.

The analytical data are consistent with those reported in the literature.²¹

1-Methyl-3,3-diphenylindolin-2-one (**3ga**)



The title compound was prepared following the general procedure **GP4** using *N*-methylaniline **1a** (22 μL , 0.20 mmol, 1.0 equiv.), EtMgBr (3.0 M-solution in Et_2O , 73 μL , 0.22 mmol, 1.1 equiv.), ketene **2g** (58.3 mg, 0.300 mmol, 1.5 equiv.) and iodine (112 mg, 0.440 mmol, 2.2 equiv.) in THF (20 mL). Purification by RP-MPLC ($\text{MeOH}/\text{H}_2\text{O}$, gradient from 20% to 90%) to give the title compound as a colourless oil (33.2 mg, 0.111 mmol, 55%).

^1H NMR (600 MHz, CDCl_3 , 300 K): δ_{H} (ppm) = 7.39 – 7.28 (m, 7H), 7.26 – 7.19 (m, 5H), 7.12 – 7.09 (m, 1H), 6.95 – 6.94 (m, 1H), 3.31 (s, 3H).

^{13}C NMR (151 MHz, CDCl_3 , 300 K): δ_{C} (ppm) = 177.6 (C_q), 143.1 (C_q), 141.9 (C_q), 128.8 (C_q), 128.4 (2 x CH), 128.3 (CH), 127.3 (CH), 126.1 (CH), 122.8 (CH), 108.5 (CH), 26.7 (CH_3).⁵

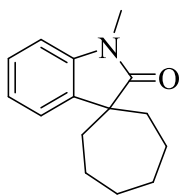
HRMS (ESI) $m/z = 322.1203$ calcd. for $[\text{C}_{21}\text{H}_{17}\text{NONa}]^+ [\text{M}+\text{Na}]^+$, found: 322.1202.

The analytical data are consistent with those reported in the literature.²²

⁵ The signal of the quaternary α -C-atom is not resolved.

3. Analytical Data of compounds

1'-Methylspiro[cycloheptane-1,3'-indolin]-2'-one (3ha)



The title compound was prepared following the general procedure **GP4** using *N*-methylaniline **1a** (22 μ L, 0.20 mmol, 1.0 equiv.), EtMgBr (3.0 M-solution in Et₂O, 73 μ L, 0.22 mmol, 1.1 equiv.), ketene **2h** (37.3 mg, 0.300 mmol, 1.5 equiv.) and iodine (112 mg, 0.440 mmol, 2.2 equiv.) in THF (20 mL). Purification by RP-MPLC (MeOH/H₂O, gradient from 20% to 90%) to give the title compound as a colourless oil (11.9 mg, 51.9 μ mol, 26%).

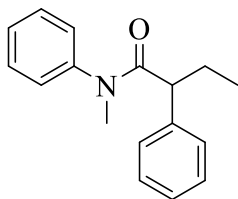
¹H NMR (300 MHz, CDCl₃, 300 K): δ_H (ppm) = 7.37 – 7.33 (m, 1H), 7.29 – 7.23 (m, 1H), 7.08 – 7.03 (m, 1H), 6.84 – 6.81 (m, 1H), 3.19 (s, 3H), 2.02 – 1.95 (m, 4H), 1.77 – 1.69 (m, 8H).

¹³C NMR (75 MHz, CDCl₃, 300 K): δ_C (ppm) = 182.2 (C_q), 142.5 (C_q), 137.4 (C_q), 127.4 (CH), 122.7 (CH), 122.3 (CH), 107.8 (CH), 50.1 (C_q), 36.9 (CH₂), 31.3 (CH₂), 26.1 (CH₃), 23.8 (CH₂).

HRMS (ESI) m/z = 230.1539 calcd. for [C₁₅H₁₉NOH]⁺ [M+H]⁺, found: 230.1539.

The analytical data are consistent with those reported in the literature.²³

3.4 Synthesis of Amides

***N*-Methyl-*N*,2-diphenylbutanamide (4aa)**

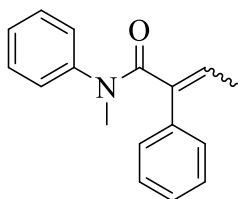
To a solution of *N*-methylaniline (22 μ L, 0.20 mmol, 1.0 equiv.) in anhydrous THF (20 mL) was added EtMgBr (3.0 M-solution in THF, 73 μ L, 0.22 mmol, 1.1 equiv.) at room temperature and the mixture was stirred for 30 minutes. Ketene **2a** (39 μ L, 0.30 mmol, 1.5 equiv.) was added at room temperature and stirring was continued for further 30 minutes. Water (20 mL) and EtOAc (20 mL) were added and the phases were separated. The aqueous phase was extracted with EtOAc (3 x 20 mL), the combined organic phases were dried over MgSO₄ and concentrated *in vacuo*. Purification by RP-MPLC (MeOH/H₂O, gradient from 20% to 90%) to give the title compound as a colourless oil (46.1 mg, 0.182 mmol, 91%).

¹H NMR (300 MHz, CDCl₃, 300 K): δ_H (ppm) = 7.40 – 7.35 (m, 3H), 7.25 – 7.15 (m, 3H), 7.07 – 6.99 (m, 4H), 3.36 (dd, *J* = 8.4, 6.7 Hz, 1H), 3.25 (s, 3H), 2.17 – 2.03 (m, 1H), 1.74 – 1.60 (m, 1H), 0.80 (t, *J* = 7.3 Hz, 3H).

¹³C NMR (75 MHz, CDCl₃, 300 K): δ_C (ppm) = 173.4 (C_q), 143.8 (C_q), 140.4 (C_q), 129.6 (CH), 128.3 (CH), 128.1 (2 x CH), 127.9 (CH), 126.7 (CH), 50.7 (CH), 37.6 (CH₂), 28.4 (CH₃), 12.4 (CH₃).

HRMS (ESI) *m/z* = 276.1359 calcd. for [C₁₇H₁₉NONa]⁺ [M+Na]⁺, found: 276.1359.

The analytical data are consistent with those reported in the literature.²⁴

***N*-Methyl-*N*,2-diphenylbut-2-enamide (5aa)**

To a solution of *N*-methylaniline (22 μ L, 0.20 mmol, 1.0 equiv.) in anhydrous THF (20 mL) was added EtMgBr (3.0 M-solution in THF, 73 μ L, 0.22 mmol, 1.1 equiv.) at room temperature and the mixture was stirred for 30 minutes. Ketene **2a** (39 μ L, 0.30 mmol, 1.5 equiv.) was added at room temperature and stirring was continued for further 30 minutes. Iodine (112 mg, 0.440 mmol, 2.2 equiv.) was added and the flask opened to air. The mixture was stirred at room temperature for 18 hours and then quenched by addition of water (20 mL) and EtOAc (20 mL). The phases were separated and the aqueous phase was extracted with EtOAc (3 x 20 mL). The combined organic phases were dried over MgSO₄ and concentrated *in vacuo*. Purification by RP-MPLC (MeOH/H₂O, gradient from 20% to 90%) followed by preparative HPLC (MeCN/H₂O, gradient from 5% to 40%) to give the title compound as a colourless oil (22.5 mg, 89.5 μ mol, 45%).

3.4 Synthesis of Amides

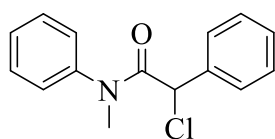
¹H NMR (300 MHz, CDCl₃, 300 K): δ_H (ppm) = 7.20 – 7.10 (m, 8H), 6.88 – 6.85 (m, 2H), 5.74 (q, J = 7.0 Hz, 1H), 3.41 (s, 3H), 1.82 (d, J = 7.1 Hz, 3H).

¹³C NMR (126 MHz, CDCl₃, 300 K): δ_C (ppm) = 169.8 (C_q), 143.2 (C_q), 139.4 (C_q), 137.8 (C_q), 128.6 (CH), 128.2 (CH), 127.1 (2 x CH), 126.4 (CH), 125.8 (CH), 125.6 (CH), 36.7 (CH₃), 16.0 (CH₃).

HRMS (ESI) m/z = 274.1202 calcd. for [C₁₅H₁₉NONa]⁺ [M+Na]⁺, found: 274.1202.

The analytical data are consistent with those reported in the literature.²⁵

2-Chloro-*N*-methyl-*N*,2-diphenylacetamide (6)



To a solution of *N*-methylaniline (1.08 mL, 10.0 mmol, 1.0 equiv.) in CH₂Cl₂ (50 mL) was added NEt₃ (2.77 mL, 20.0 mmol, 2.0 equiv.) at 0 °C. 2-Chloro-2-phenylacetyl chloride (1.90 mL, 12.0 mmol, 1.2 equiv.) was added dropwise over 5 minutes at this temperature and the mixture was allowed to warm to room temperature overnight. Water (50 mL) was added and the phases were separated. The aqueous phase was extracted with CH₂Cl₂ (3 x 50 mL). The combined organic phases were dried over MgSO₄, filtered and concentrated *in vacuo*. Purification by FC (EtOAc/pentane, v/v = 3:17) gave the title compound as a yellow oil (2.43 g, 9.34 mmol, 93%).

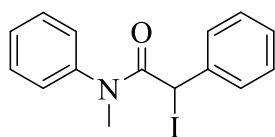
¹H NMR (300 MHz, CDCl₃, 300 K): δ_H (ppm) = 7.46 – 7.31 (m, 3H), 7.32–7.27 (m, 5H), 7.13 (s, 2H), 5.33 (s, 1H), 3.31 (s, 3H).

¹³C NMR (75 MHz, CDCl₃, 300 K): δ_C (ppm) = 167.5 (C_q), 142.7 (C_q), 136.5 (C_q), 130.1 (CH), 129.0 (CH), 128.7 (CH), 128.6 (CH), 128.3 (CH), 127.6 (CH), 56.9 (CH), 38.3 (CH₃).

HRMS (ESI) m/z = 282.0656 calcd. for [C₁₅H₁₄NOCINa]⁺ [M+Na]⁺, found: 282.0654.

The analytical data are consistent with those reported in the literature.²⁶

2-Iodo-*N*-methyl-*N*,2-diphenylacetamide (7)



2-Chloro-*N*-methyl-*N*,2-diphenylacetamide **6** (100 mg, 0.385 mmol, 1.0 equiv.) was dissolved in anhydrous acetone (0.5 mL). Sodium iodide (69.3 mg, 0.462 mmol, 1.2 equiv.) was added at room temperature and mixture was stirred overnight. Brine (10 mL) and EtOAc (10 mL) were added and the phases separated. The aqueous phase was extracted with EtOAc (3 x 10 mL). The combined organic phases were dried over MgSO₄, filtered and concentrated *in vacuo*.

3.4 Synthesis of Amides

Purification by RP-MPLC (MeOH/H₂O, gradient from 5% to 90%) gave the title compound as a yellow oil (77.3 mg, 0.220 mmol, 57%).

FT-IR (neat): ν (cm⁻¹) = 3060, 2925, 1659, 1594, 1494, 1454, 1416, 1376, 1289, 1247, 1109, 1073, 1036, 1001, 912, 840, 773, 728, 695, 943, 557.

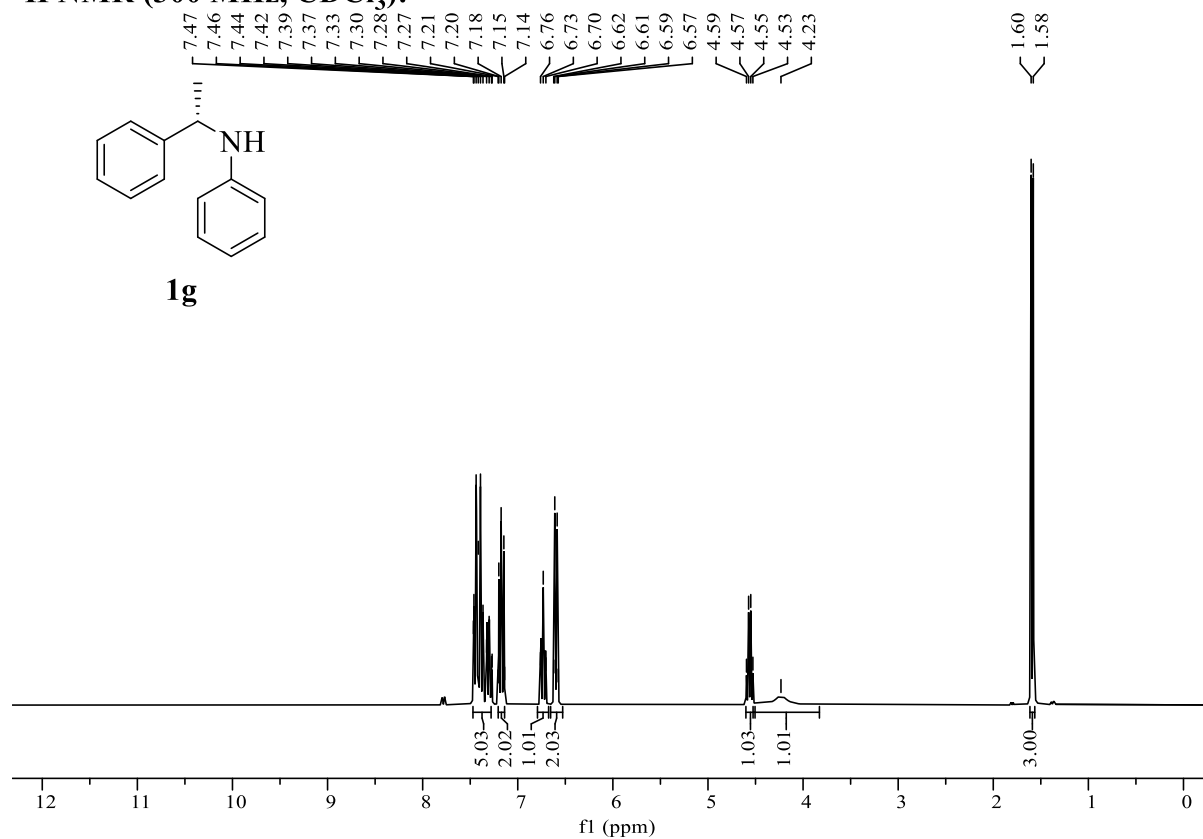
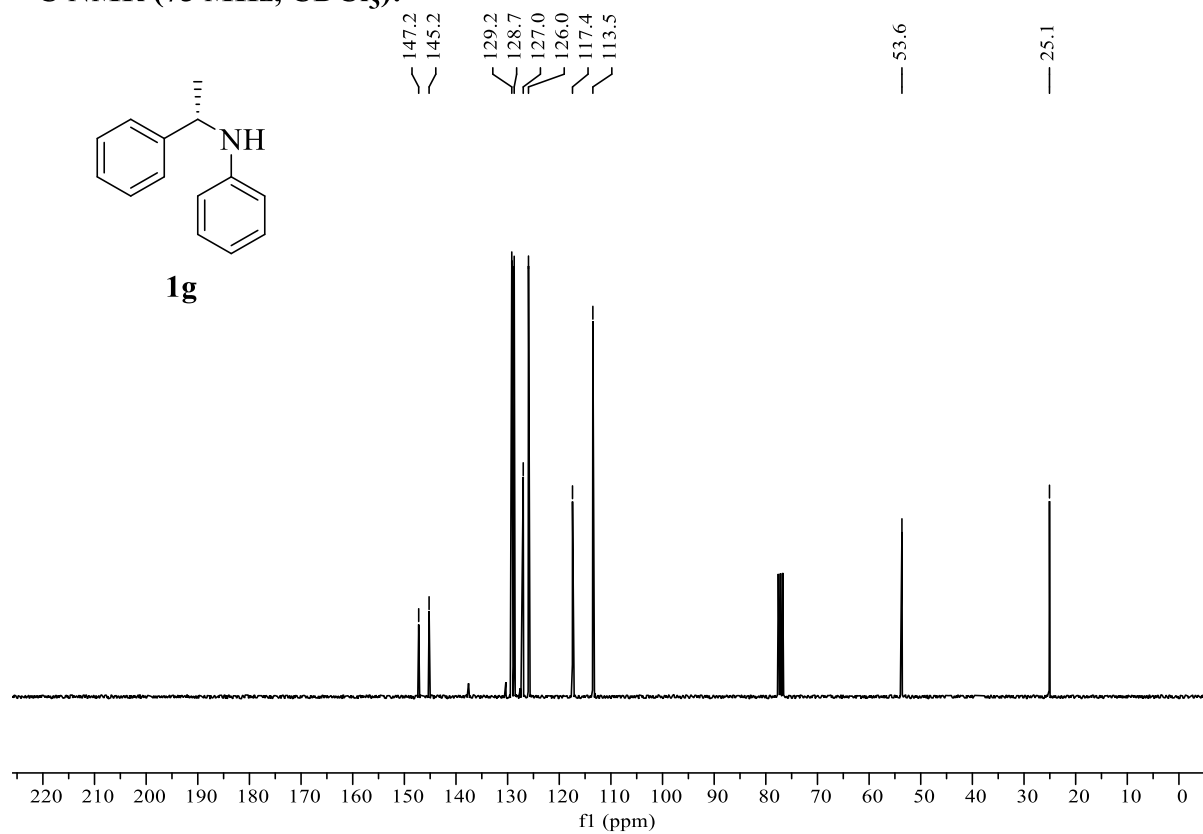
¹H NMR (300 MHz, CDCl₃, 300 K): δ_H (ppm) = 7.50 – 7.43 (m, 5H), 7.28 – 7.20 (m, 5H), 5.51 (s, 1H), 3.28 (s, 3H).

¹³C NMR (75 MHz, CDCl₃, 300 K): δ_C (ppm) = 168.7 (C_q), 143.3 (C_q), 138.3 (C_q), 130.1 (CH), 128.9 (CH), 128.7 (CH), 128.5 (CH), 127.0 (CH), 38.5 (CH), 22.3 (CH₃).⁶

HRMS (ESI) m/z = 374.0012 calcd. for [C₁₅H₁₄NOINa]⁺ [M+Na]⁺, found: 374.0015.

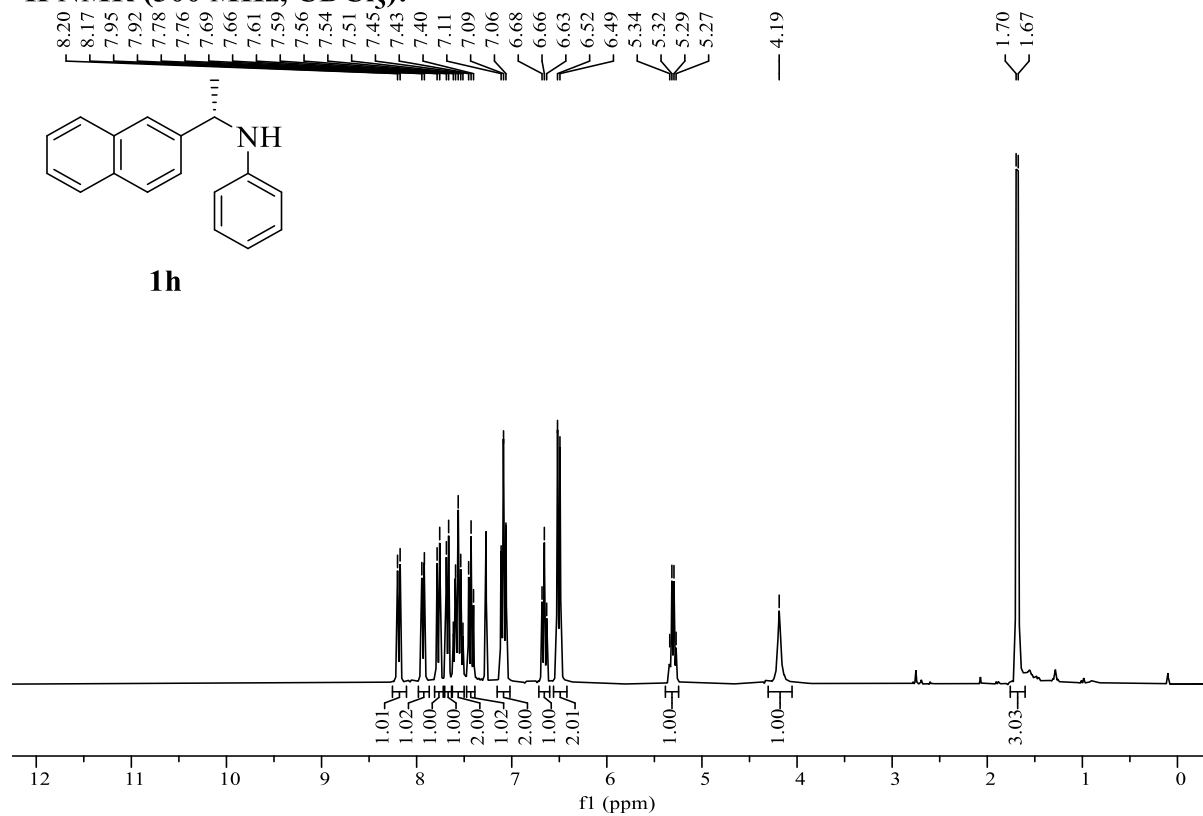
⁶ One aromatic CH-signal was not resolved.

4. NMR Data of compounds

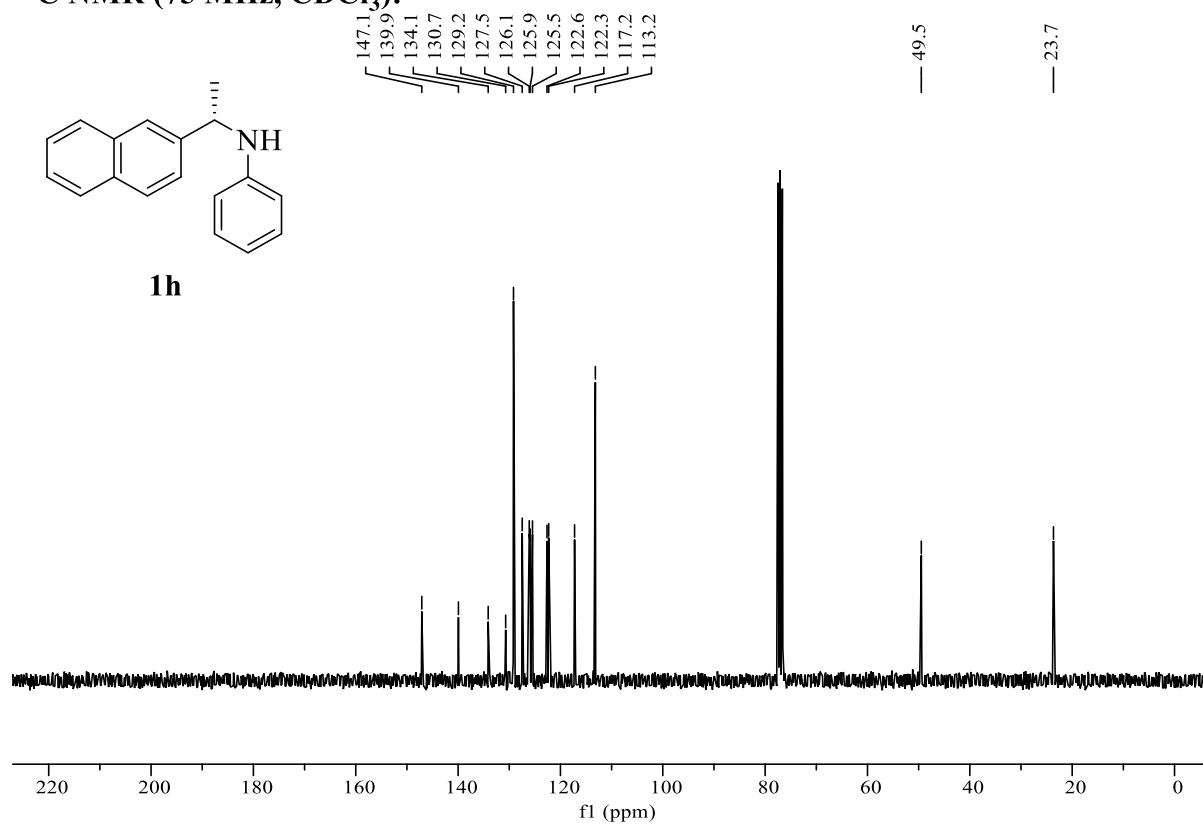
 ^1H NMR (300 MHz, CDCl_3): ^{13}C NMR (75 MHz, CDCl_3):

4. NMR Data of compounds

¹H NMR (300 MHz, CDCl₃):

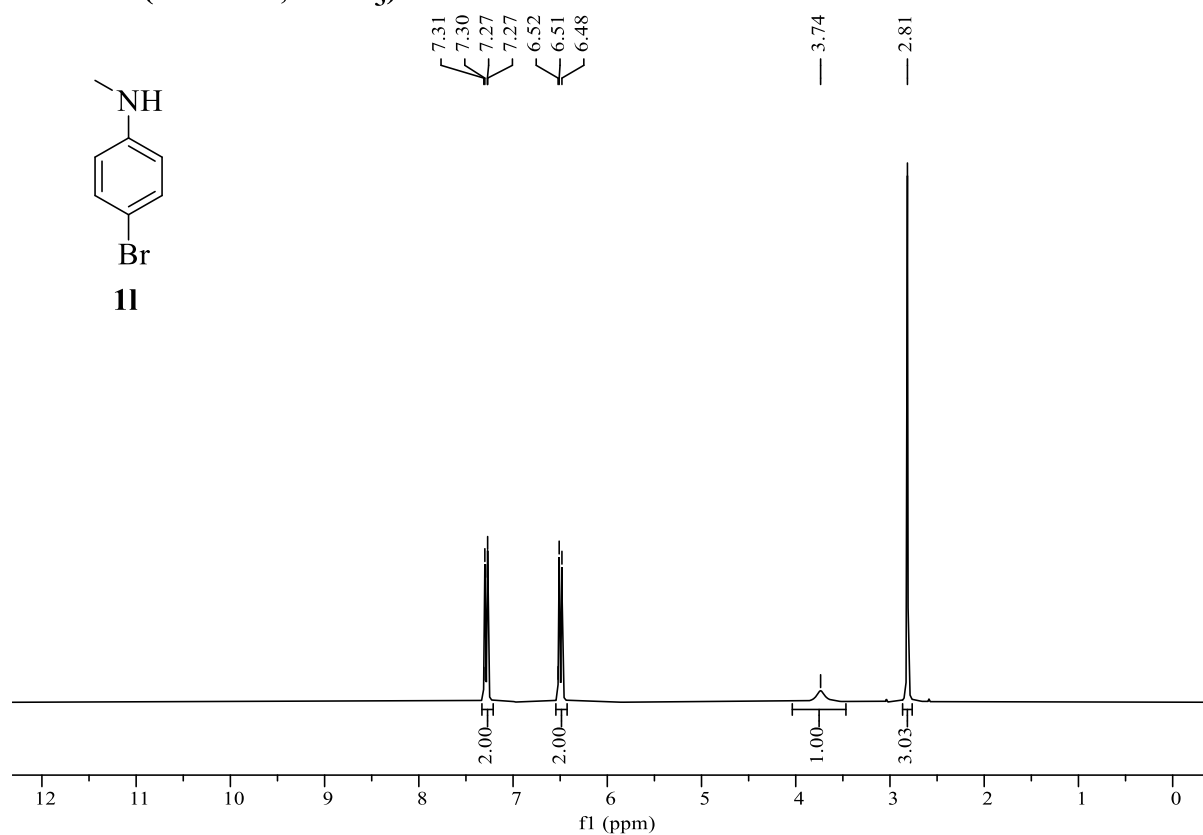


¹³C NMR (75 MHz, CDCl₃):

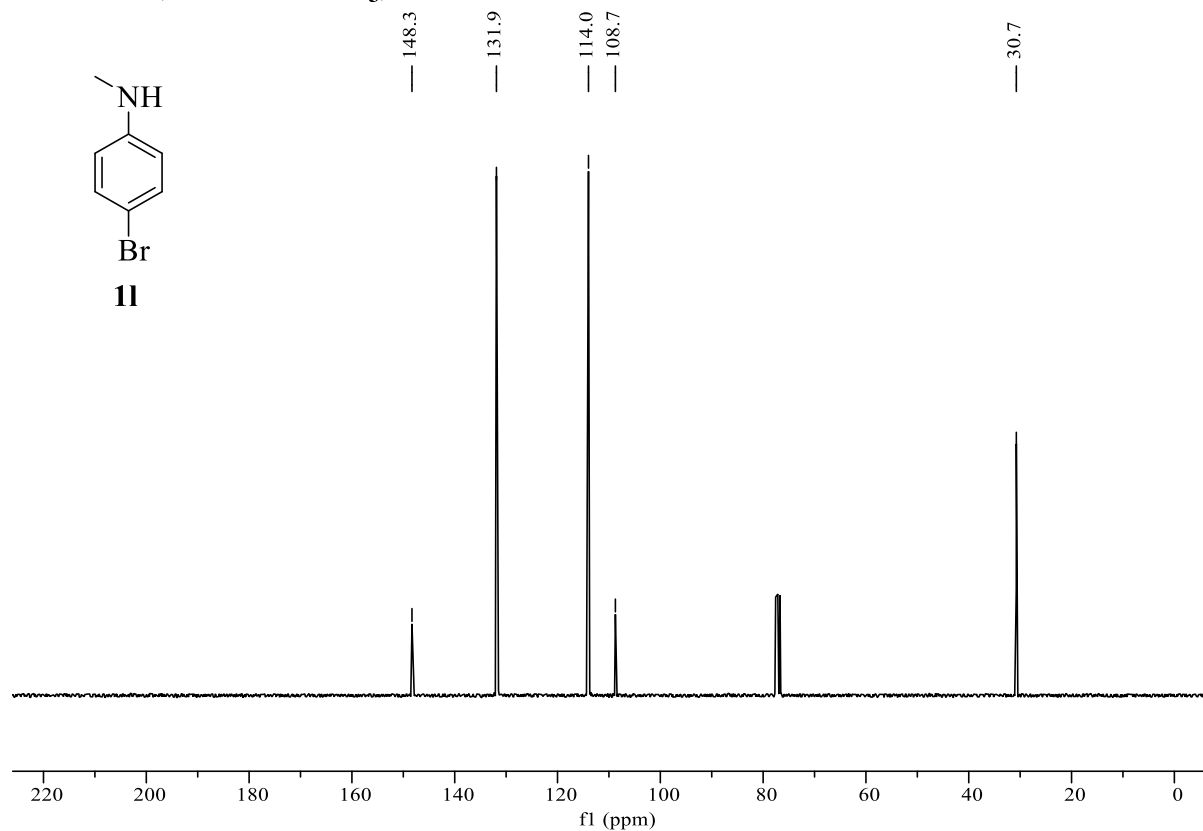


4. NMR Data of compounds

^1H NMR (300 MHz, CDCl_3):

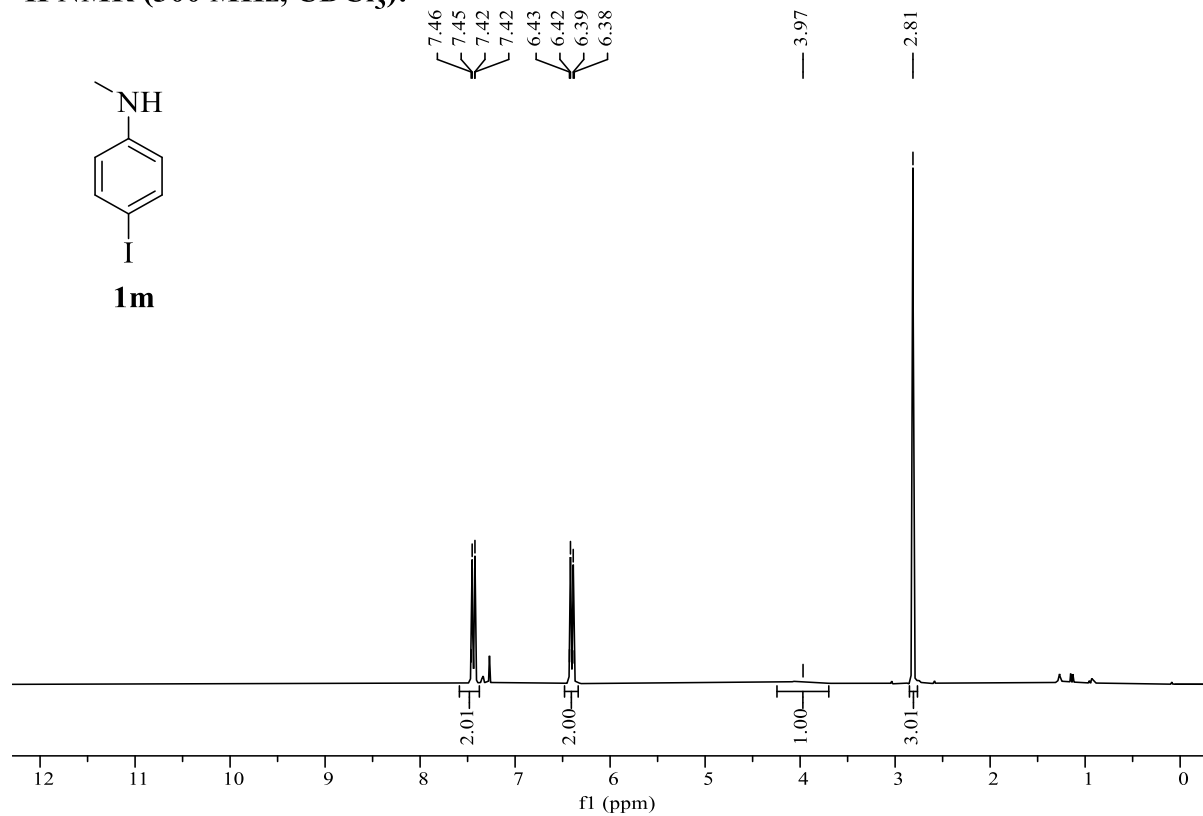


^{13}C NMR (75 MHz, CDCl_3):

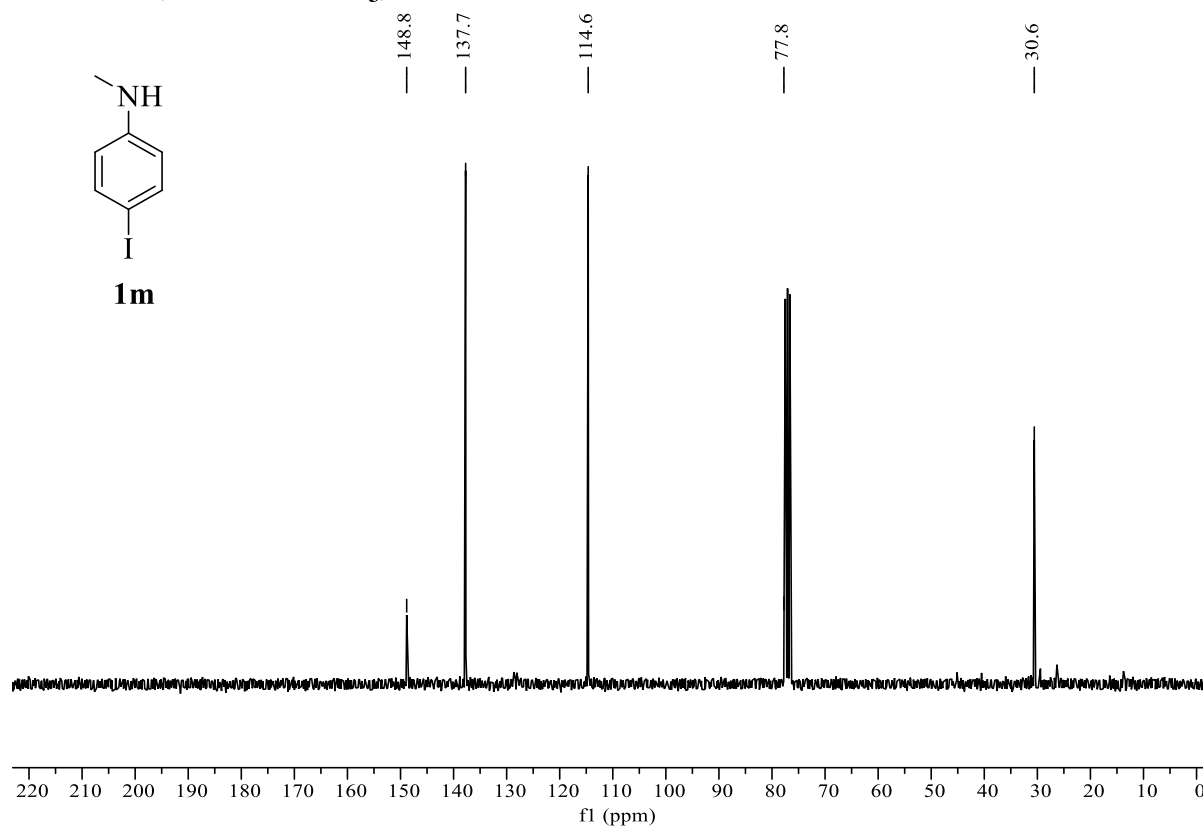


4. NMR Data of compounds

^1H NMR (300 MHz, CDCl_3):

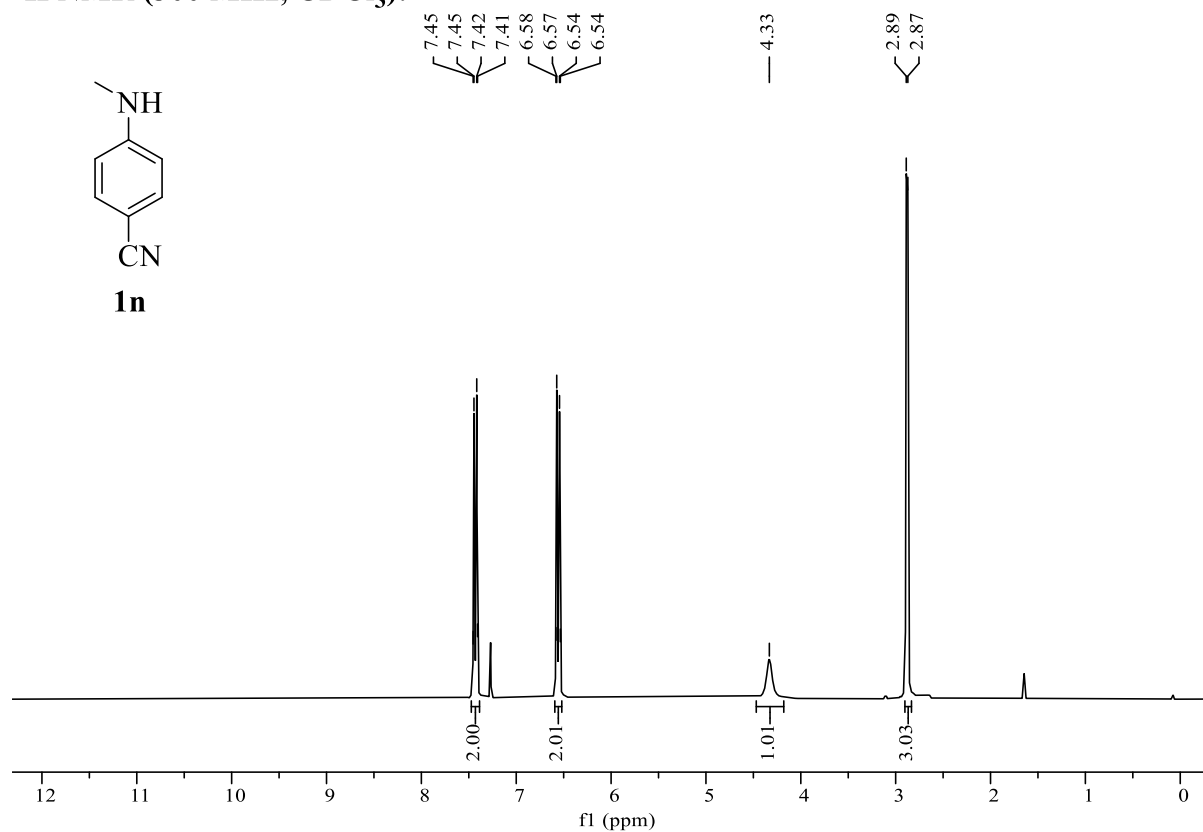


^{13}C NMR (75 MHz, CDCl_3):

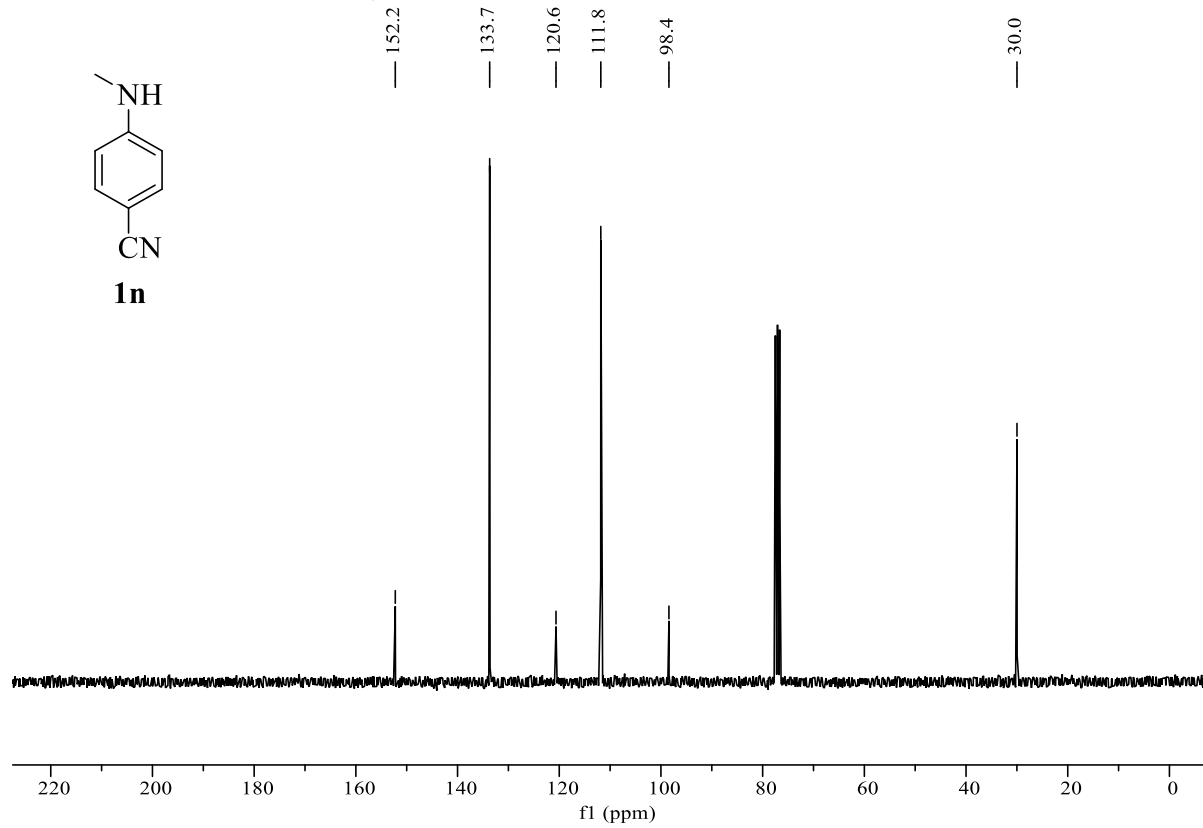


4. NMR Data of compounds

^1H NMR (300 MHz, CDCl_3):

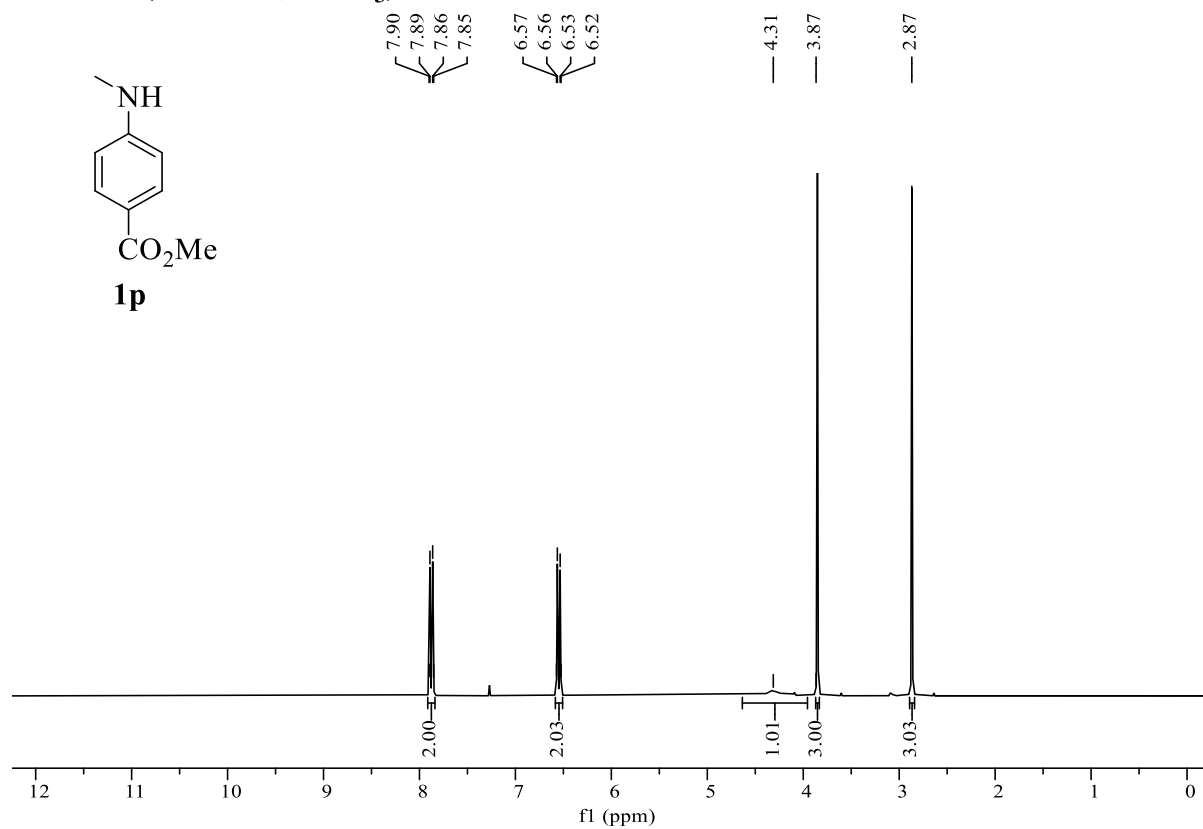


^{13}C NMR (75 MHz, CDCl_3):

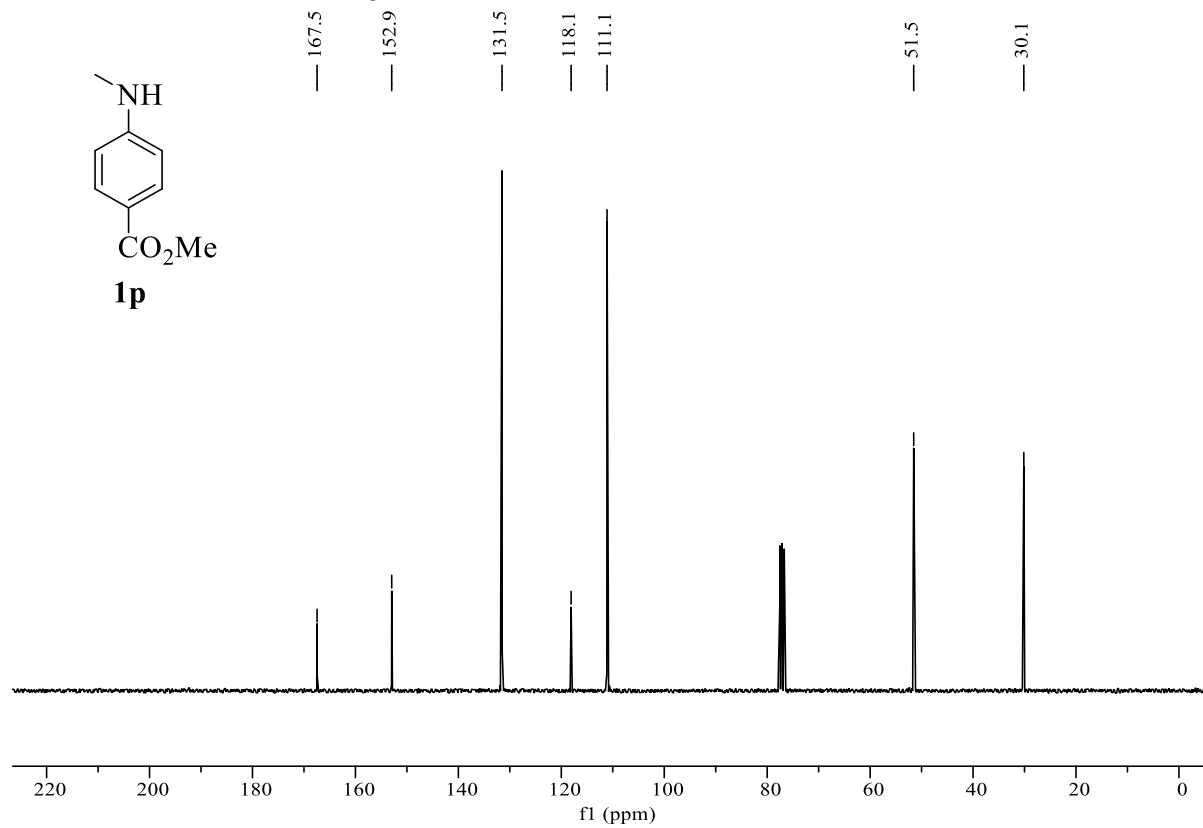


4. NMR Data of compounds

^1H NMR (300 MHz, CDCl_3):

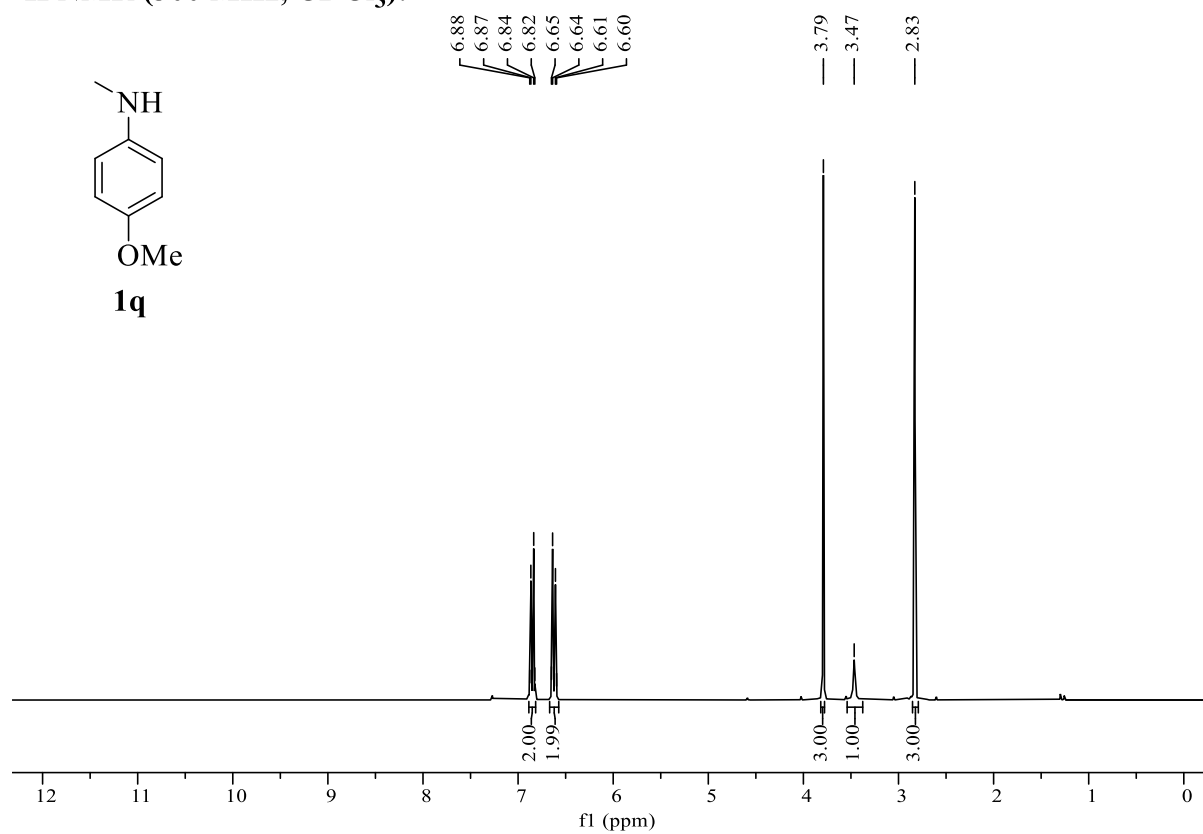


^{13}C NMR (75 MHz, CDCl_3):

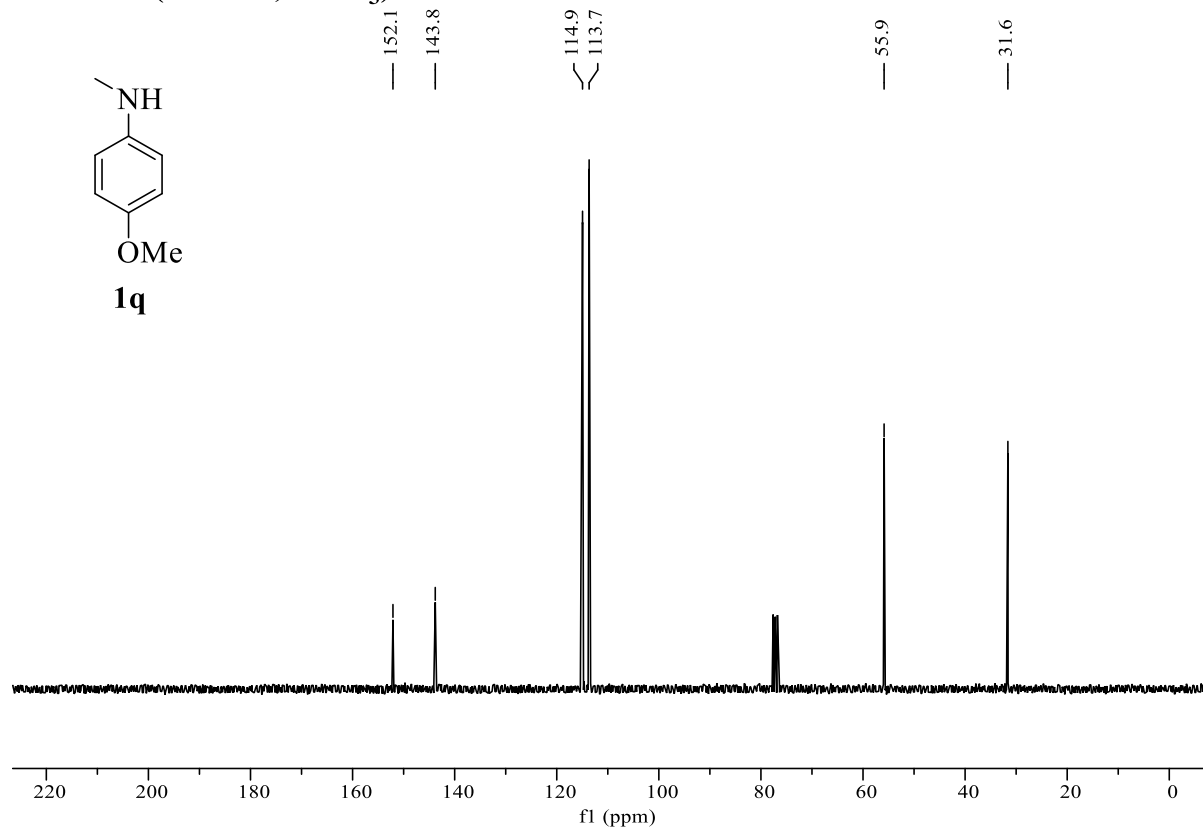


4. NMR Data of compounds

^1H NMR (300 MHz, CDCl_3):

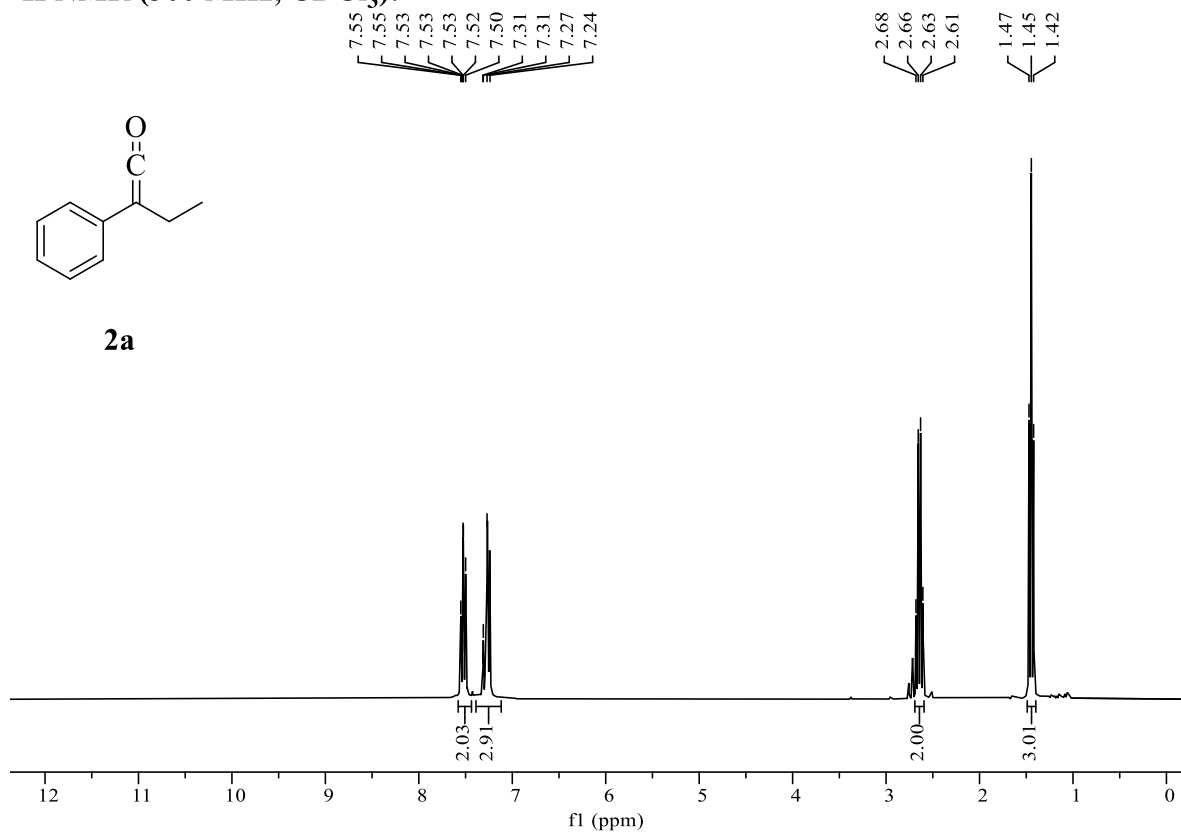


^{13}C NMR (75 MHz, CDCl_3):

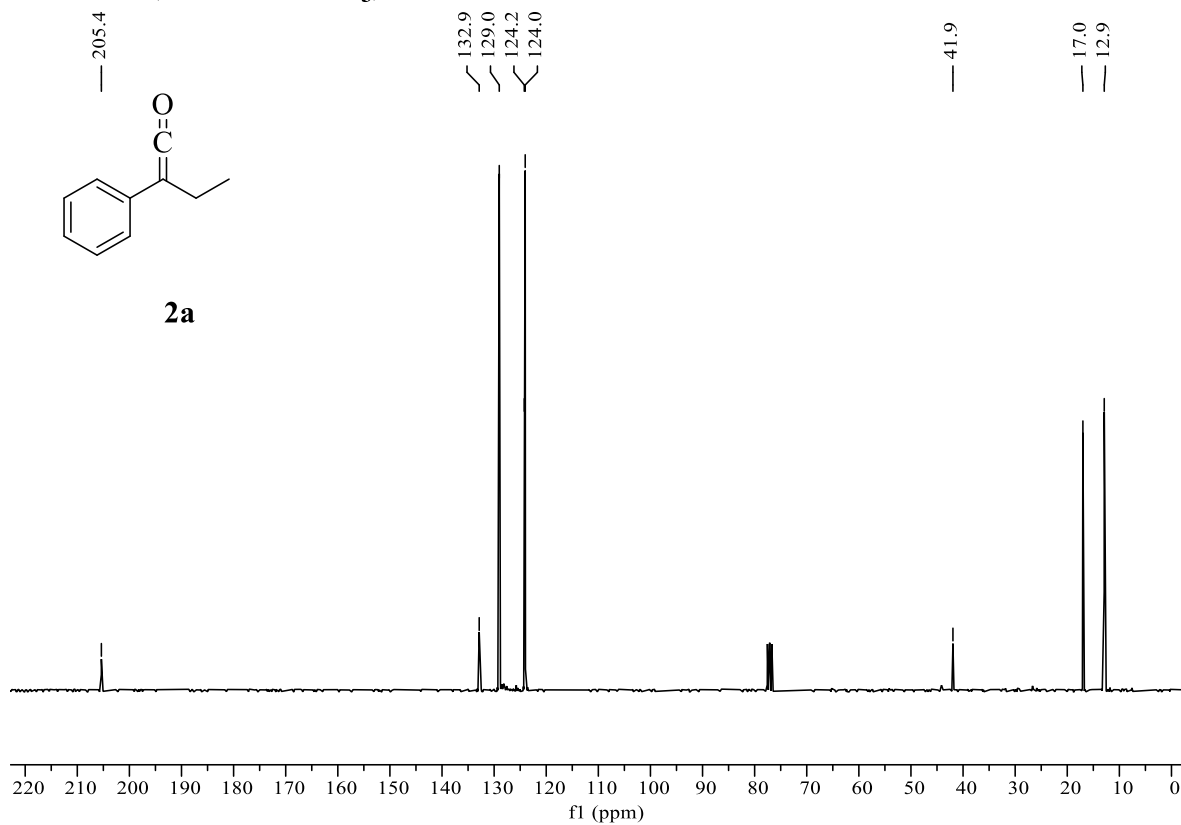


4. NMR Data of compounds

^1H NMR (300 MHz, CDCl_3):

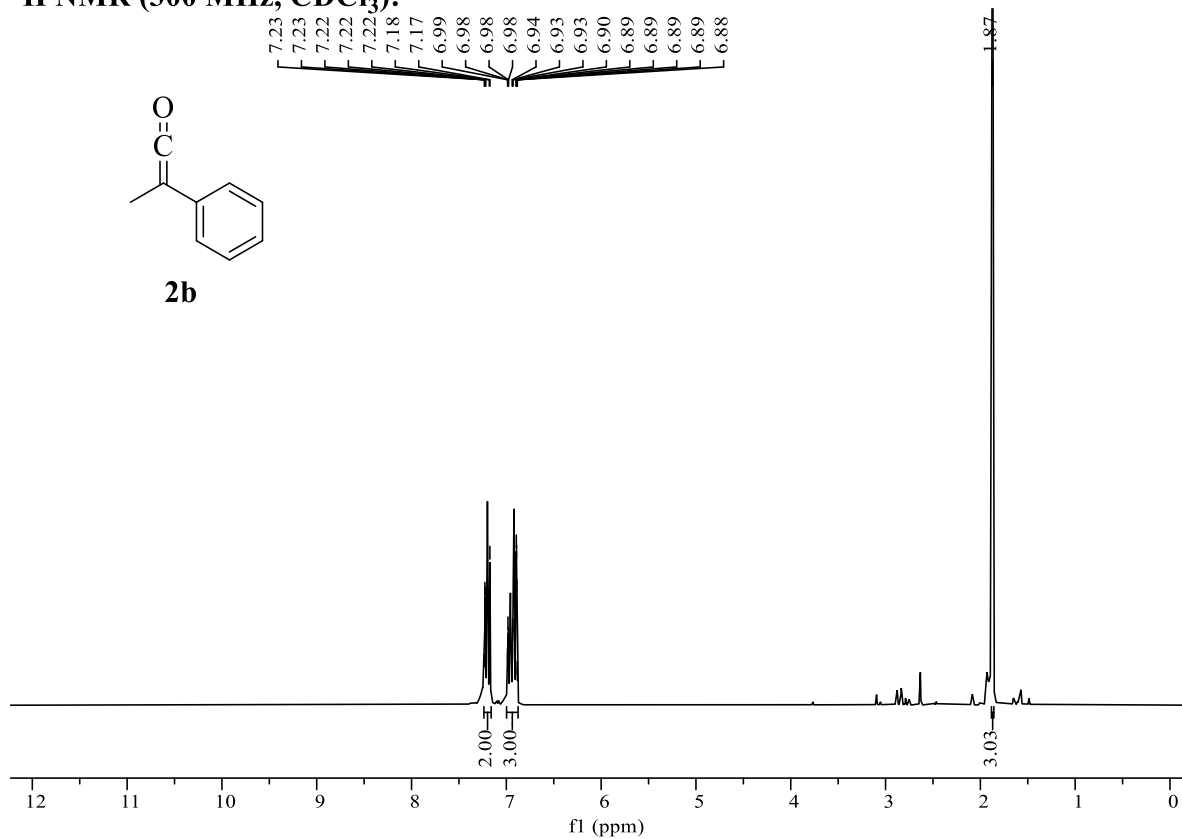


^{13}C NMR (75 MHz, CDCl_3):

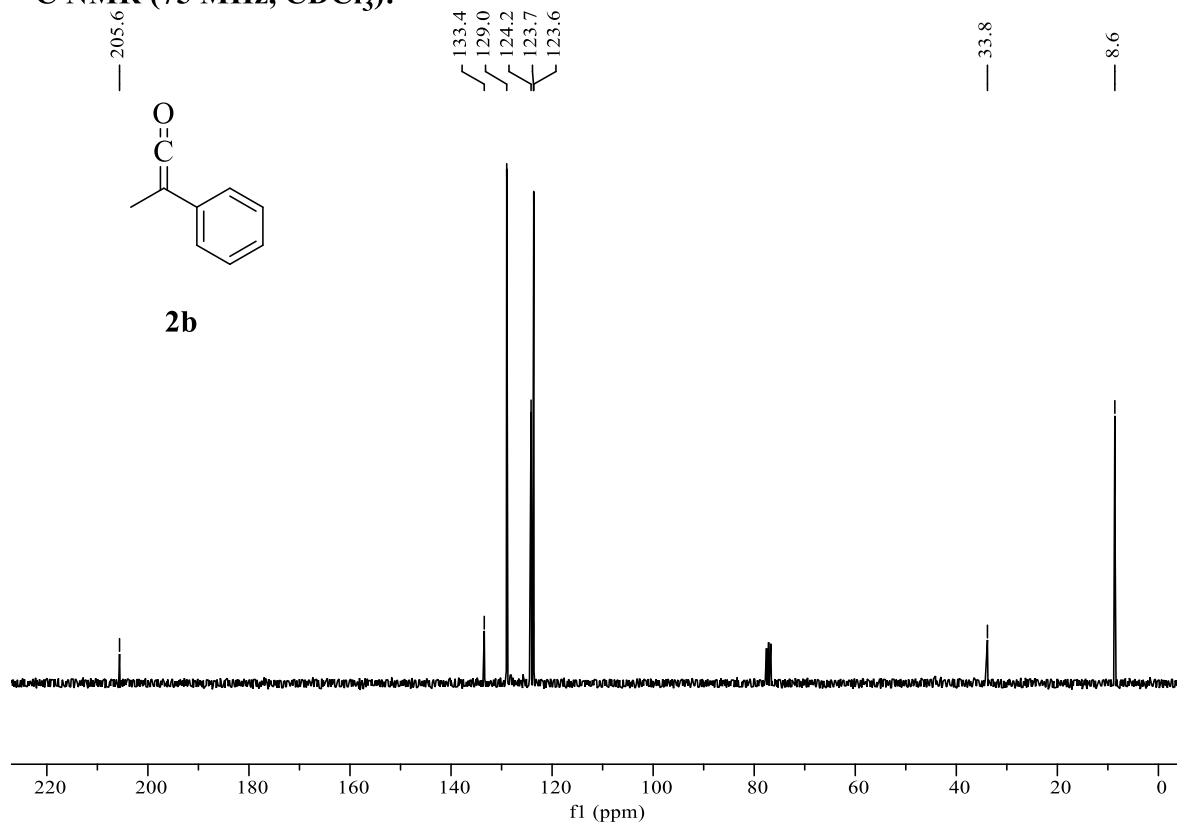


4. NMR Data of compounds

^1H NMR (300 MHz, CDCl_3):

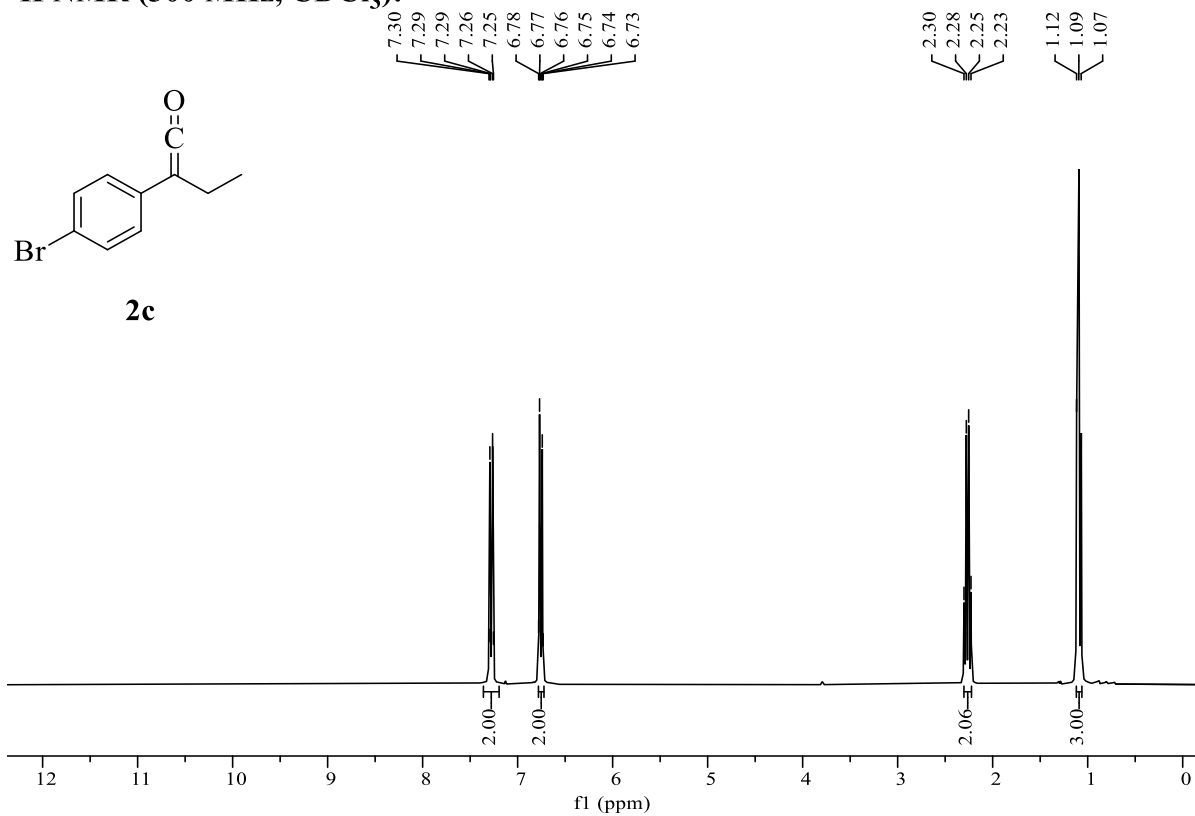


^{13}C NMR (75 MHz, CDCl_3):

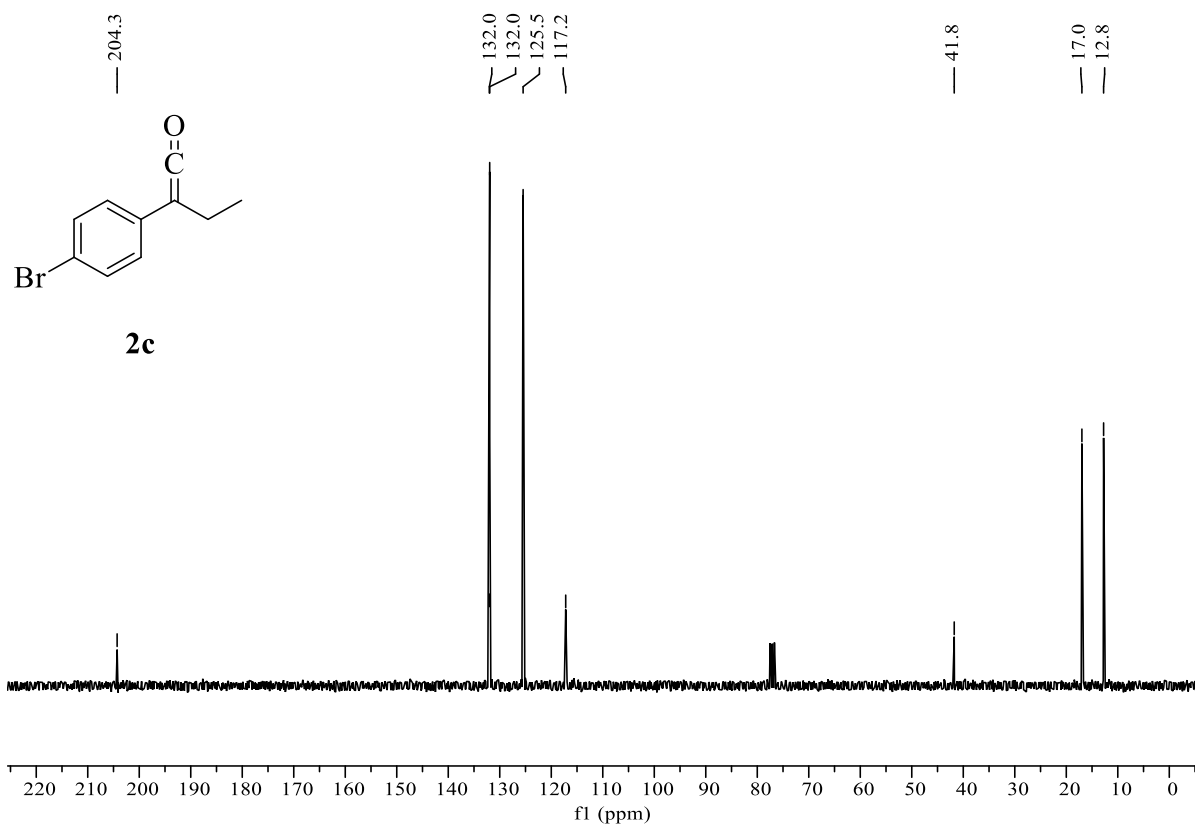


4. NMR Data of compounds

^1H NMR (300 MHz, CDCl_3):

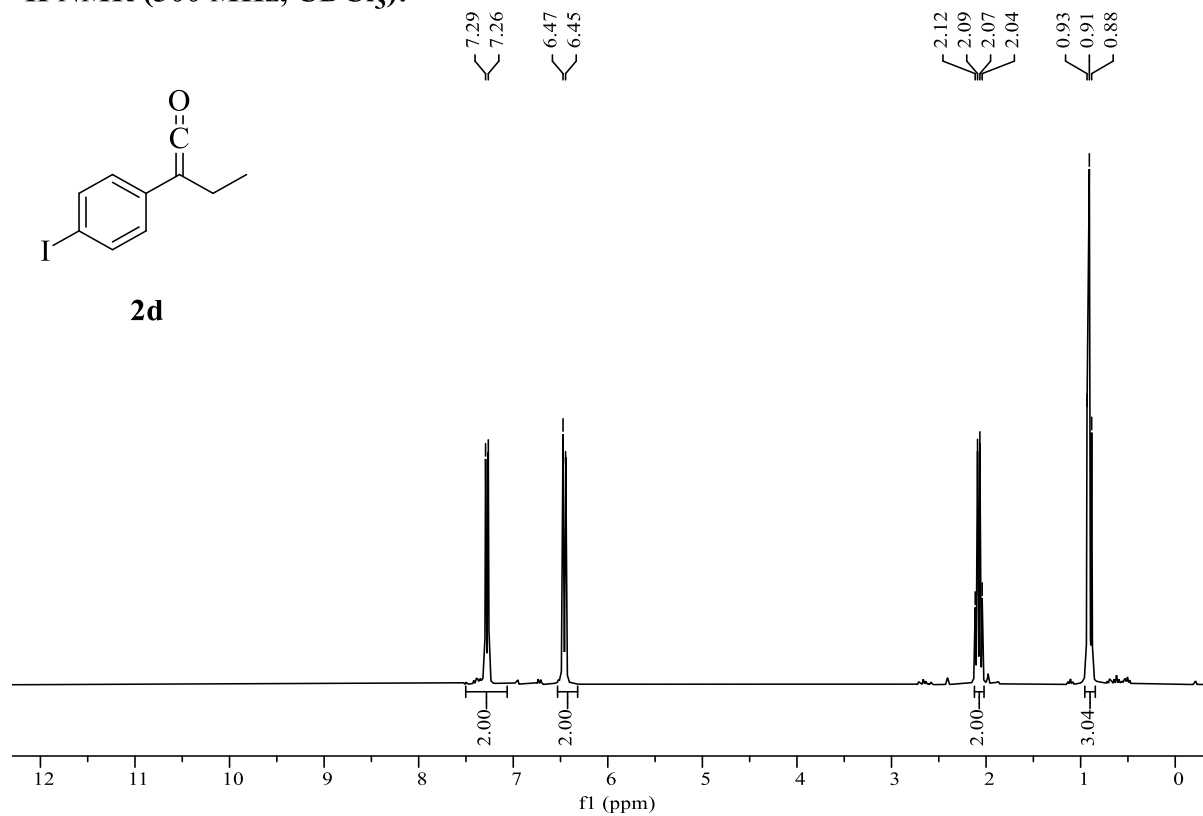


^{13}C NMR (75 MHz, CDCl_3):

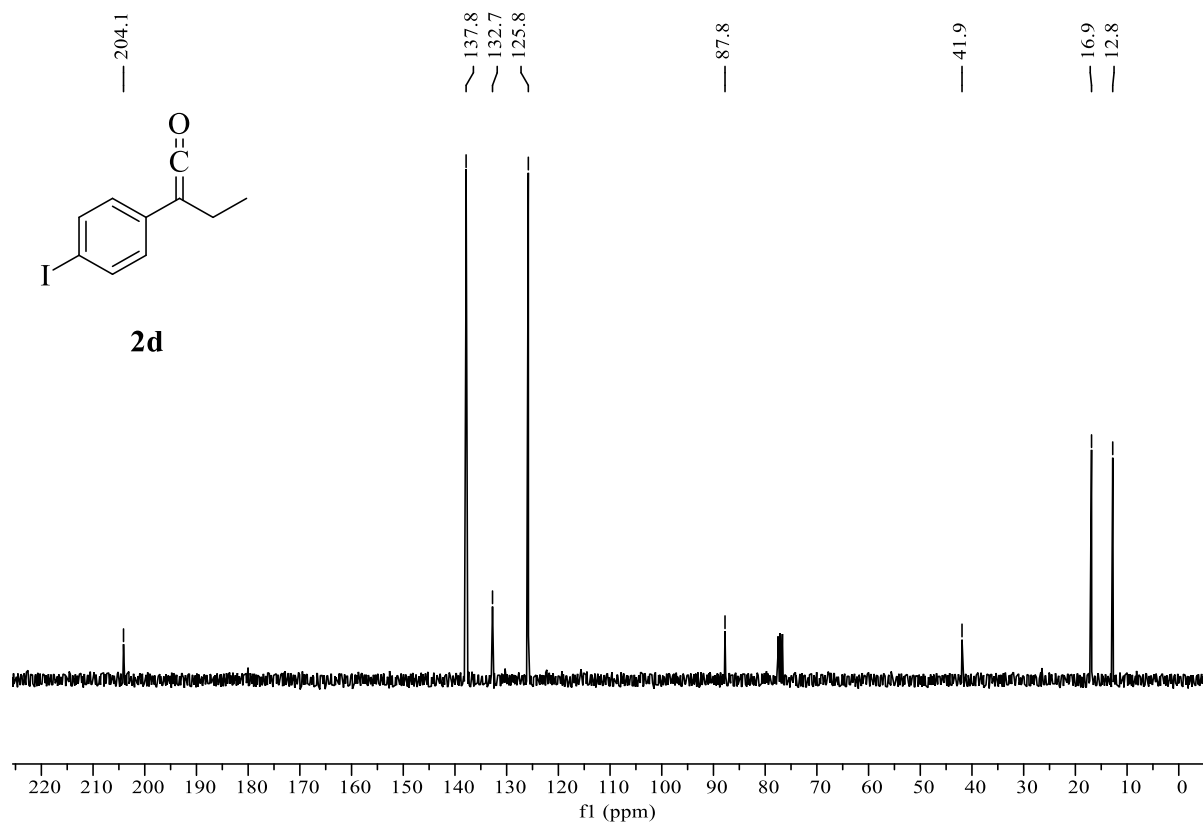


4. NMR Data of compounds

^1H NMR (300 MHz, CDCl_3):

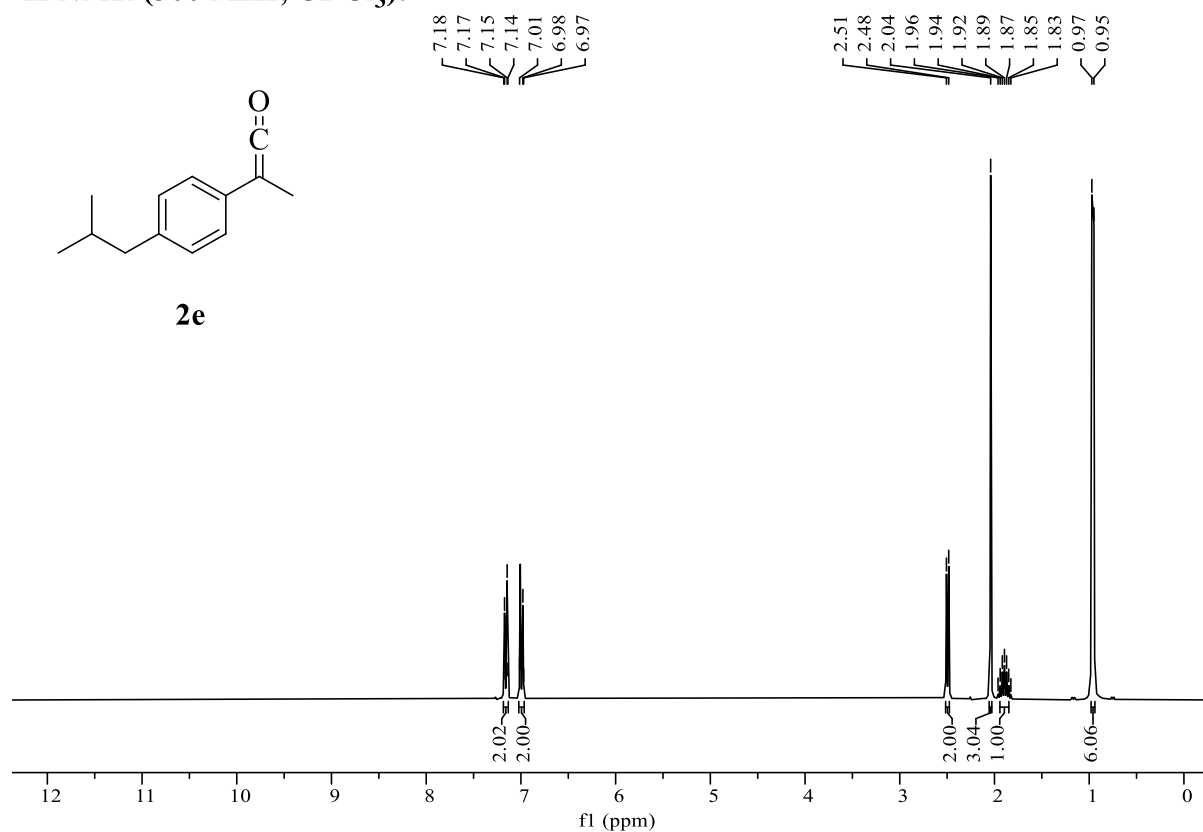


^{13}C NMR (75 MHz, CDCl_3):

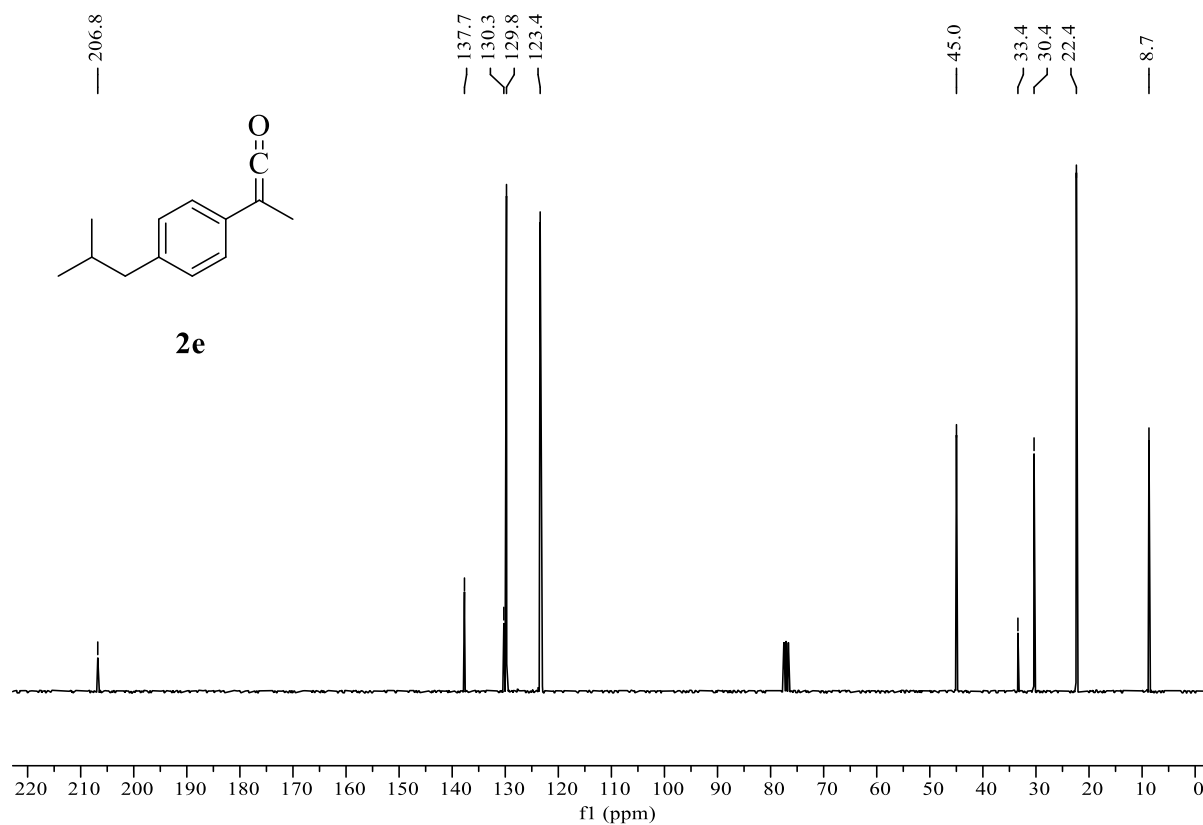


4. NMR Data of compounds

¹H NMR (300 MHz, CDCl₃):

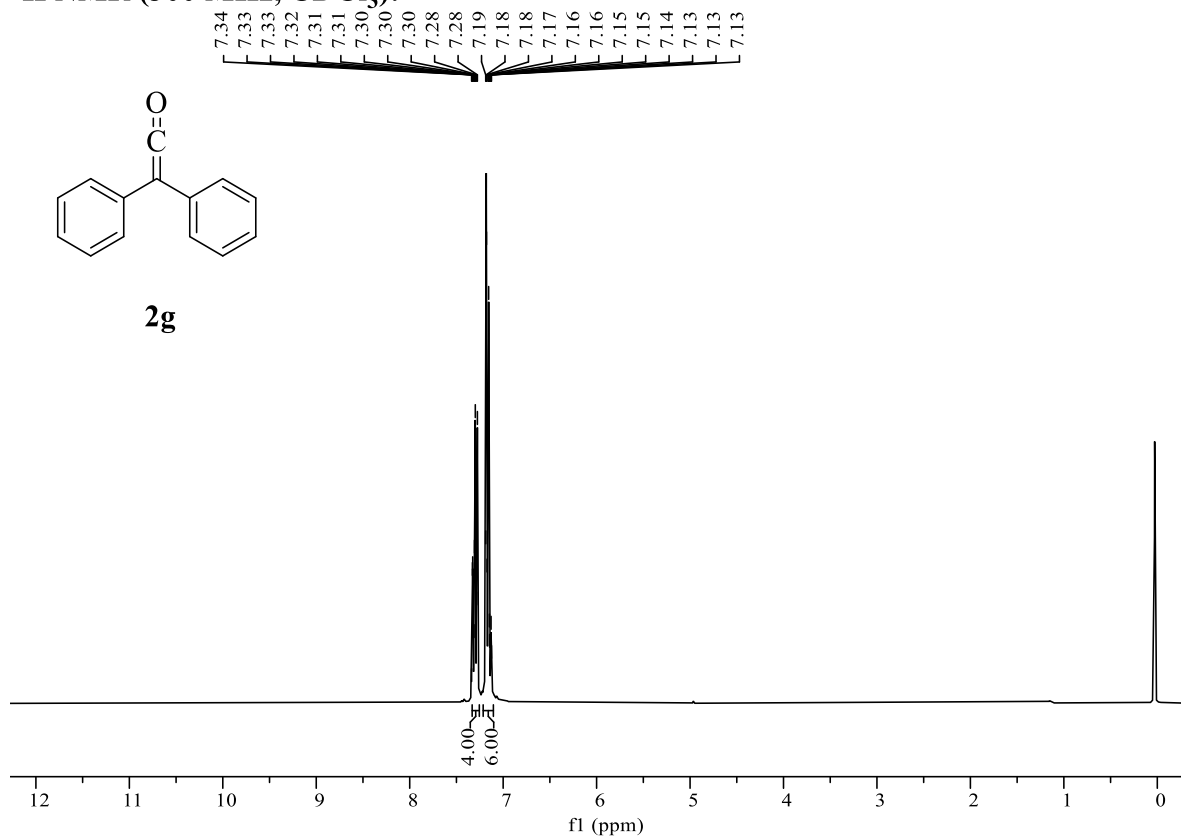


¹³C NMR (75 MHz, CDCl₃):

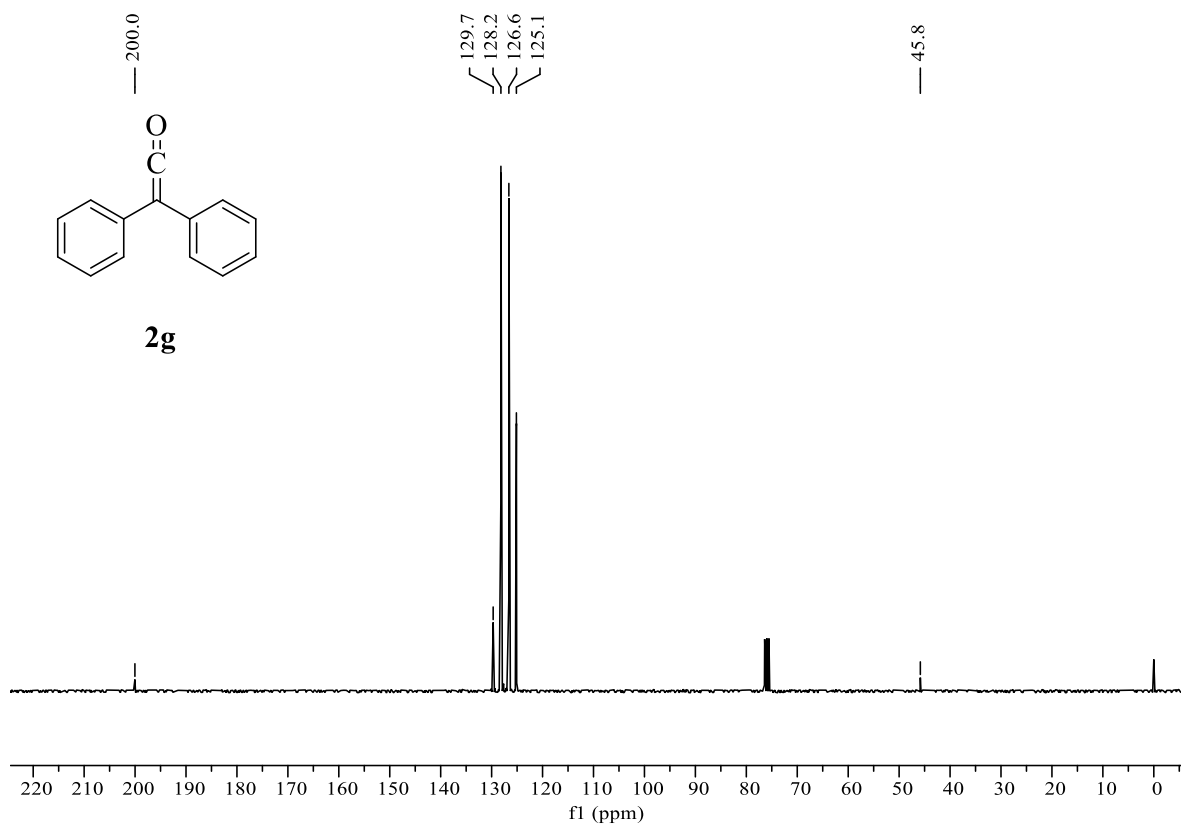


4. NMR Data of compounds

¹H NMR (300 MHz, CDCl₃):

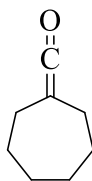


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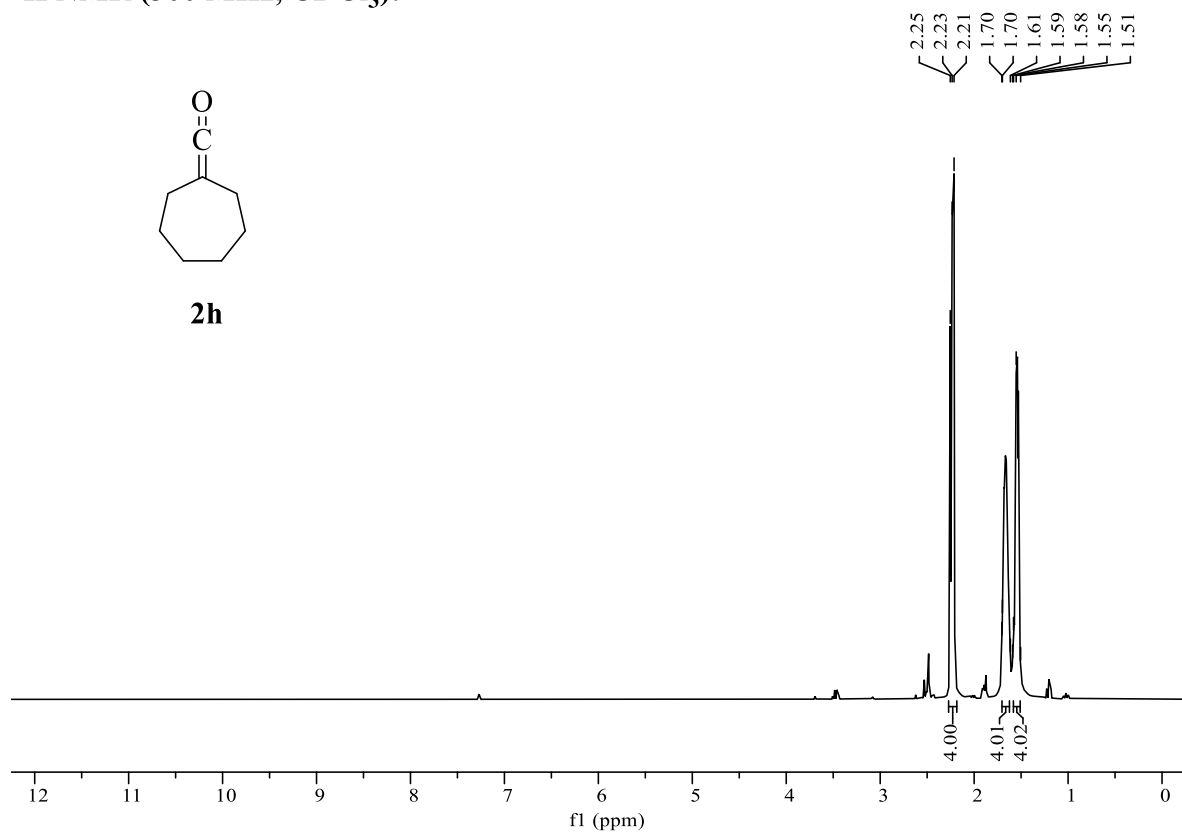


4. NMR Data of compounds

^1H NMR (300 MHz, CDCl_3):

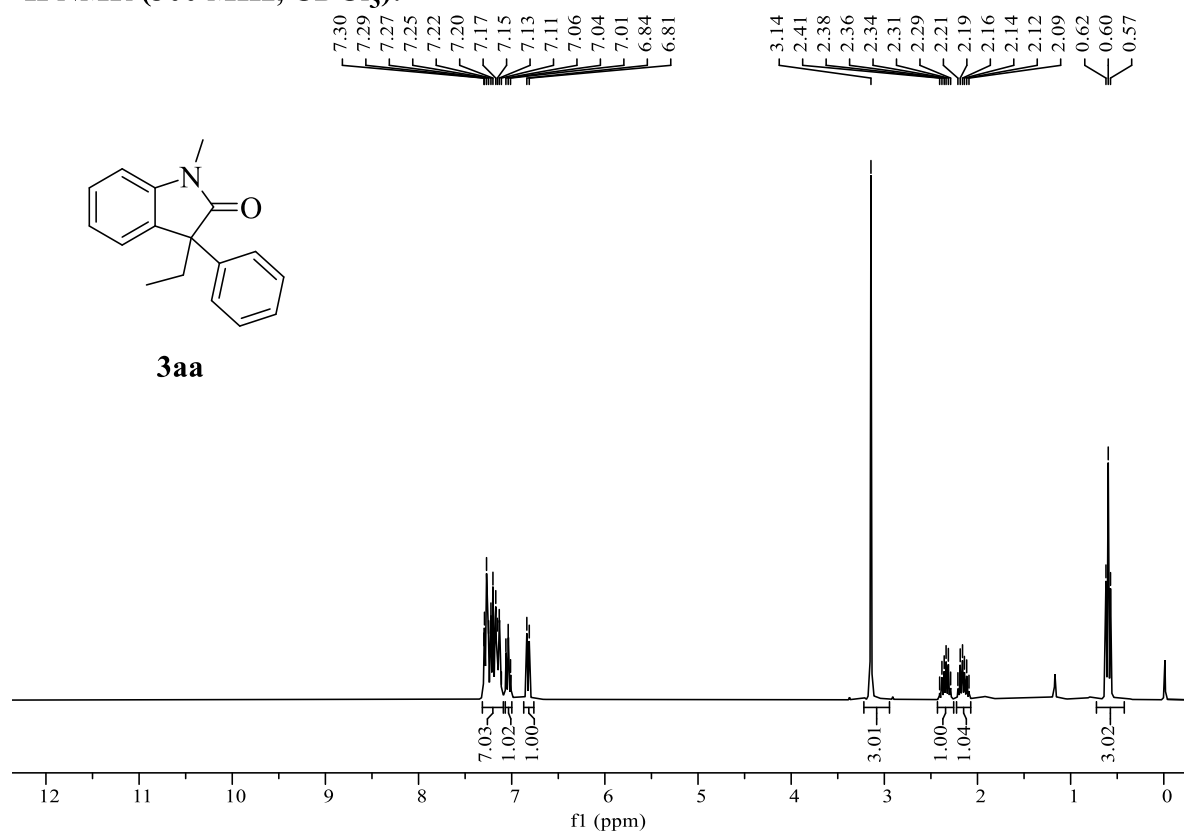


2h

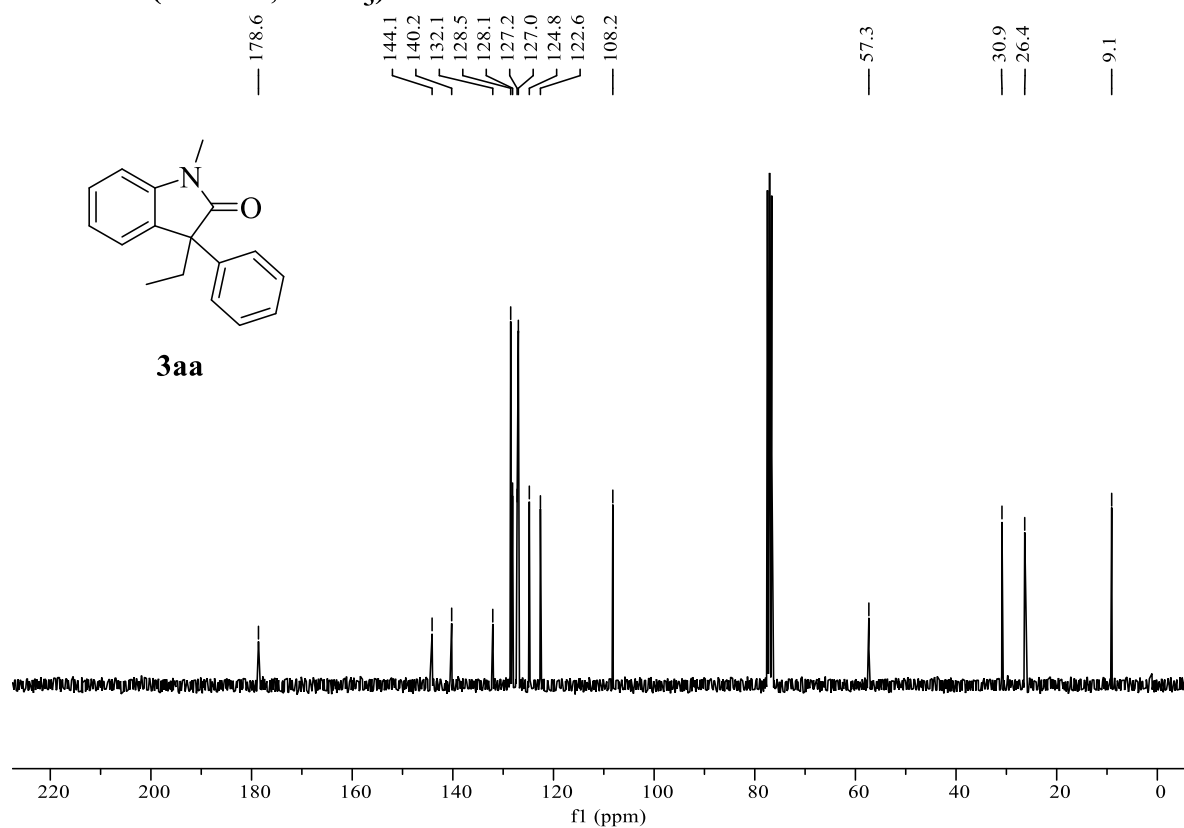


4. NMR Data of compounds

^1H NMR (300 MHz, CDCl_3):

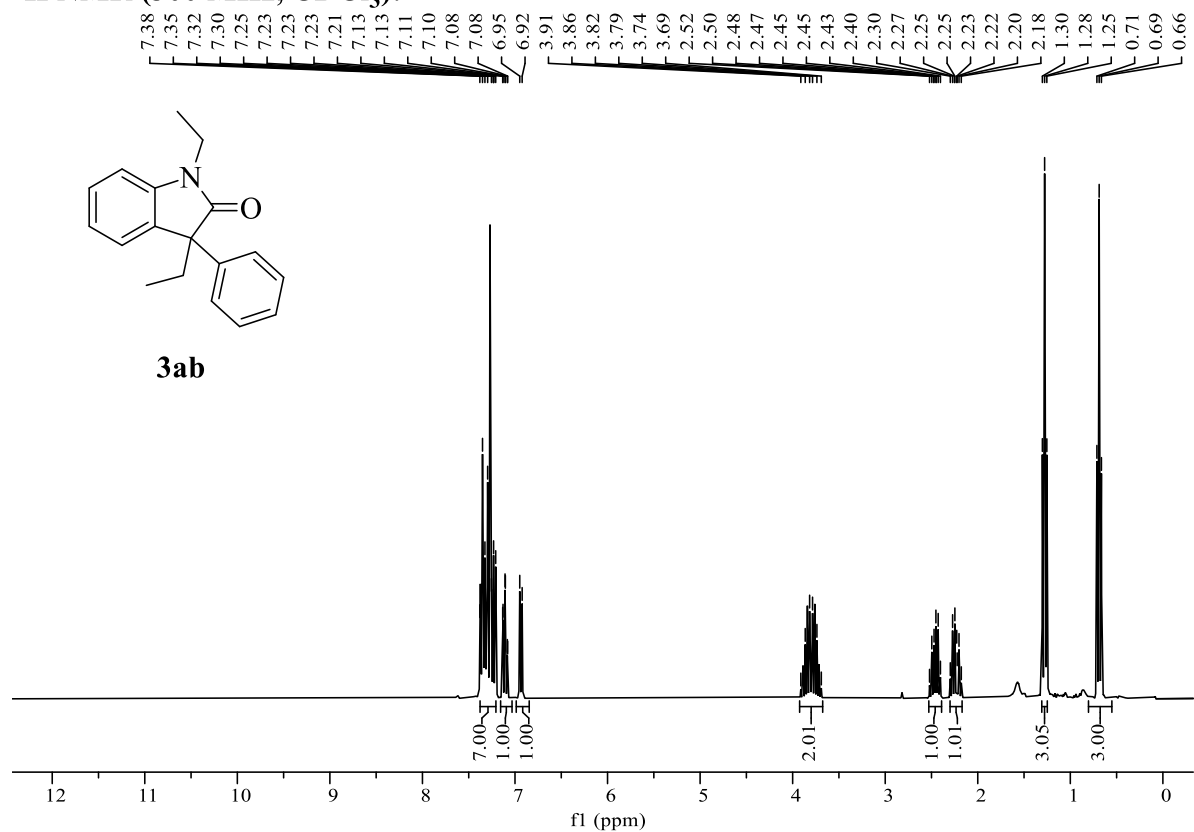


^{13}C NMR (75 MHz, CDCl_3):

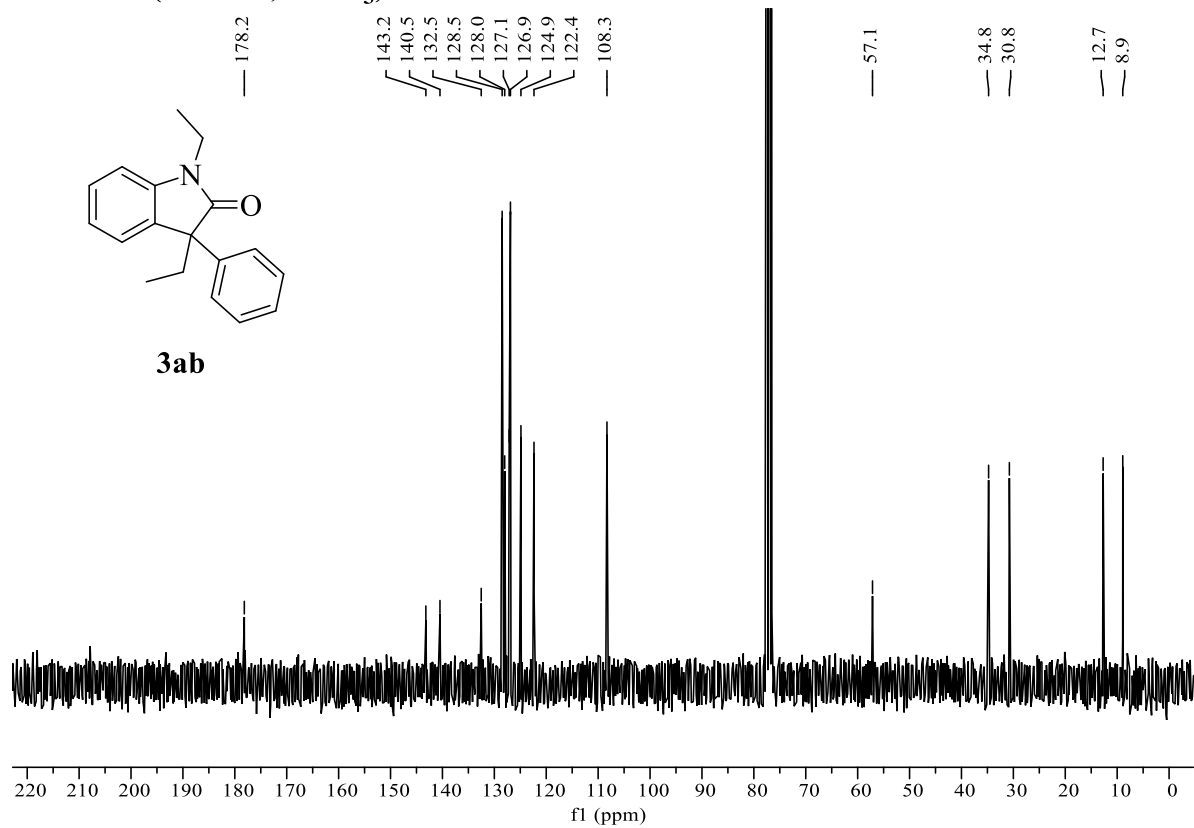


4. NMR Data of compounds

¹H NMR (300 MHz, CDCl₃):

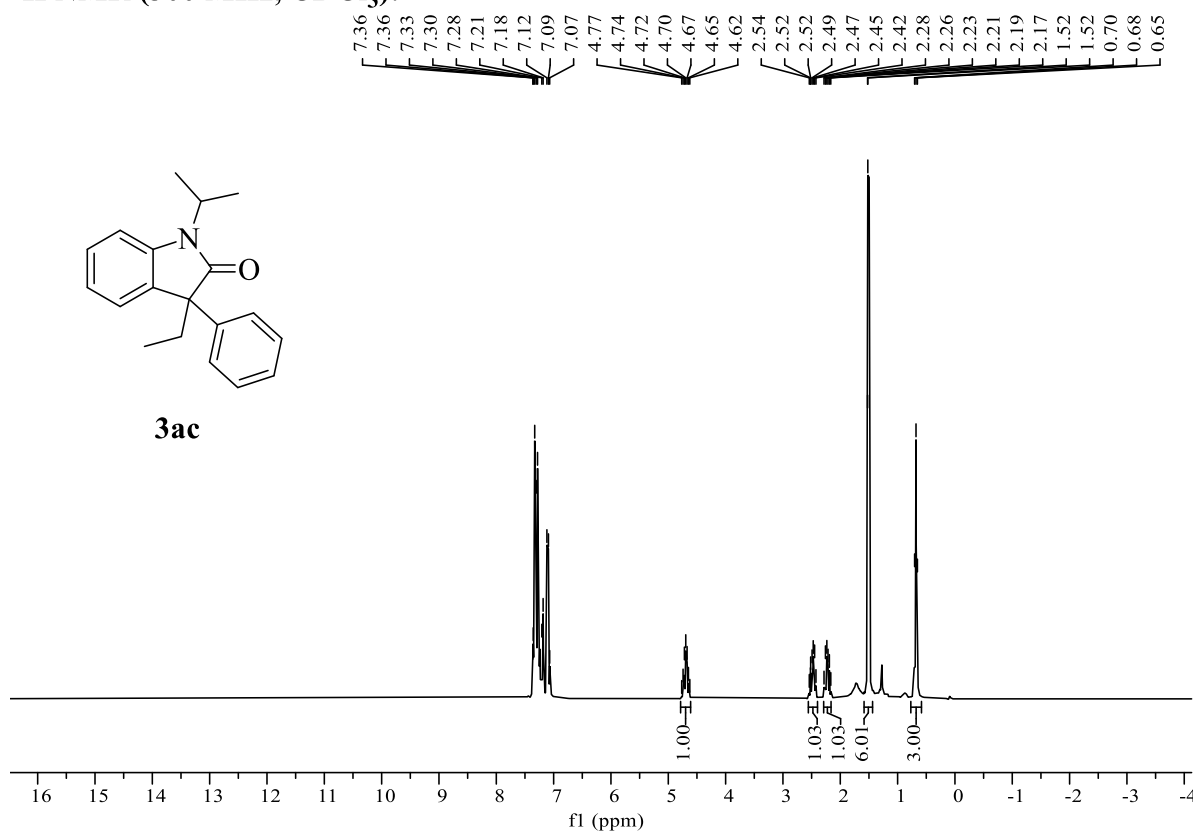


¹³C NMR (75 MHz, CDCl₃):

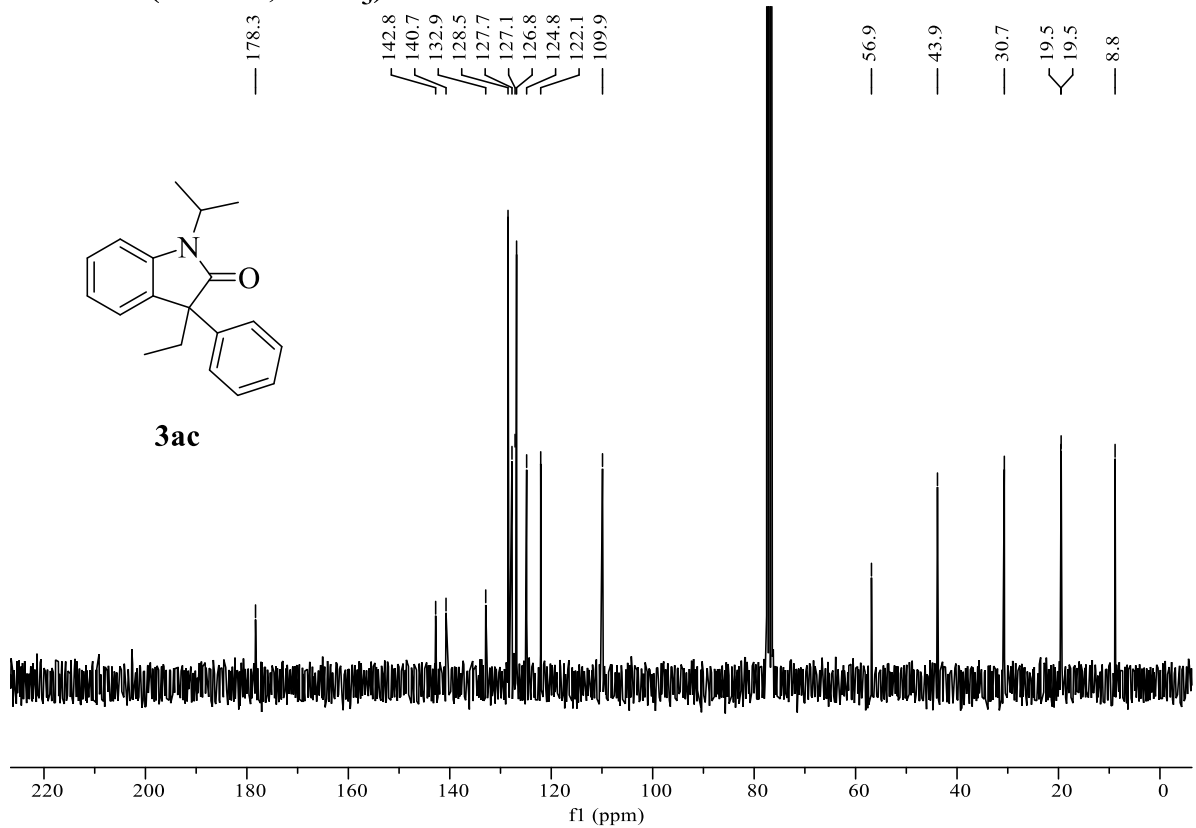


4. NMR Data of compounds

¹H NMR (300 MHz, CDCl₃):

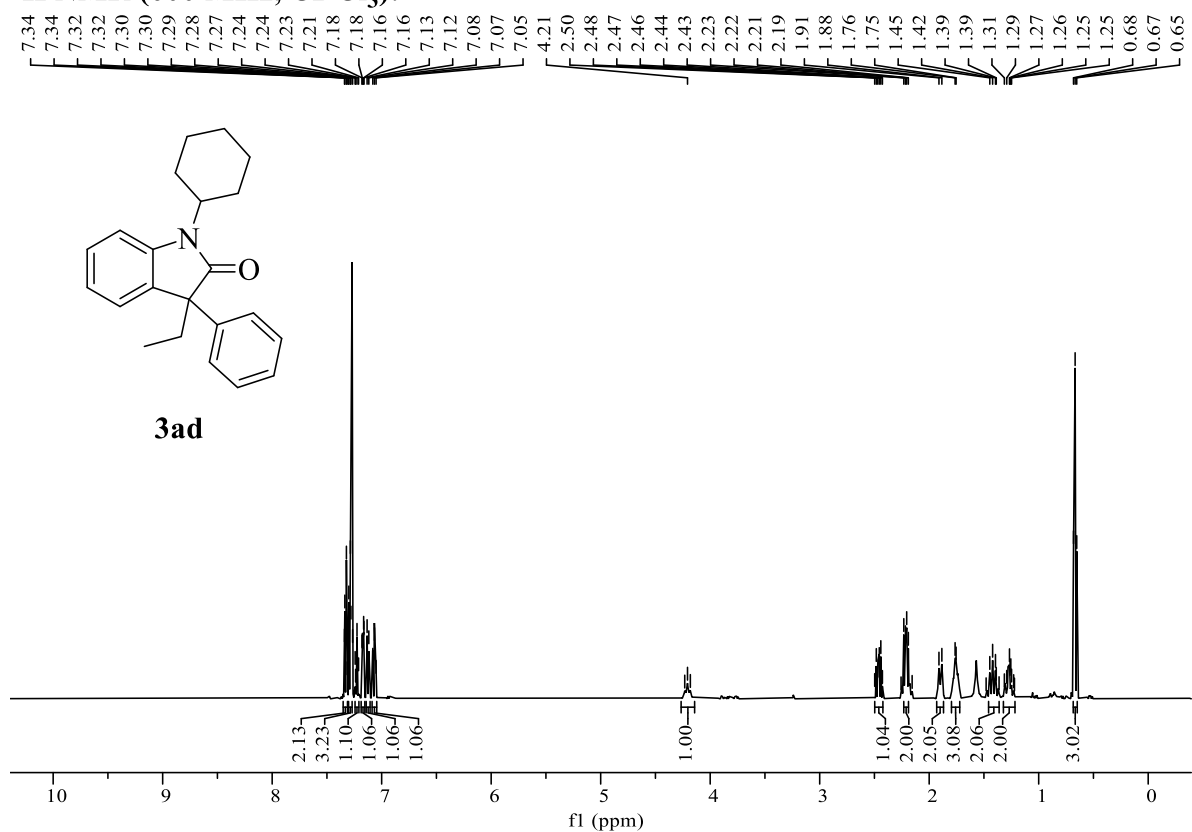


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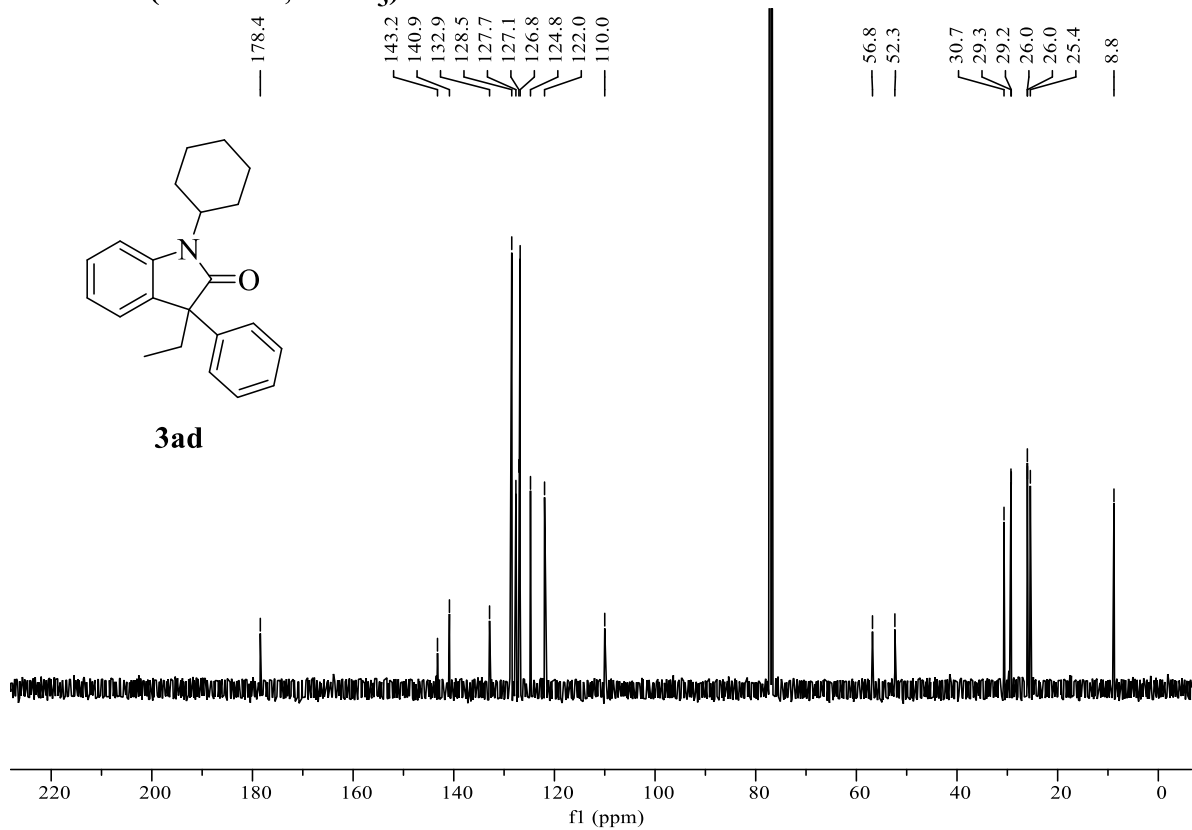


4. NMR Data of compounds

¹H NMR (600 MHz, CDCl₃):

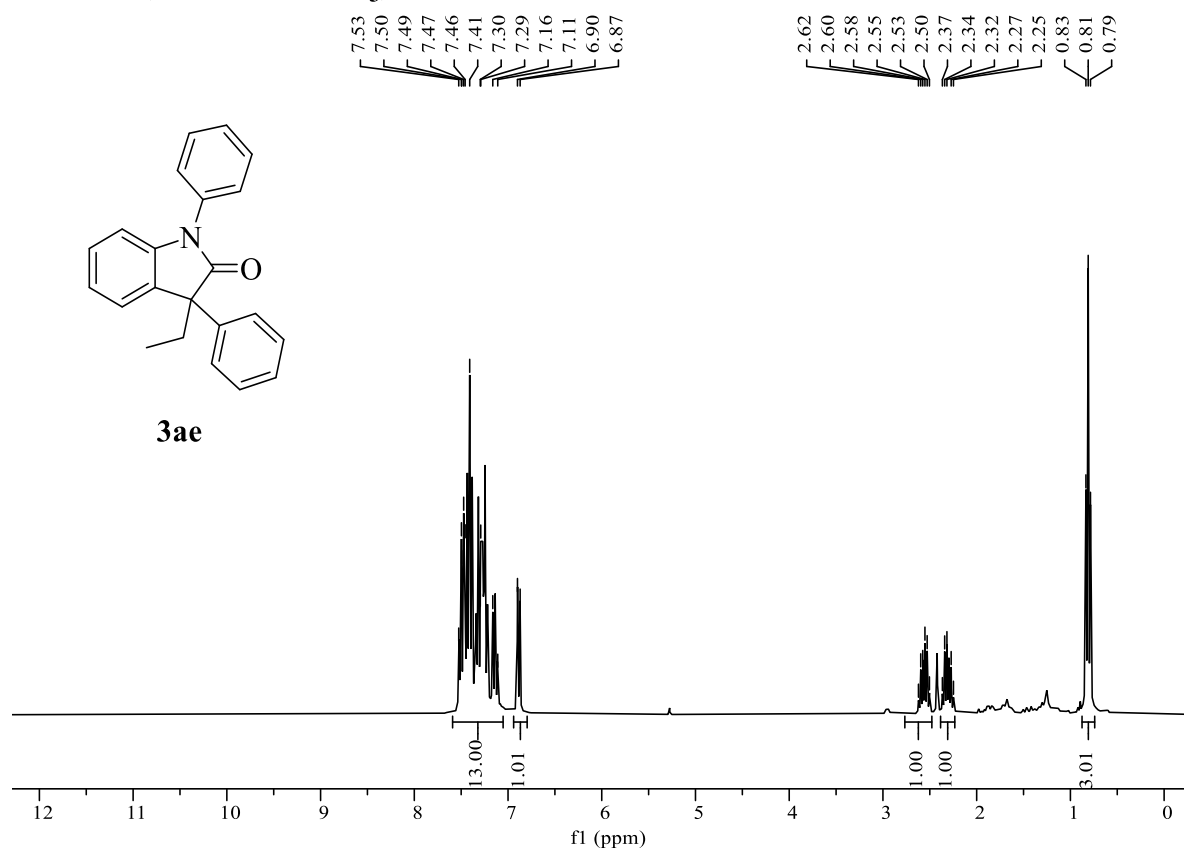


¹³C NMR (151 MHz, CDCl₃):

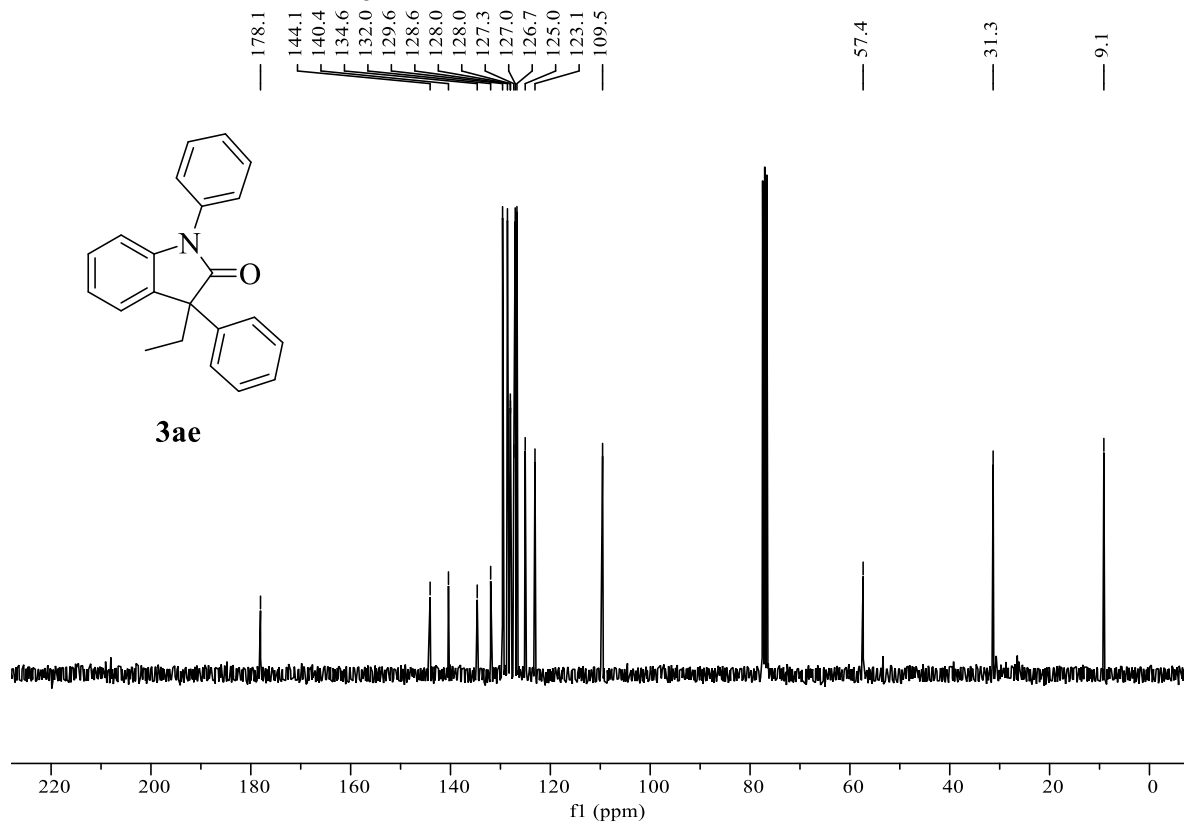


4. NMR Data of compounds

^1H NMR (300 MHz, CDCl_3):

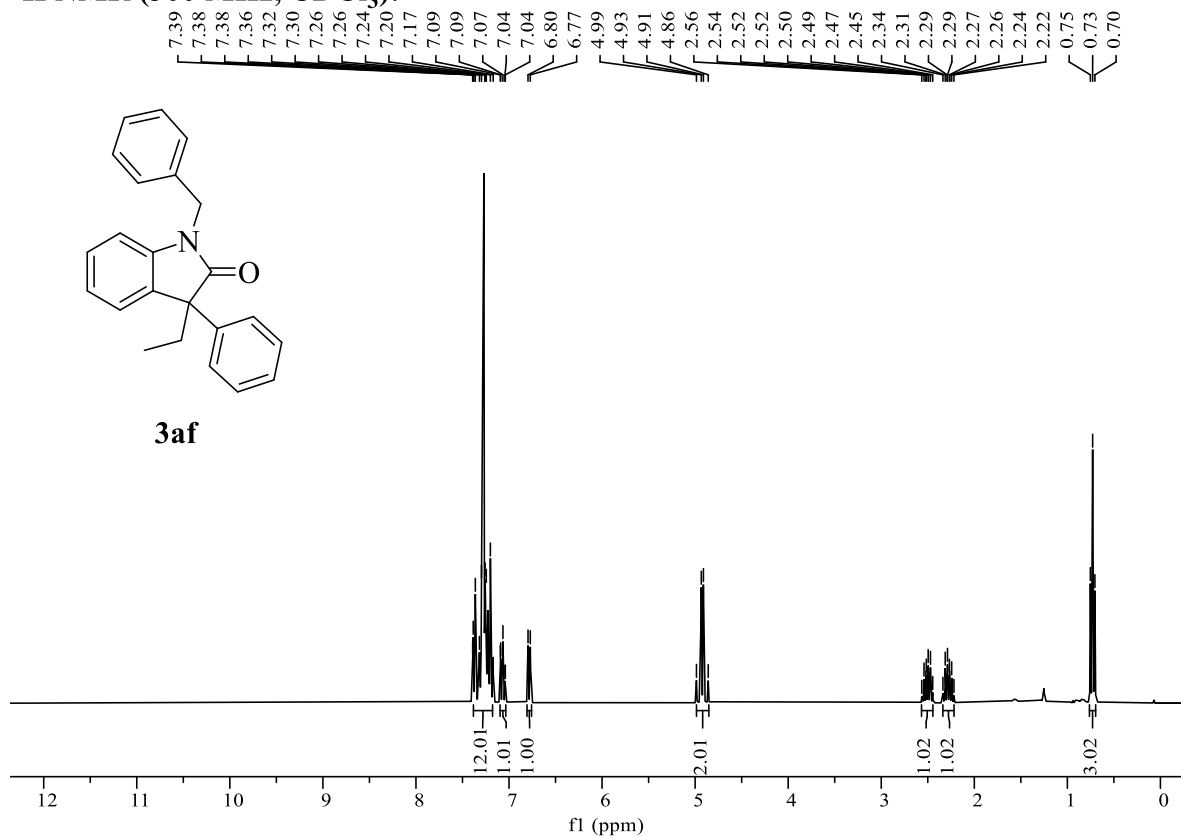


^{13}C NMR (75 MHz, CDCl_3):

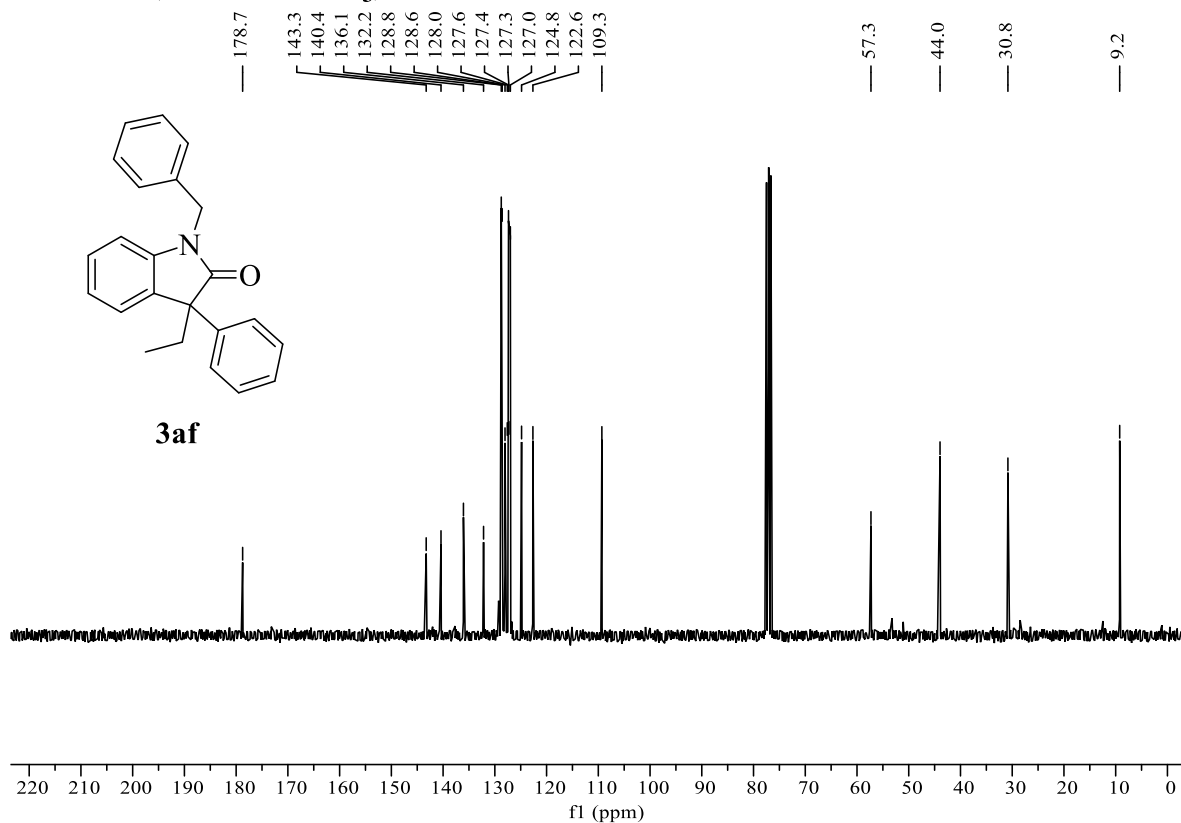


4. NMR Data of compounds

¹H NMR (300 MHz, CDCl₃):

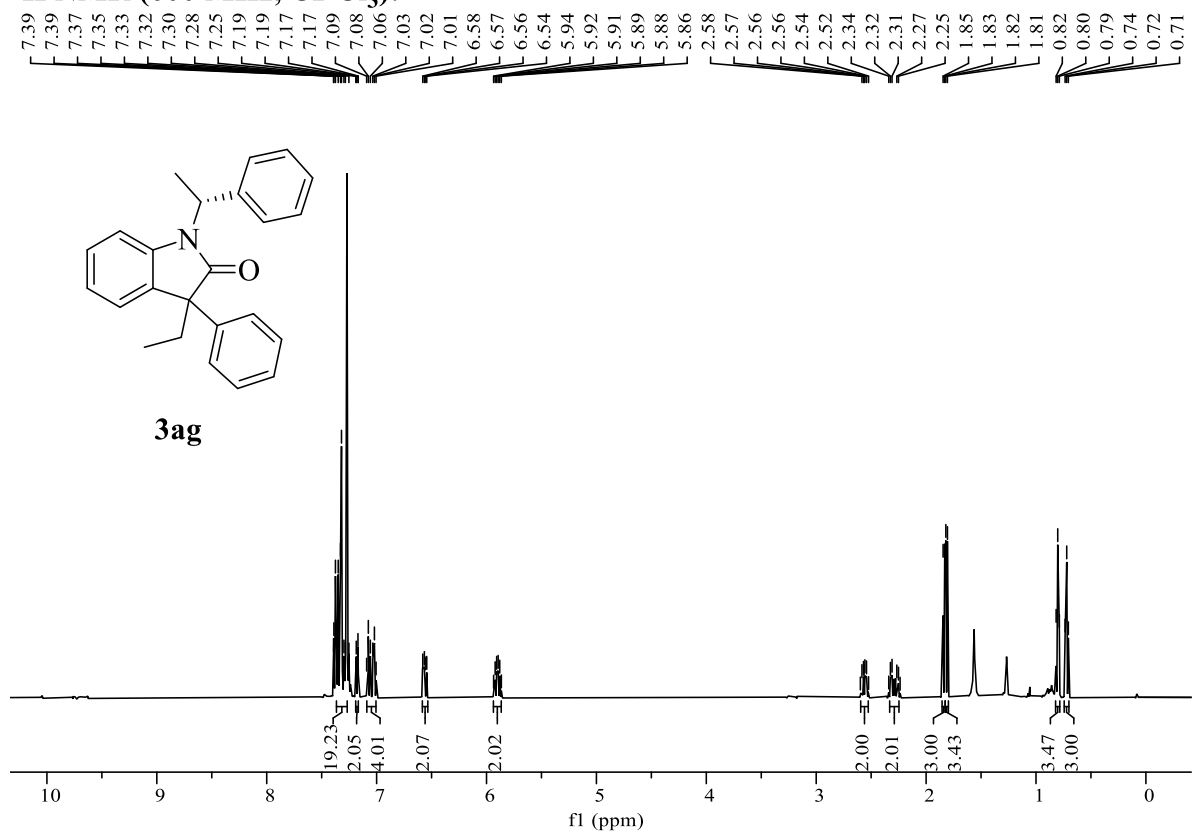


¹³C NMR (75 MHz, CDCl₃):

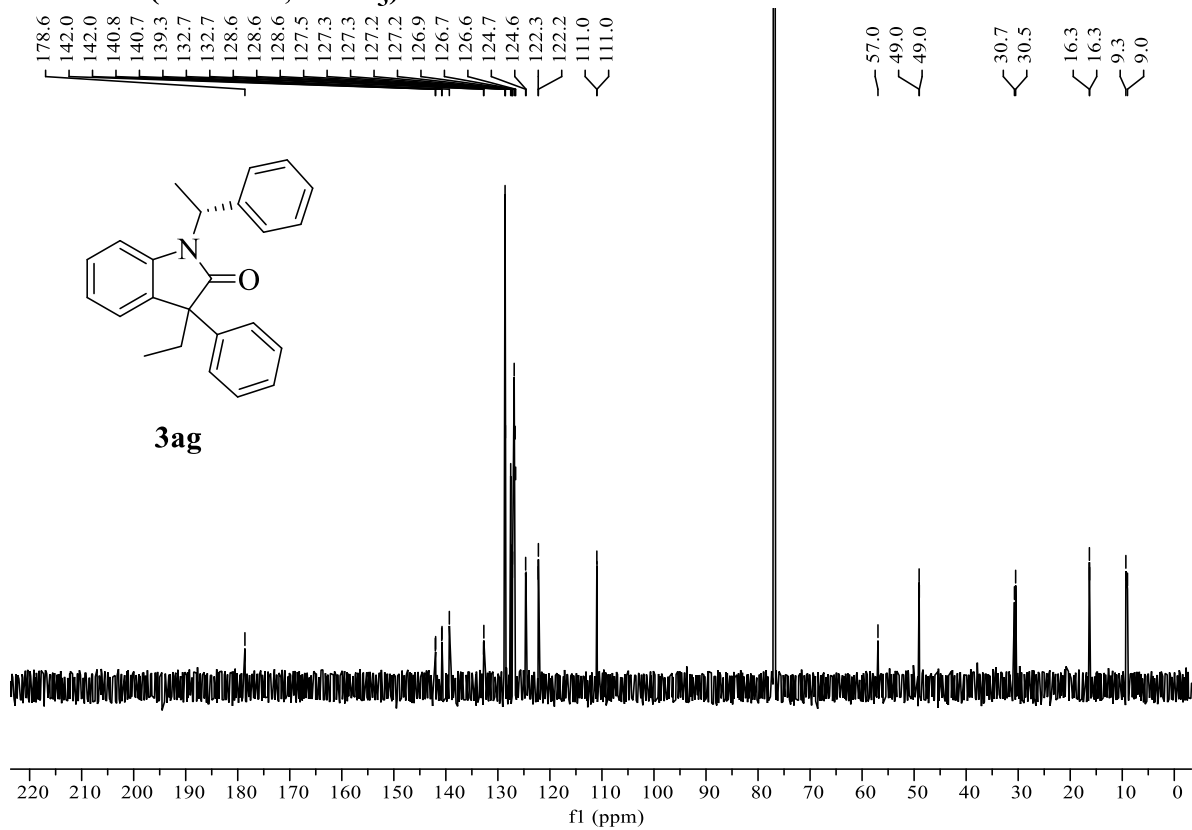


4. NMR Data of compounds

¹H NMR (600 MHz, CDCl₃):

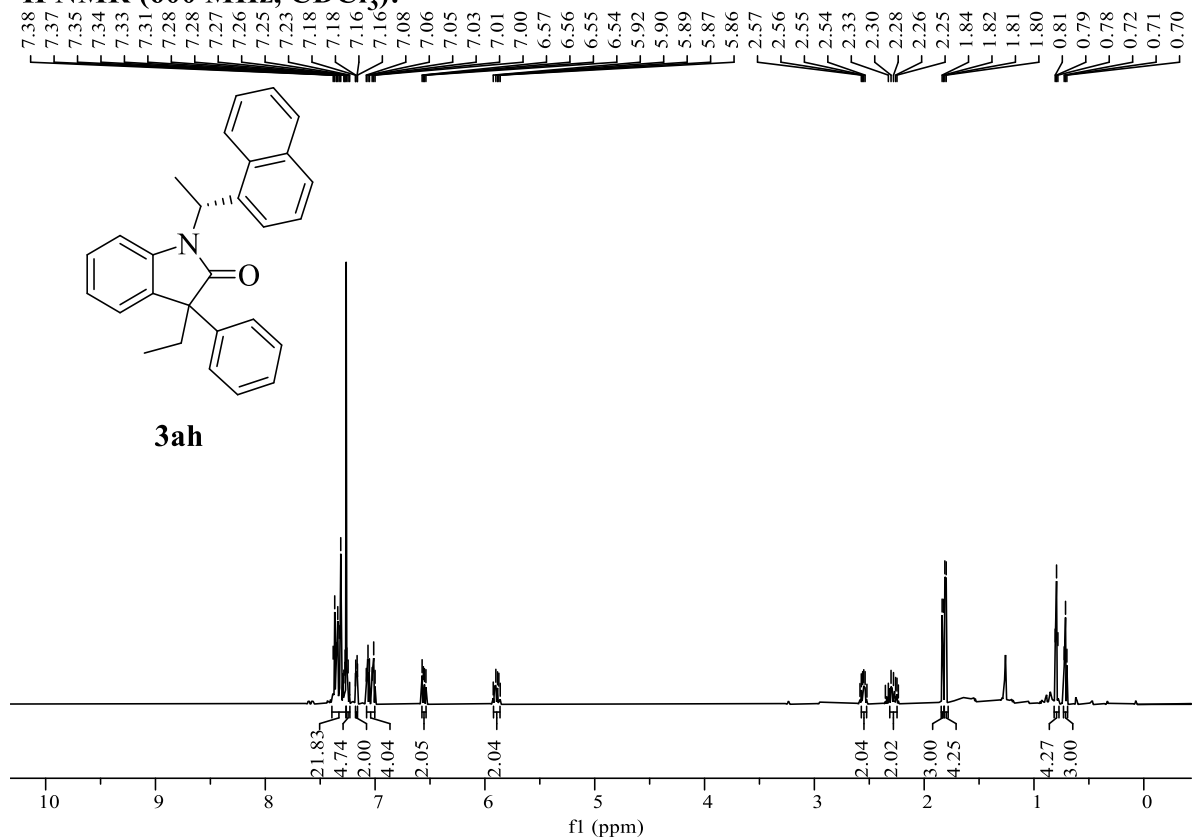


¹³C NMR (151 MHz, CDCl₃):

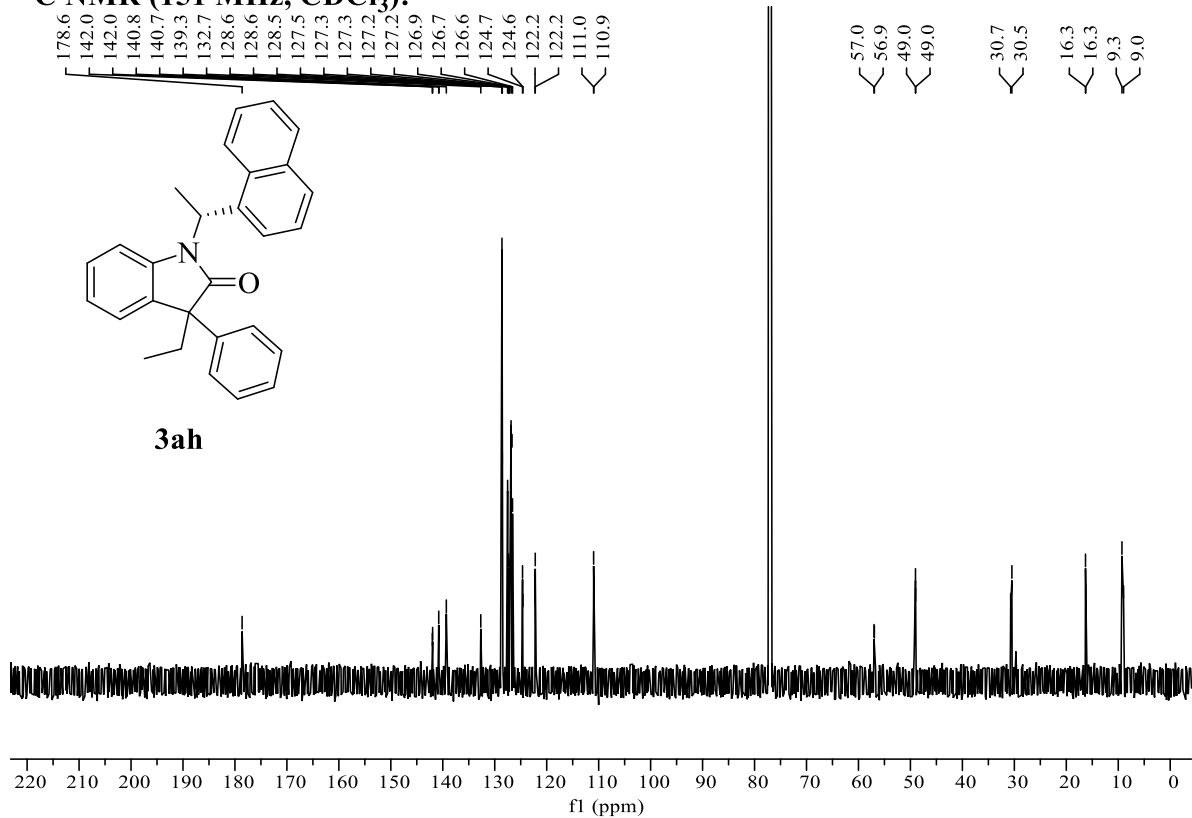


4. NMR Data of compounds

¹H NMR (600 MHz, CDCl₃):

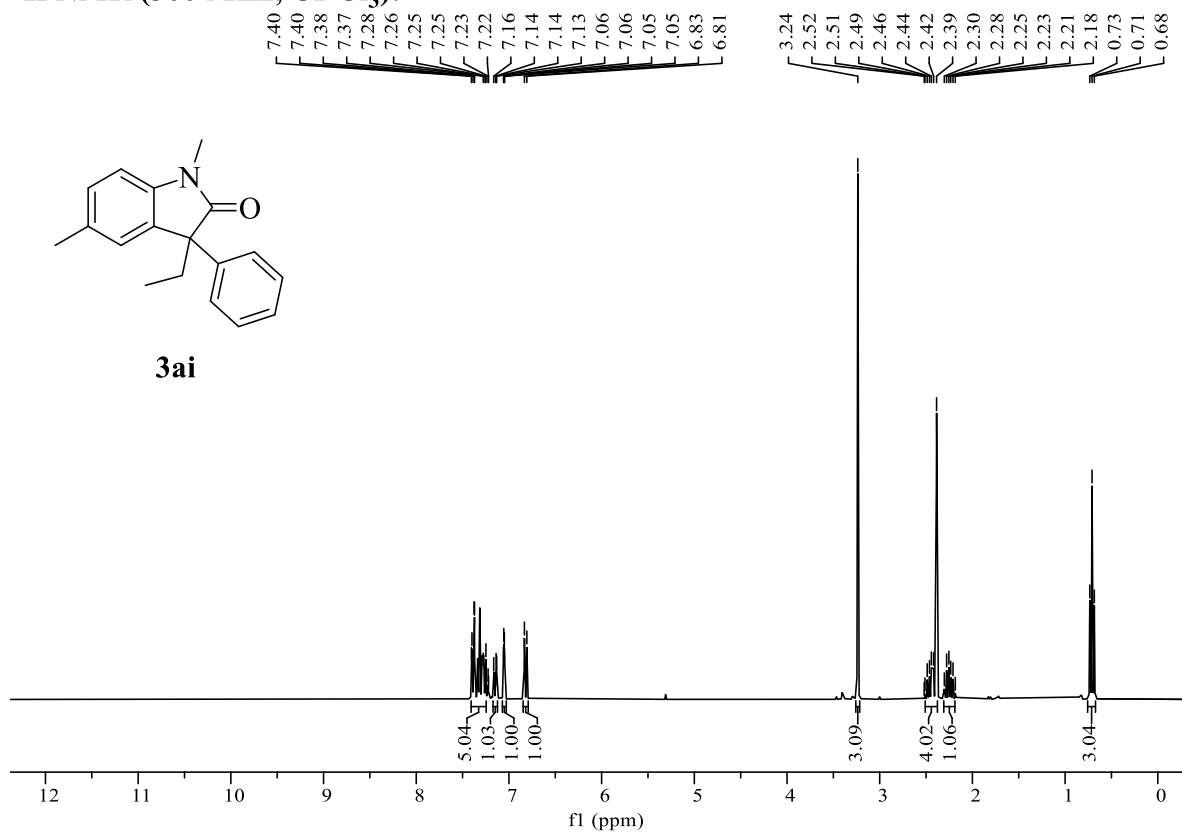


¹³C NMR (151 MHz, CDCl₃):

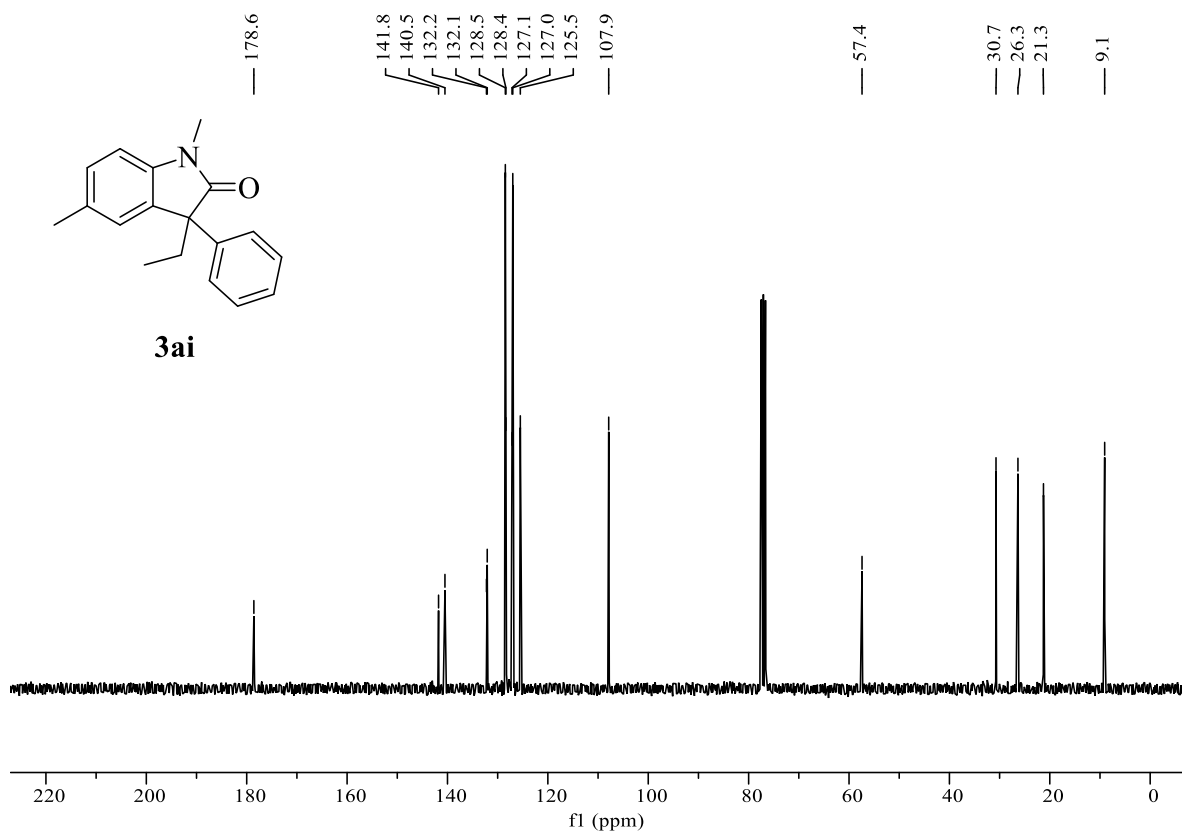


4. NMR Data of compounds

¹H NMR (300 MHz, CDCl₃):

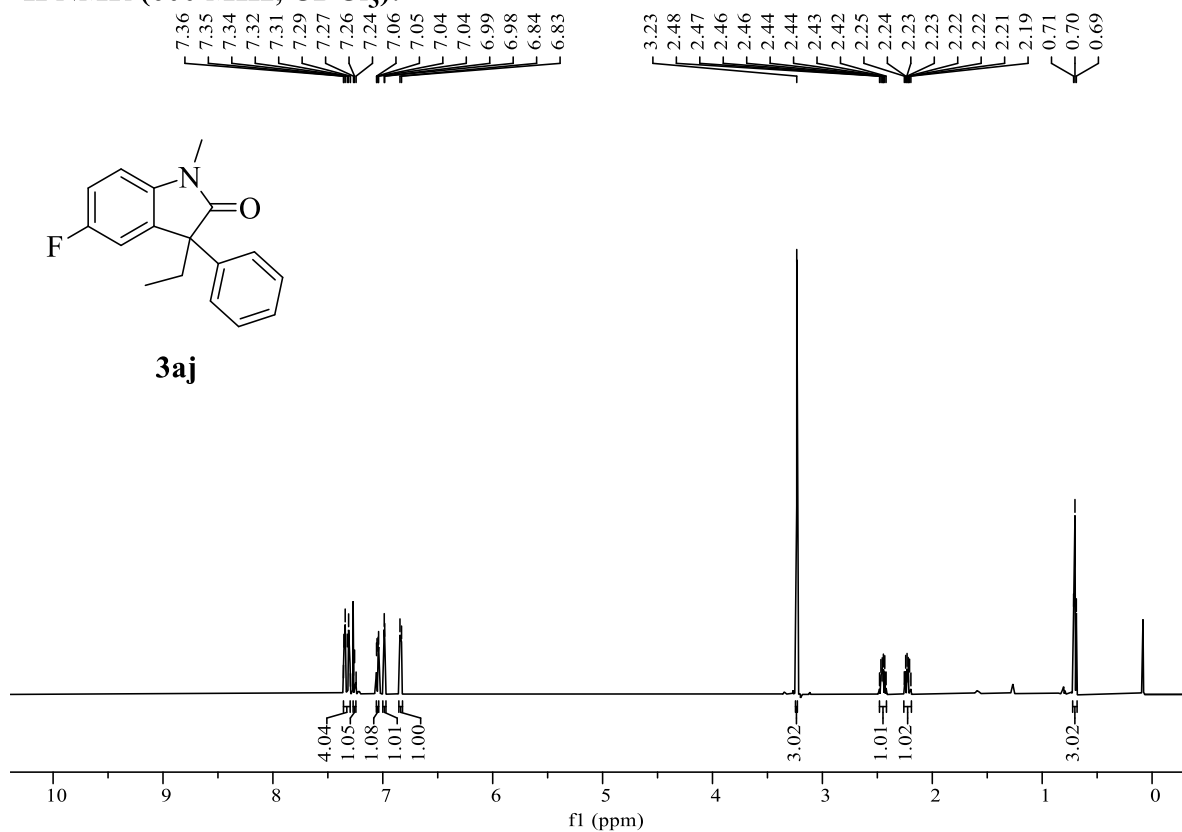


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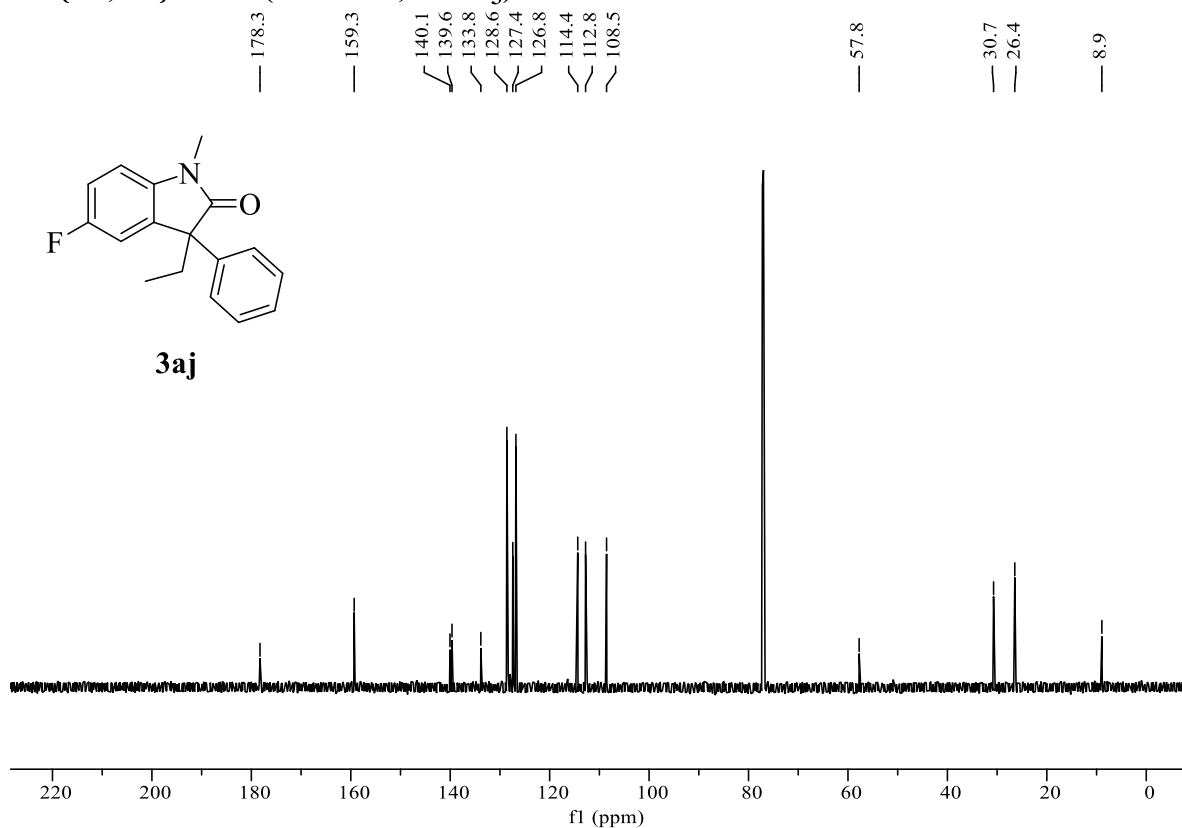


4. NMR Data of compounds

^1H NMR (600 MHz, CDCl_3):

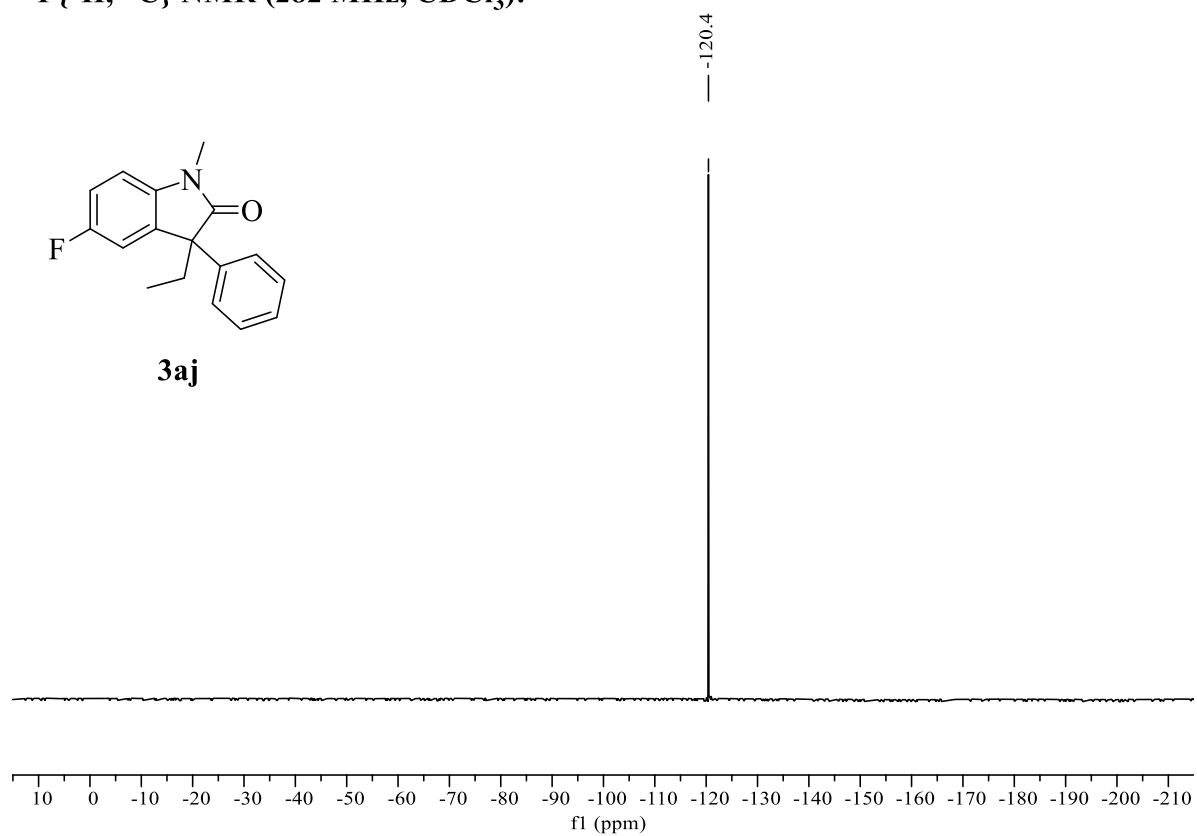


$^{13}\text{C}\{^1\text{H}, ^{19}\text{F}\}$ NMR (151 MHz, CDCl_3):



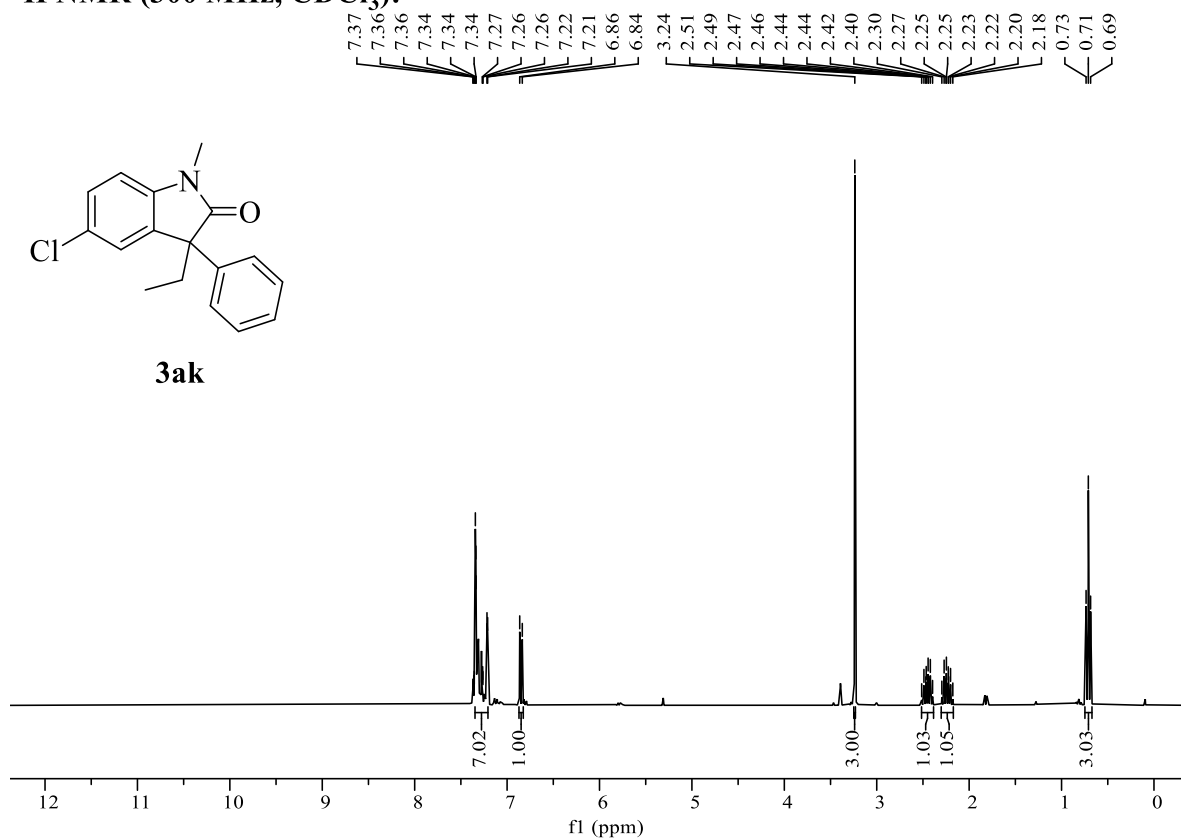
4. NMR Data of compounds

$^{19}\text{F}\{^1\text{H}, ^{13}\text{C}\}$ NMR (282 MHz, CDCl_3):

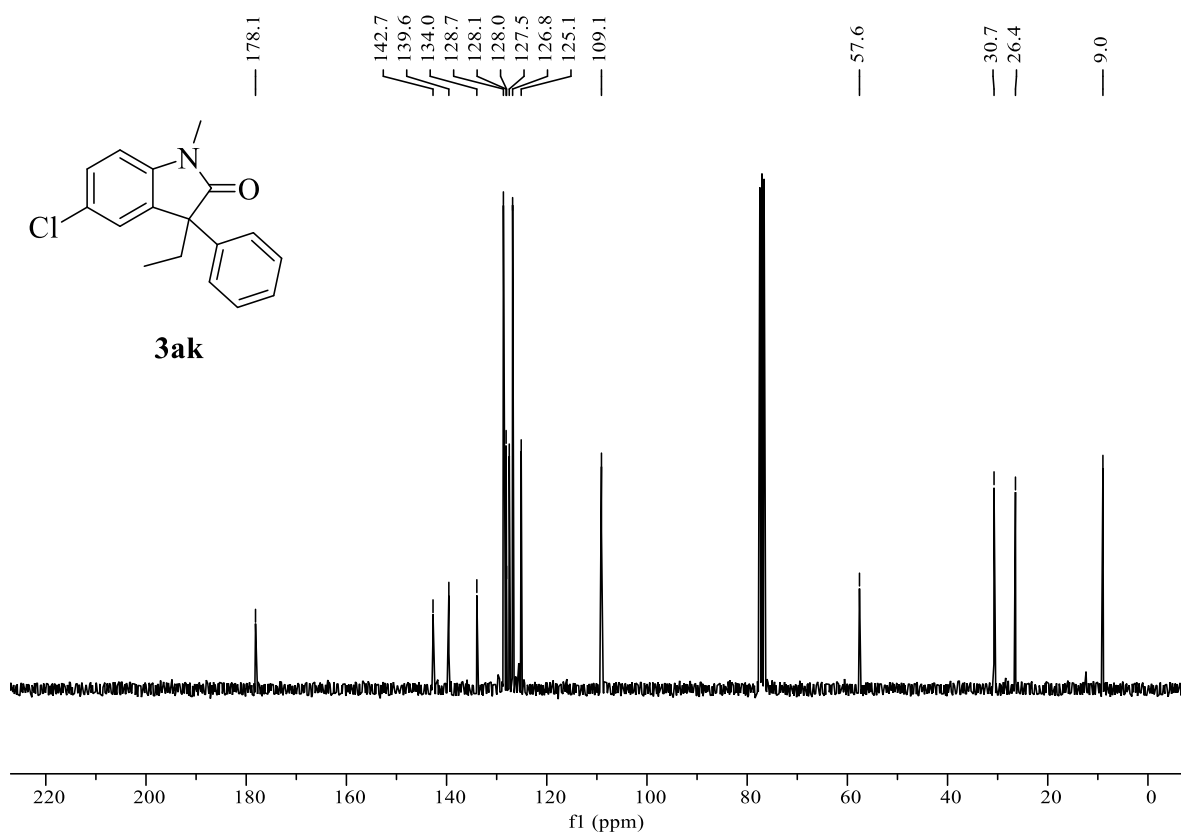


4. NMR Data of compounds

¹H NMR (300 MHz, CDCl₃):

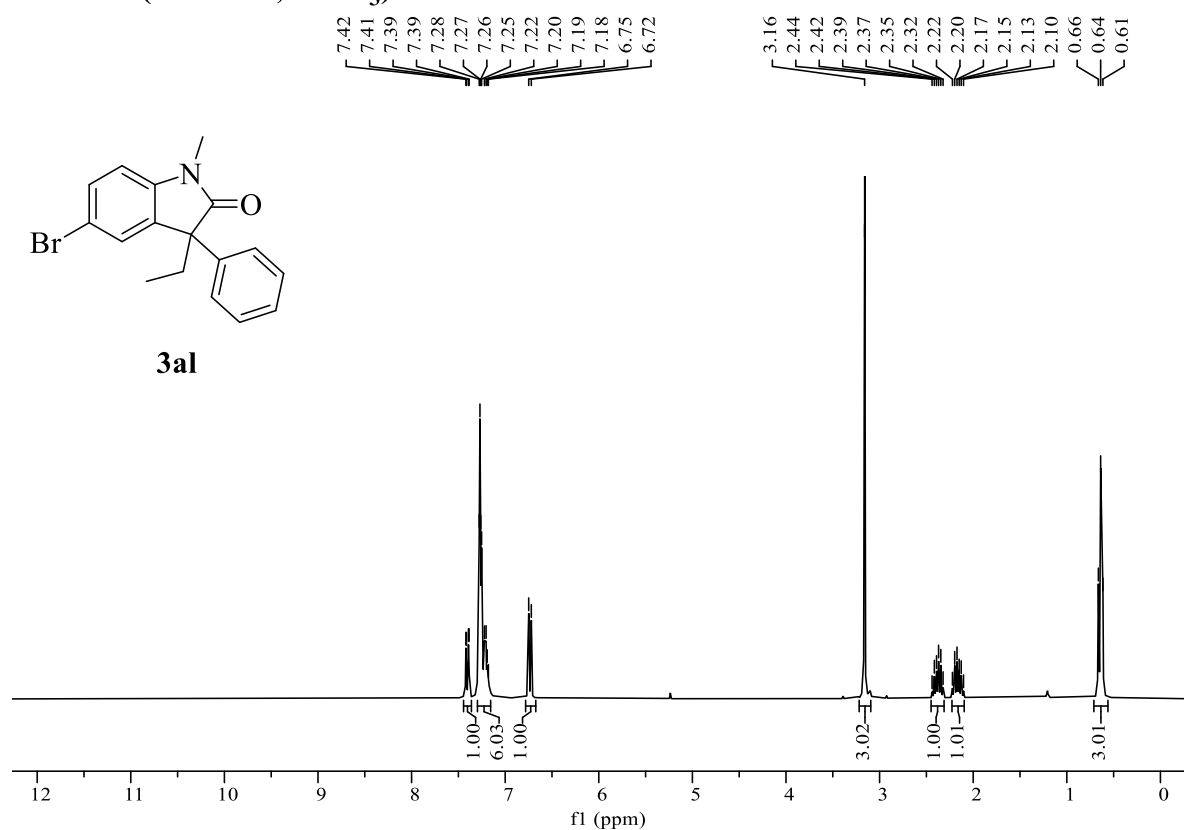


¹³C NMR (75 MHz, CDCl₃):

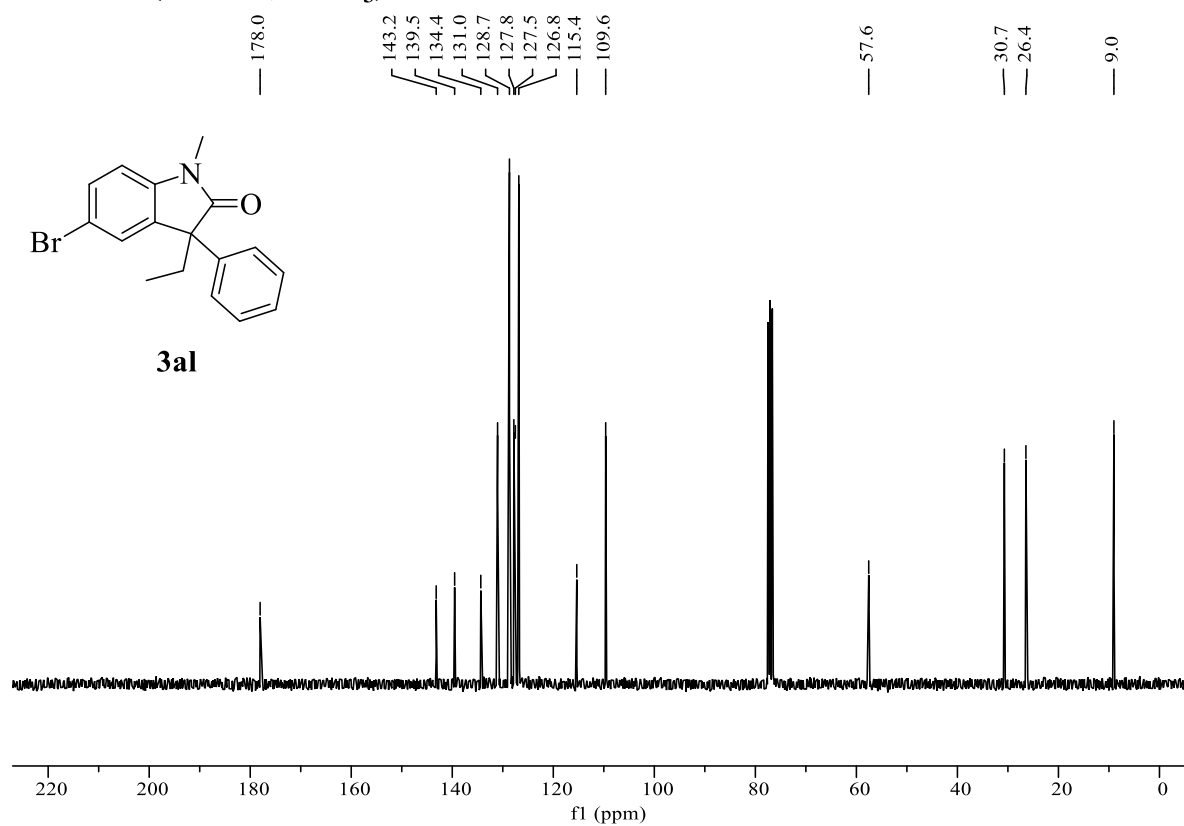


4. NMR Data of compounds

^1H NMR (300 MHz, CDCl_3):

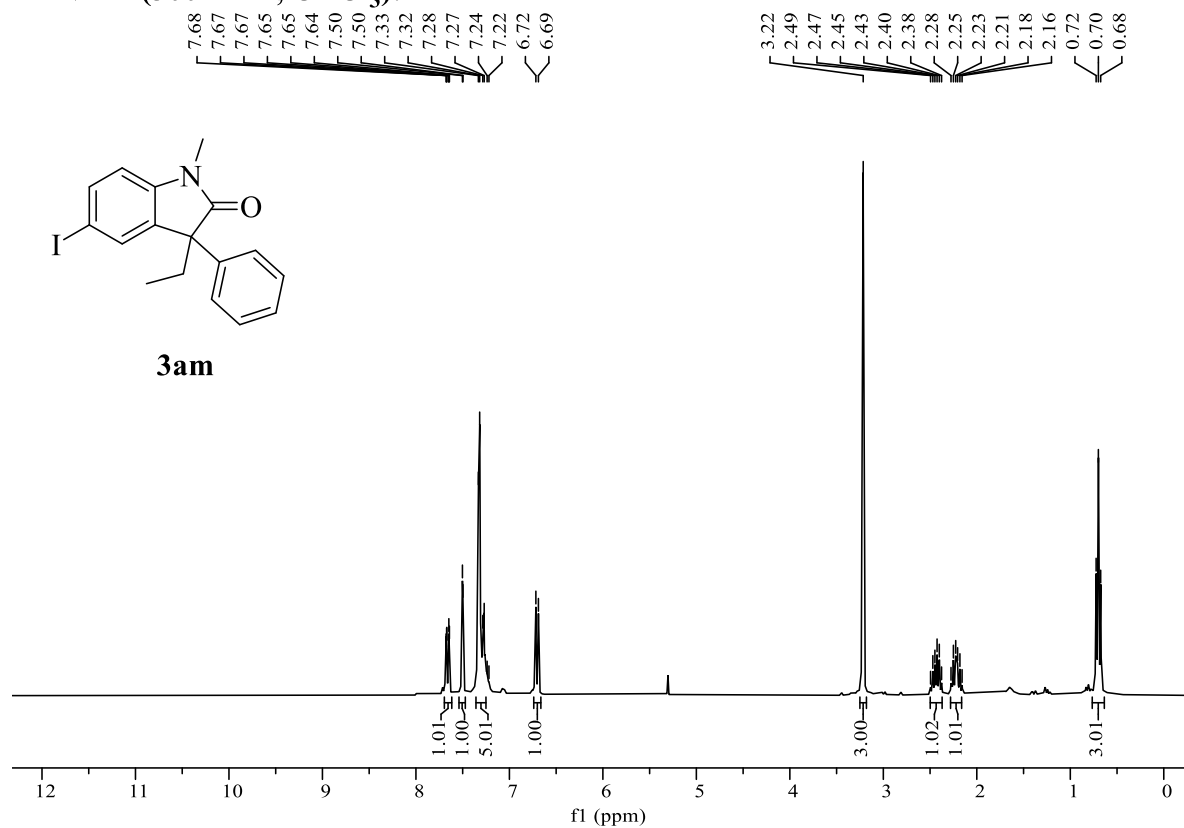


^{13}C NMR (75 MHz, CDCl_3):

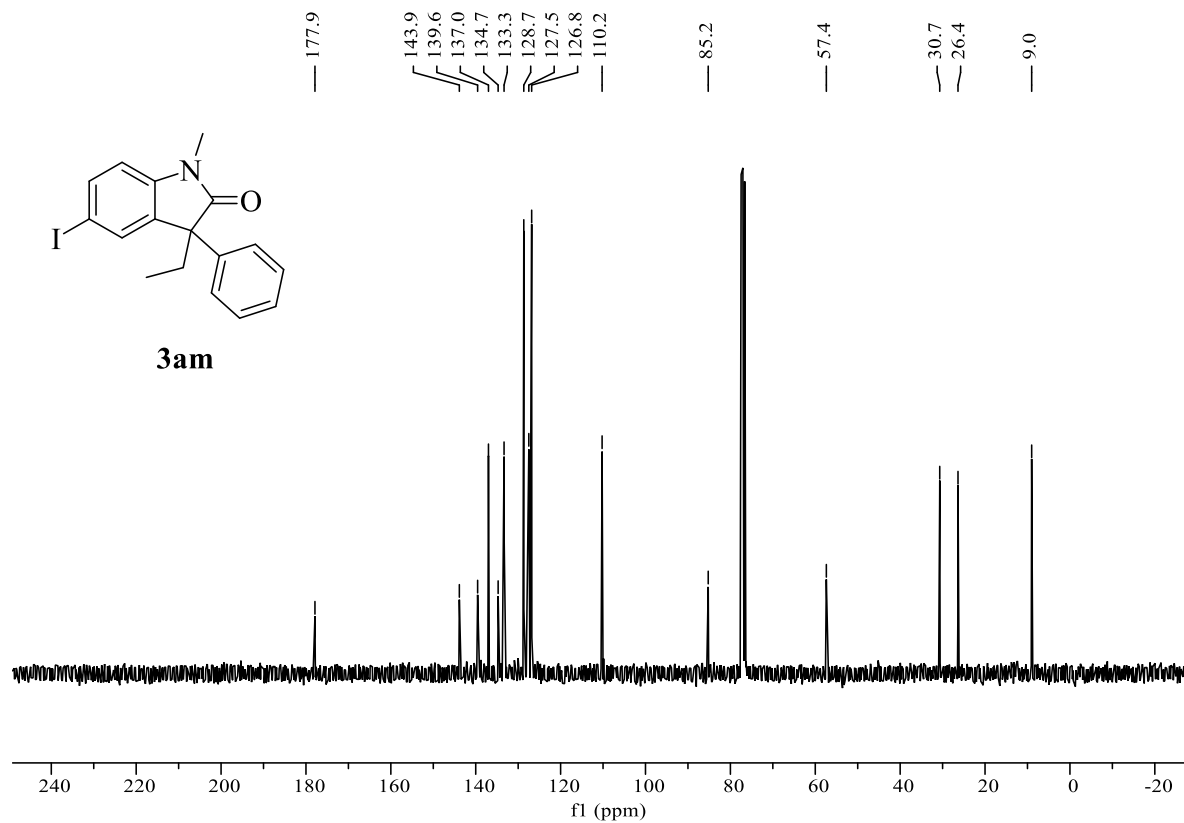


4. NMR Data of compounds

¹H NMR (300 MHz, CDCl₃):

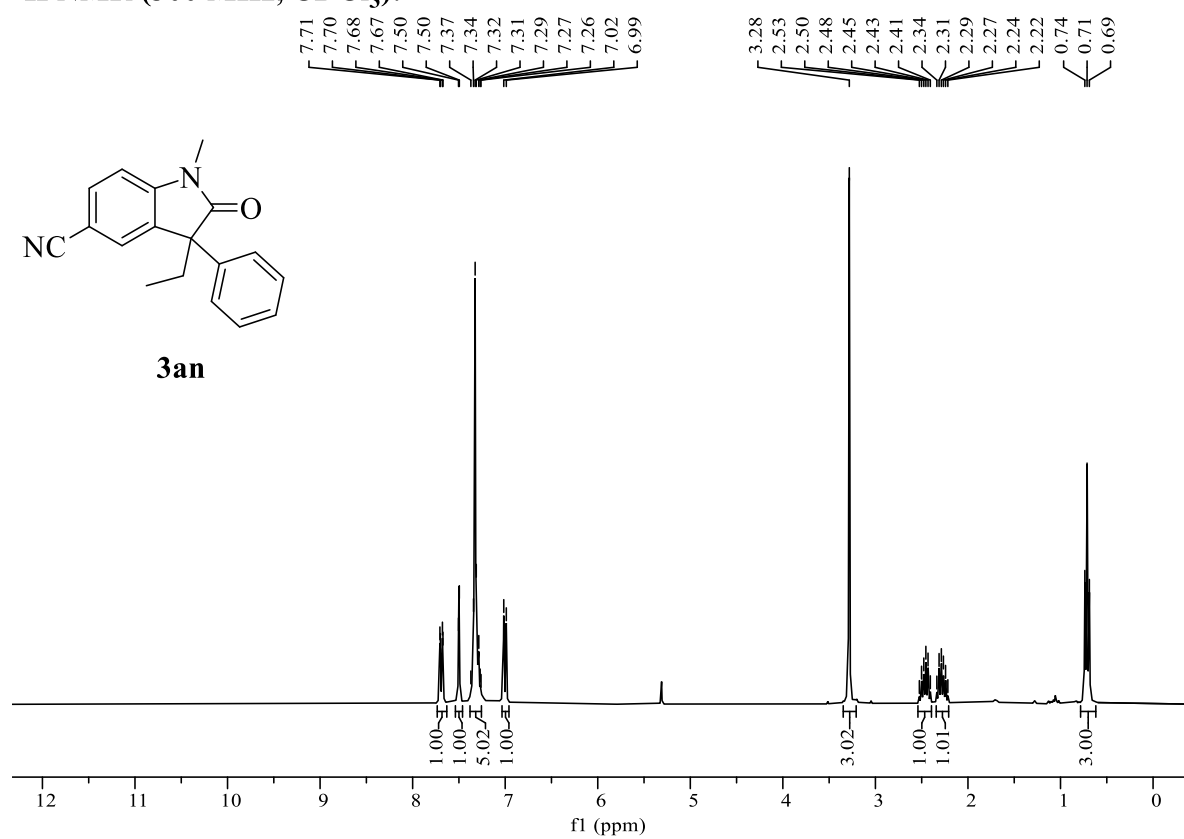


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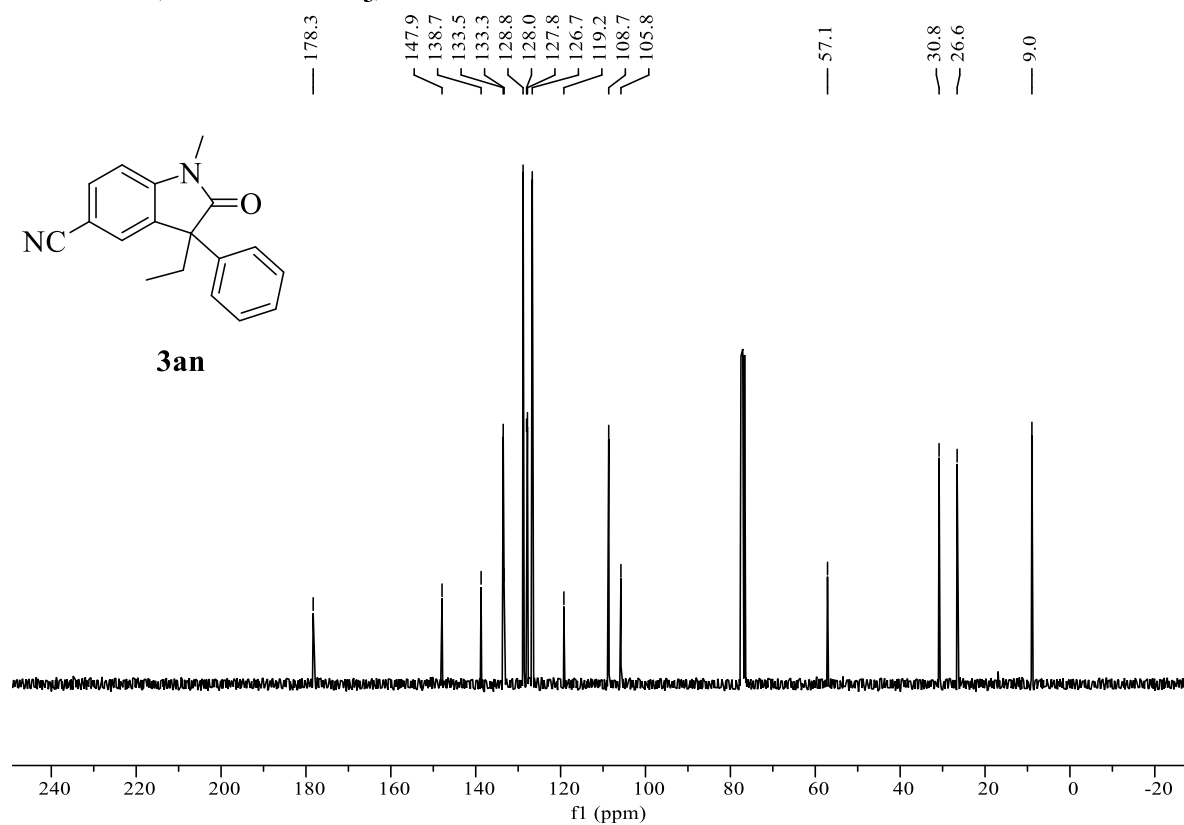


4. NMR Data of compounds

^1H NMR (300 MHz, CDCl_3):

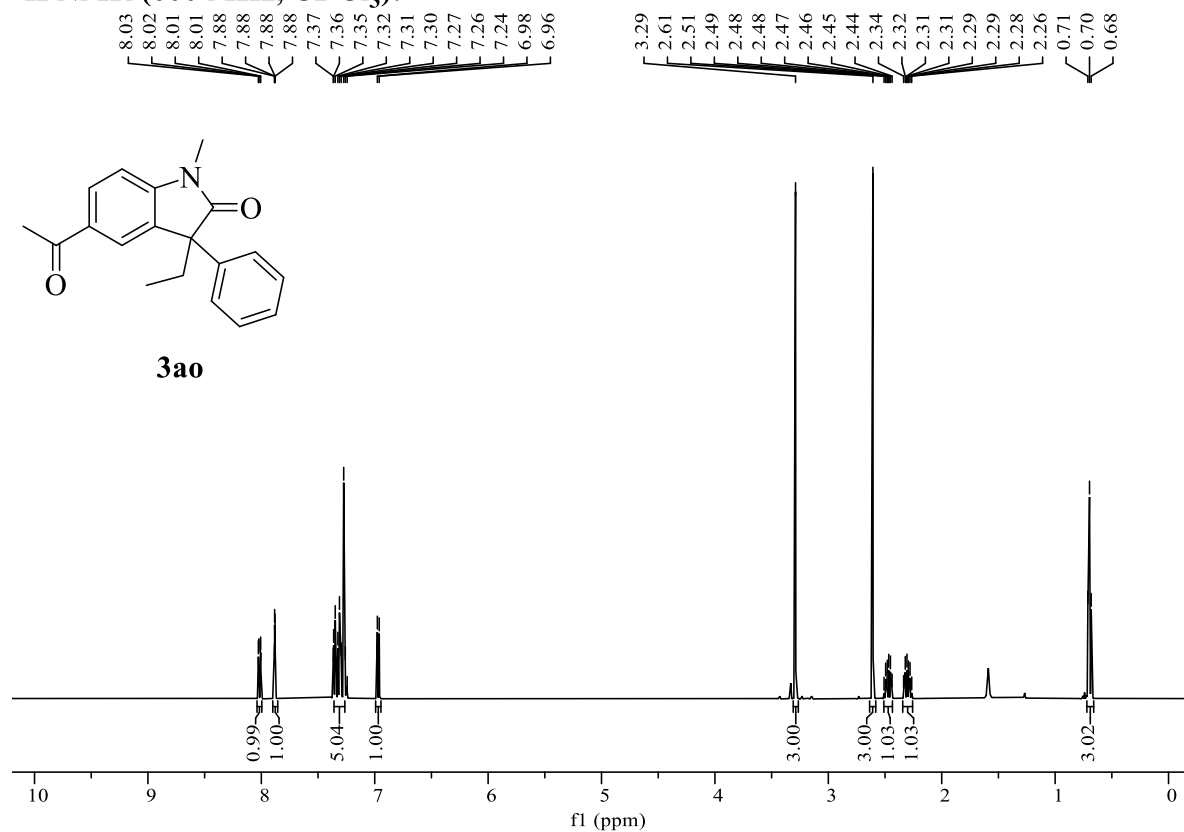


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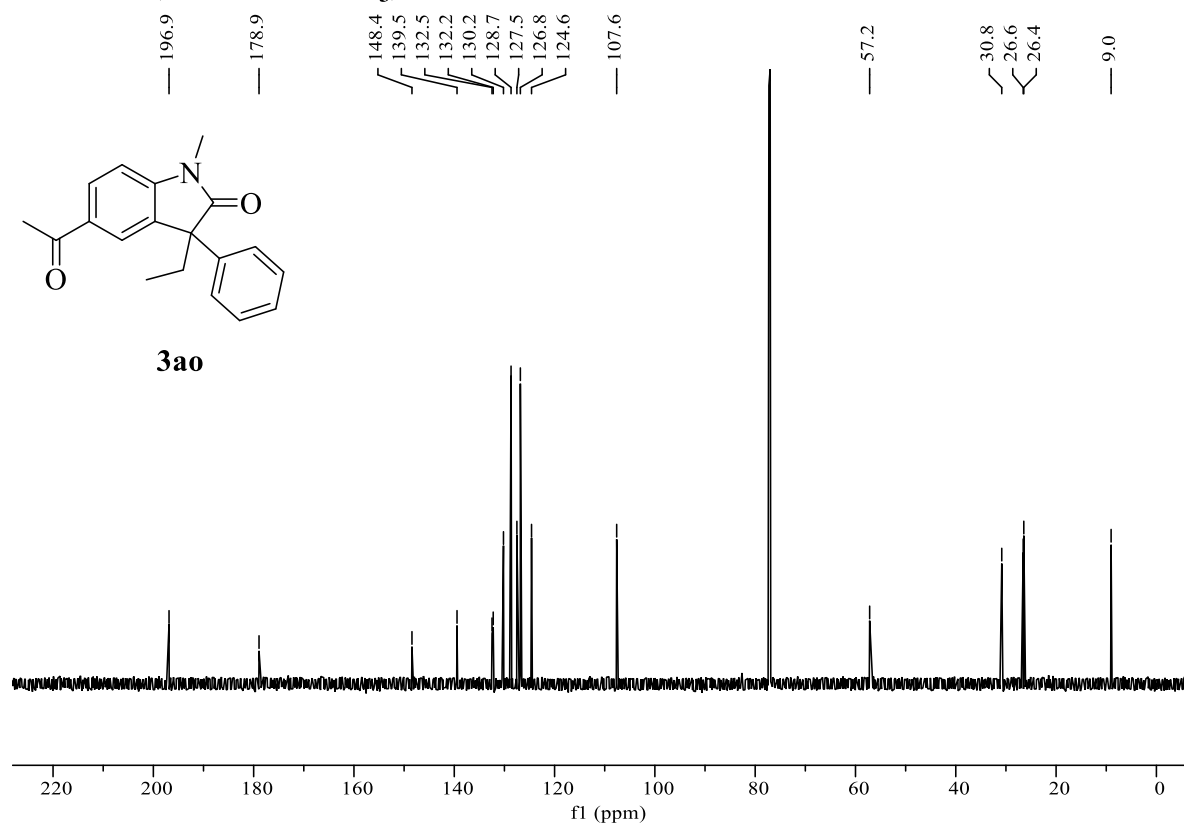


4. NMR Data of compounds

¹H NMR (600 MHz, CDCl₃):

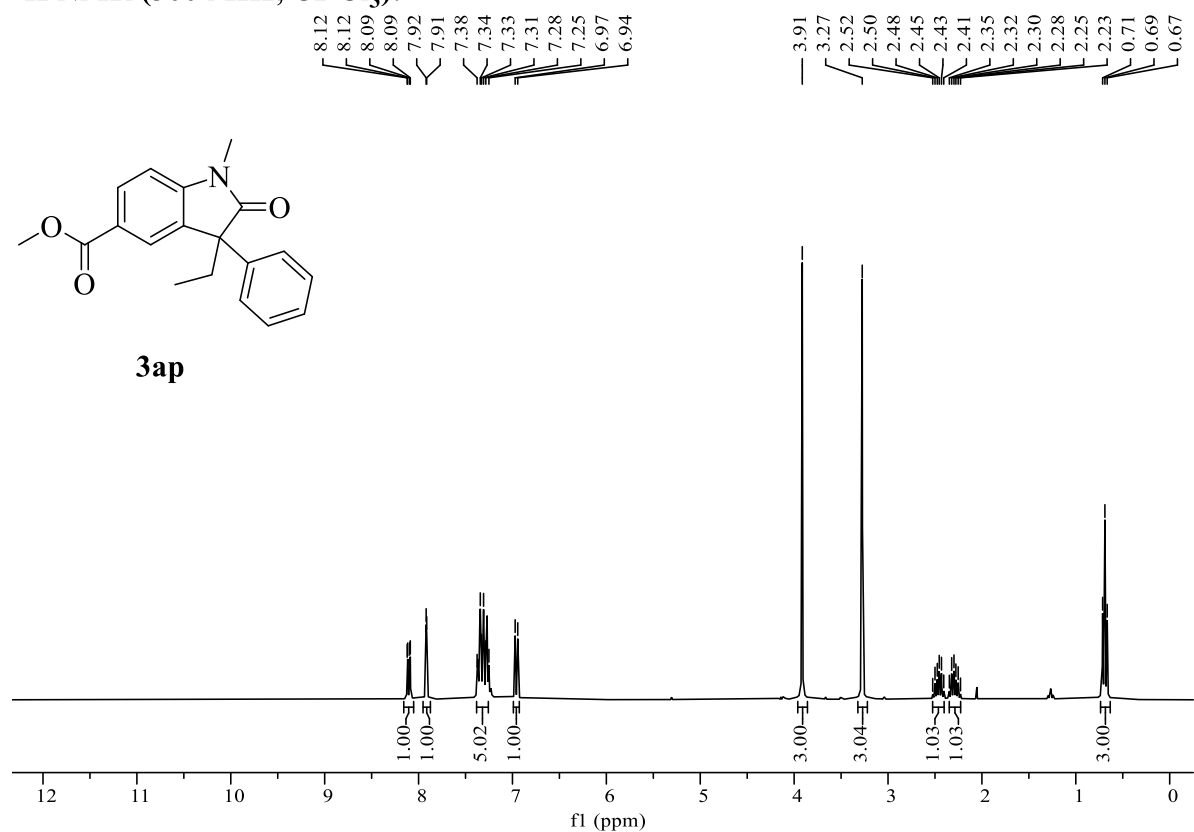


¹³C NMR (151 MHz, CDCl₃):

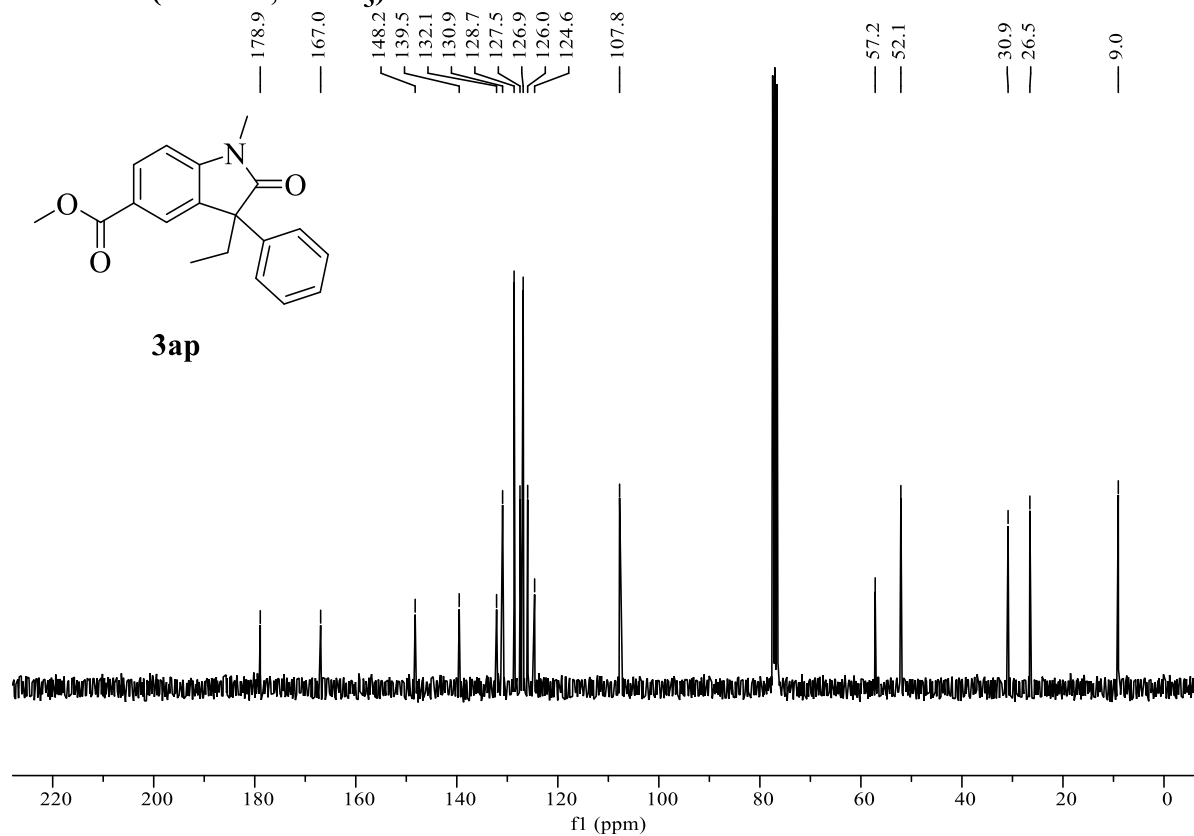


4. NMR Data of compounds

¹H NMR (300 MHz, CDCl₃):

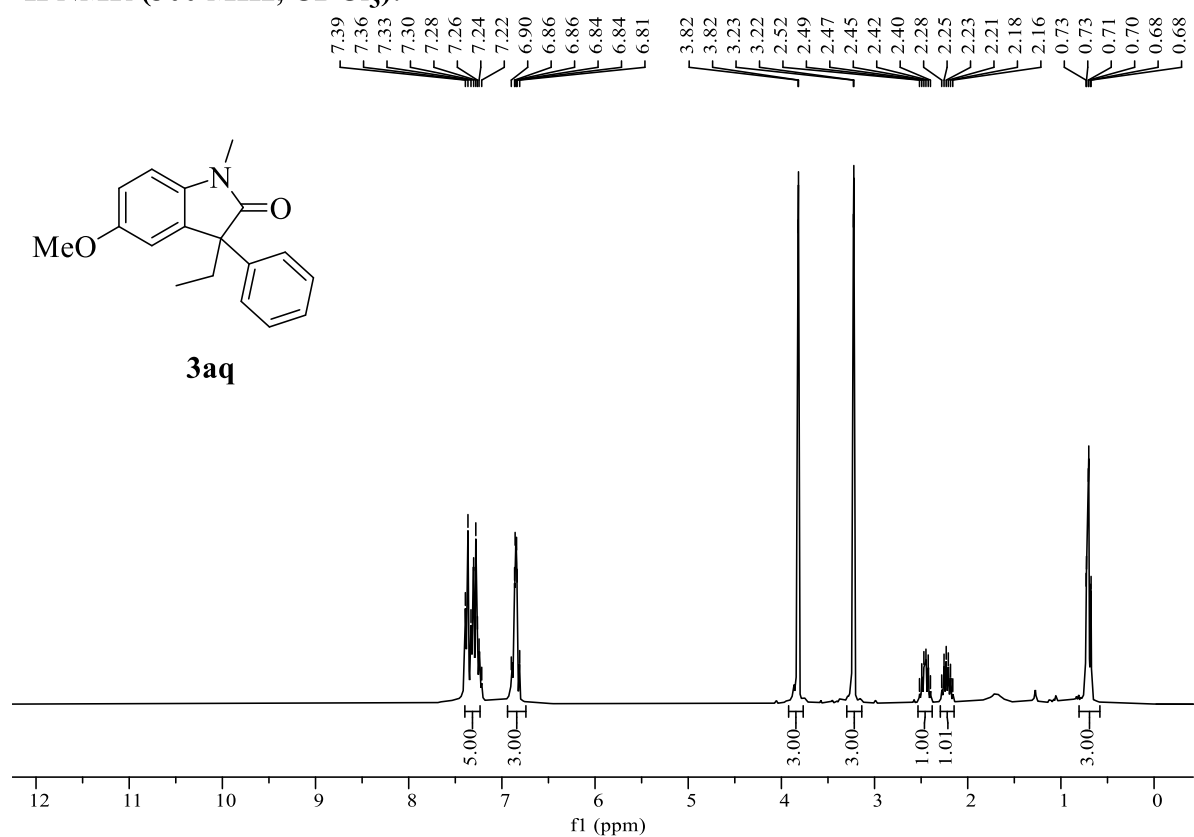


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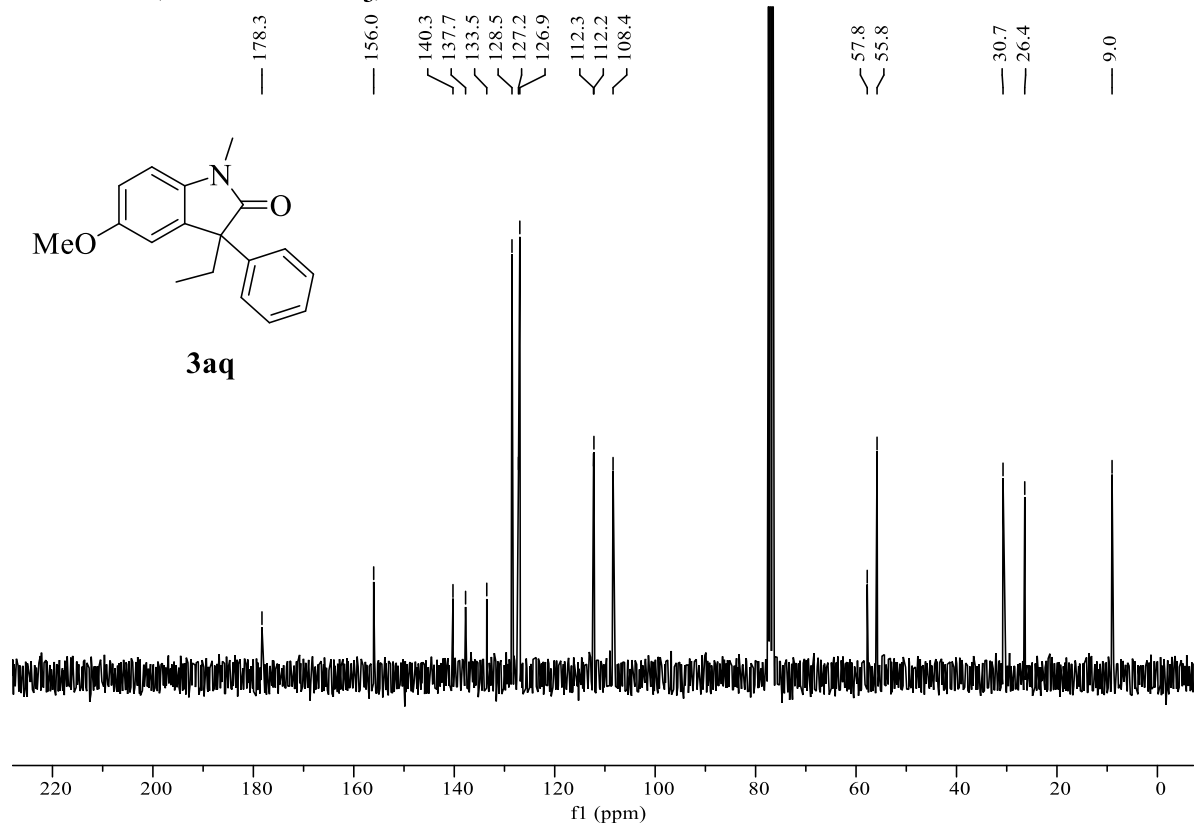


4. NMR Data of compounds

^1H NMR (300 MHz, CDCl_3):

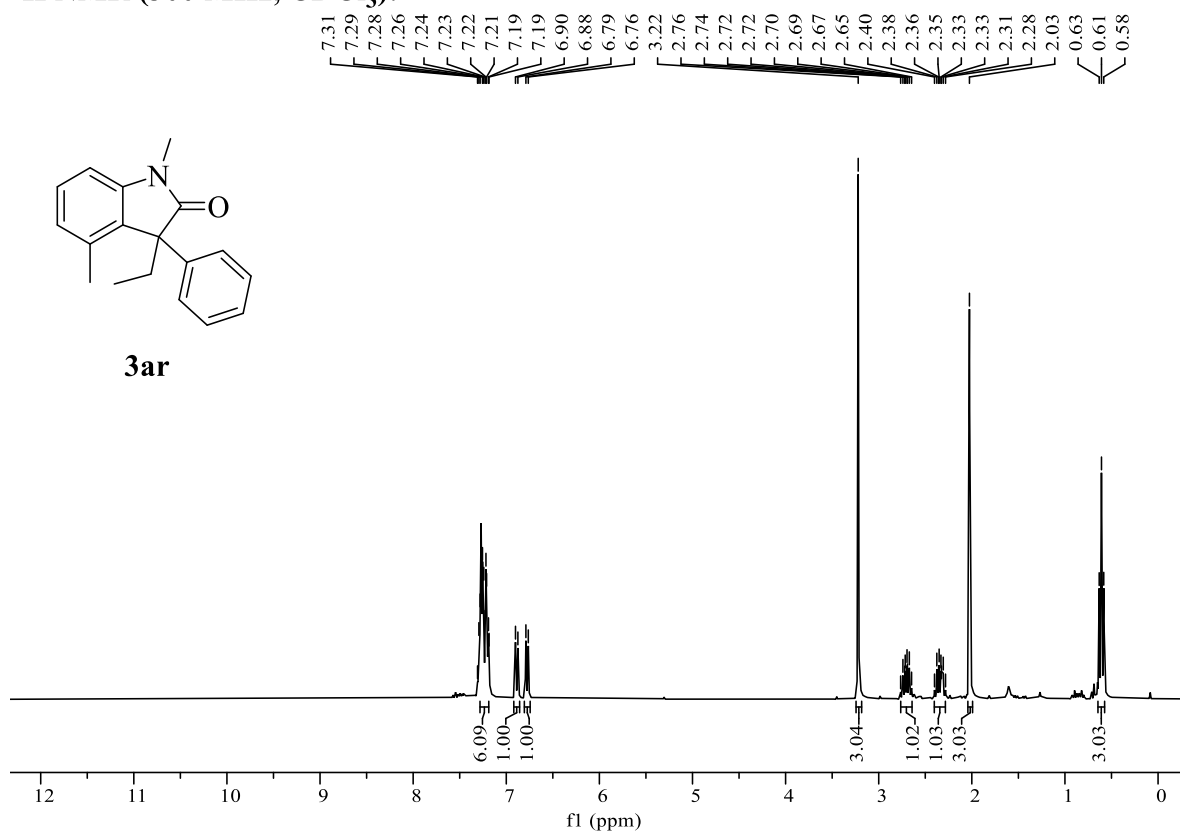


^{13}C NMR (75 MHz, CDCl_3):

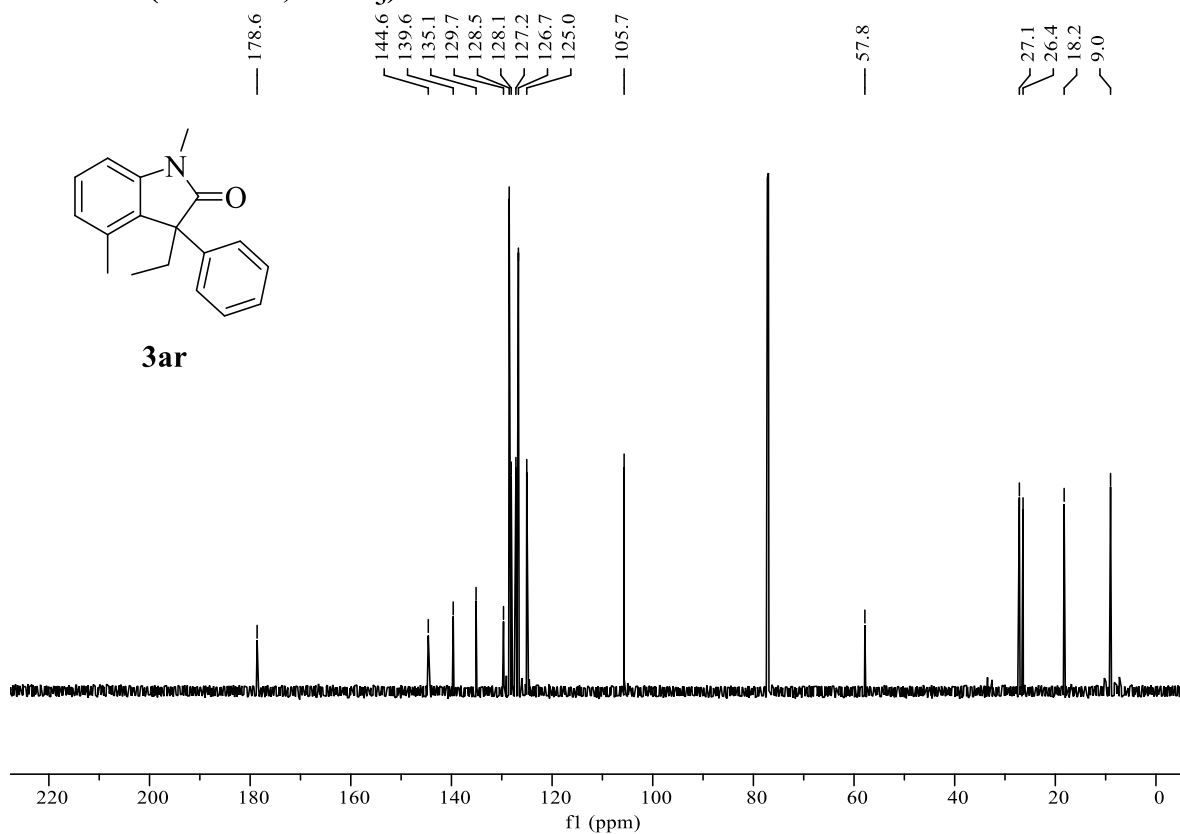


4. NMR Data of compounds

¹H NMR (300 MHz, CDCl₃):

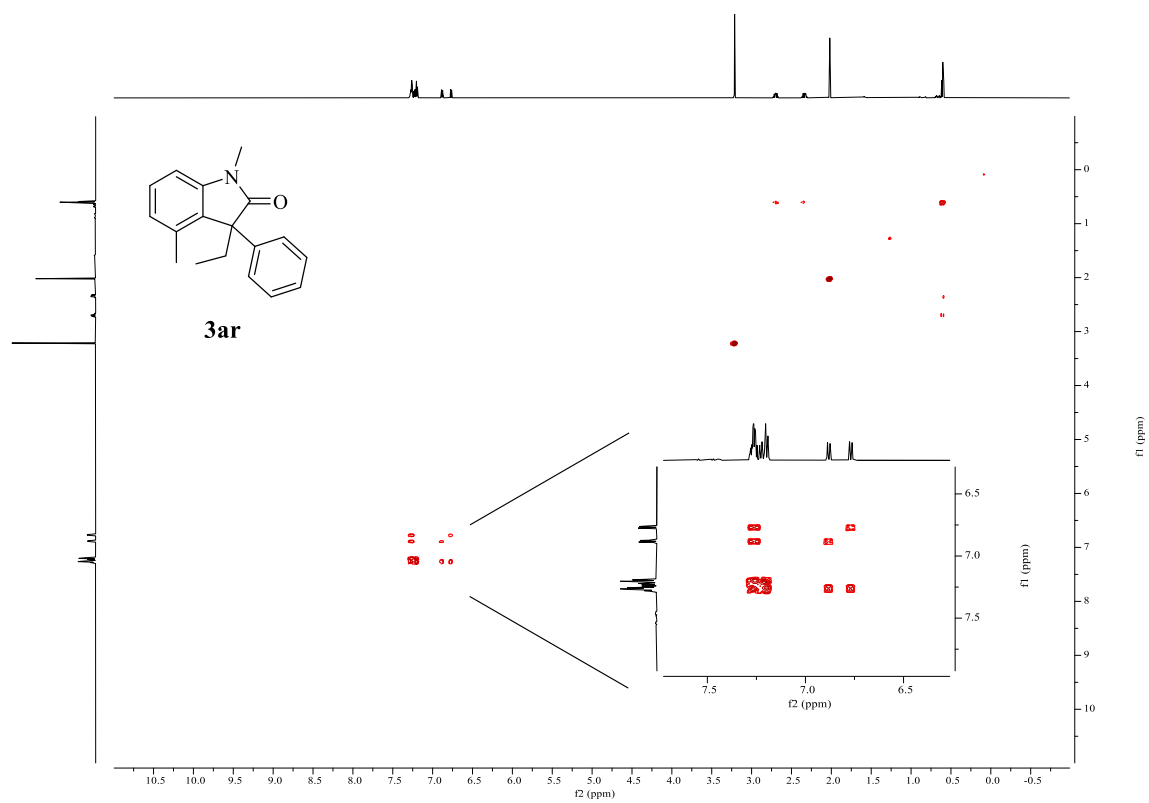


¹³C NMR (151 MHz, CDCl₃):



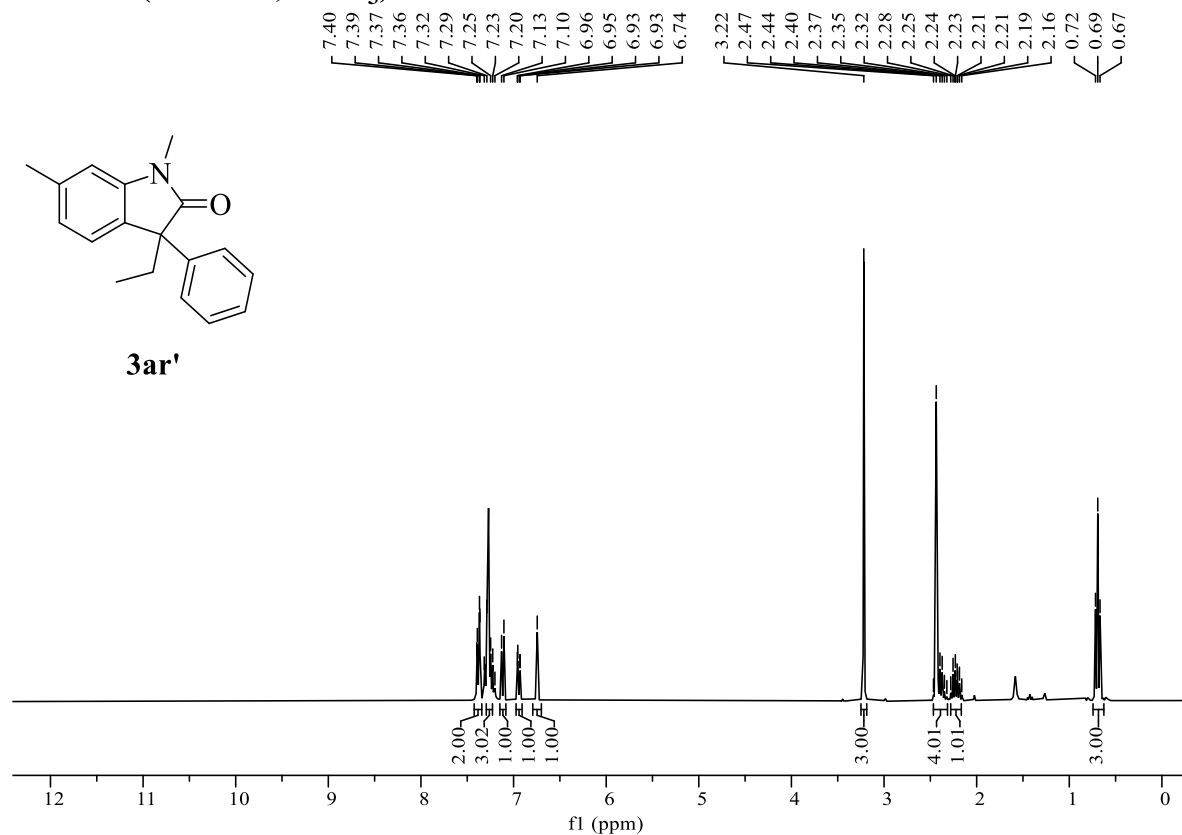
4. NMR Data of compounds

2D-COSY NMR (600 MHz, CDCl₃)

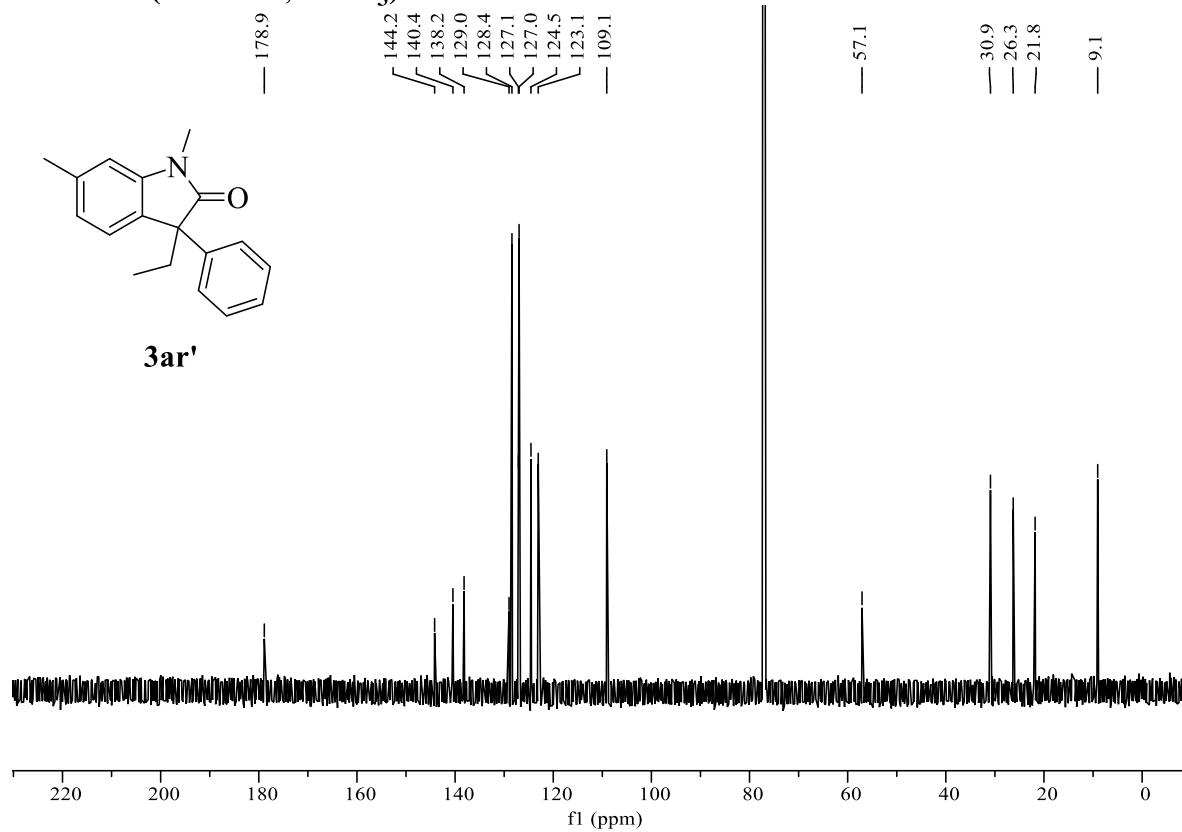


4. NMR Data of compounds

^1H NMR (300 MHz, CDCl_3):

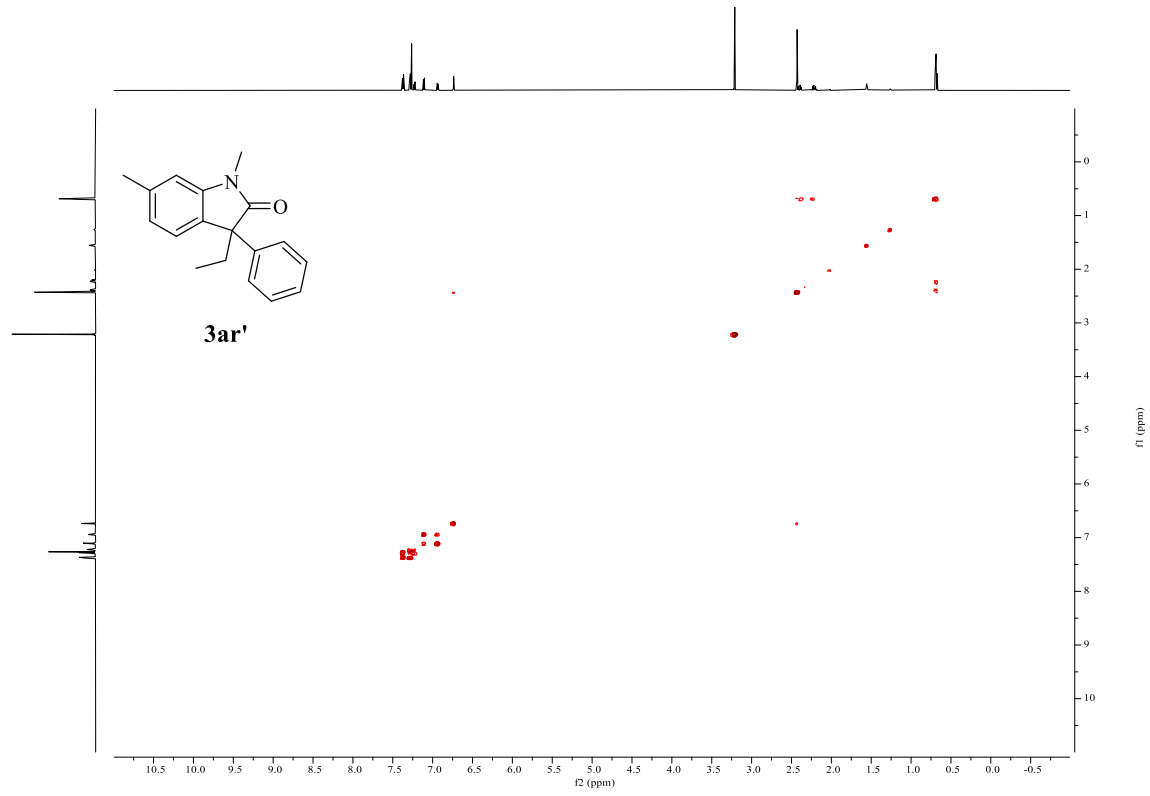


^{13}C NMR (151 MHz, CDCl_3):



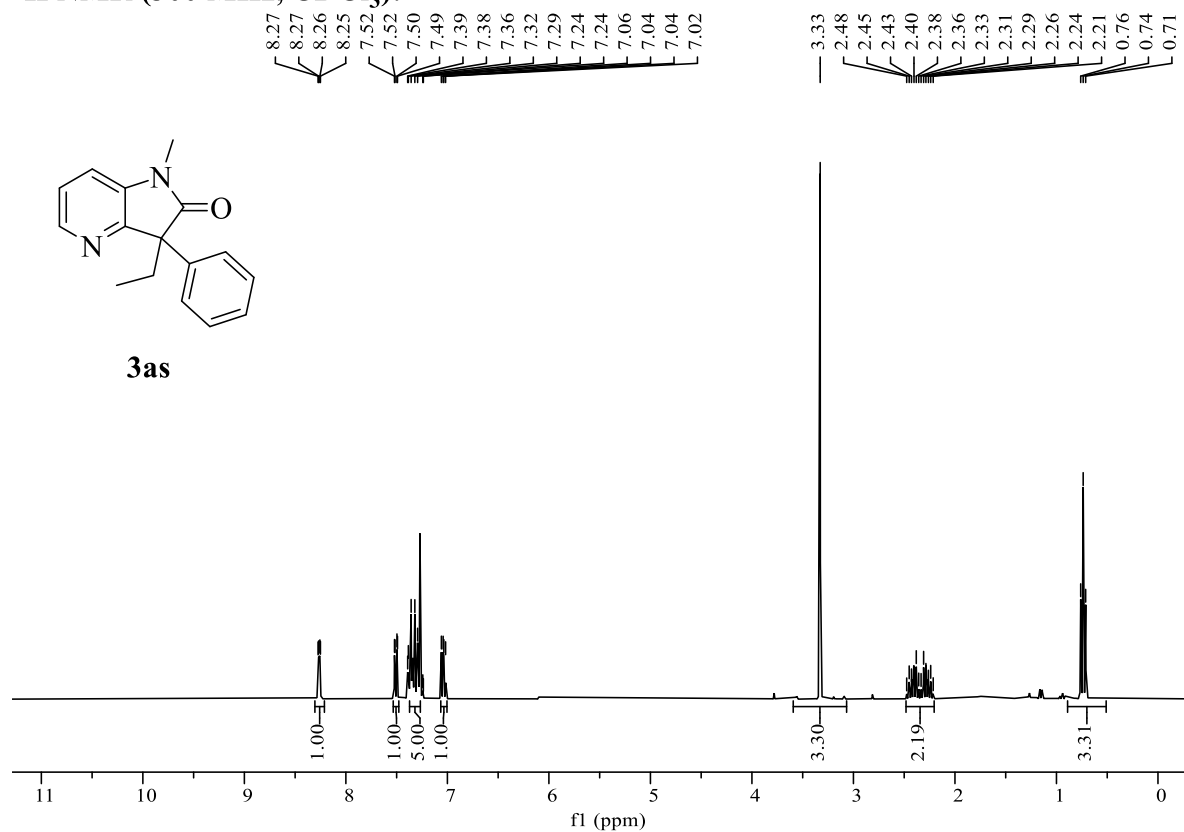
4. NMR Data of compounds

2D-COSY NMR (600 MHz, CDCl₃)

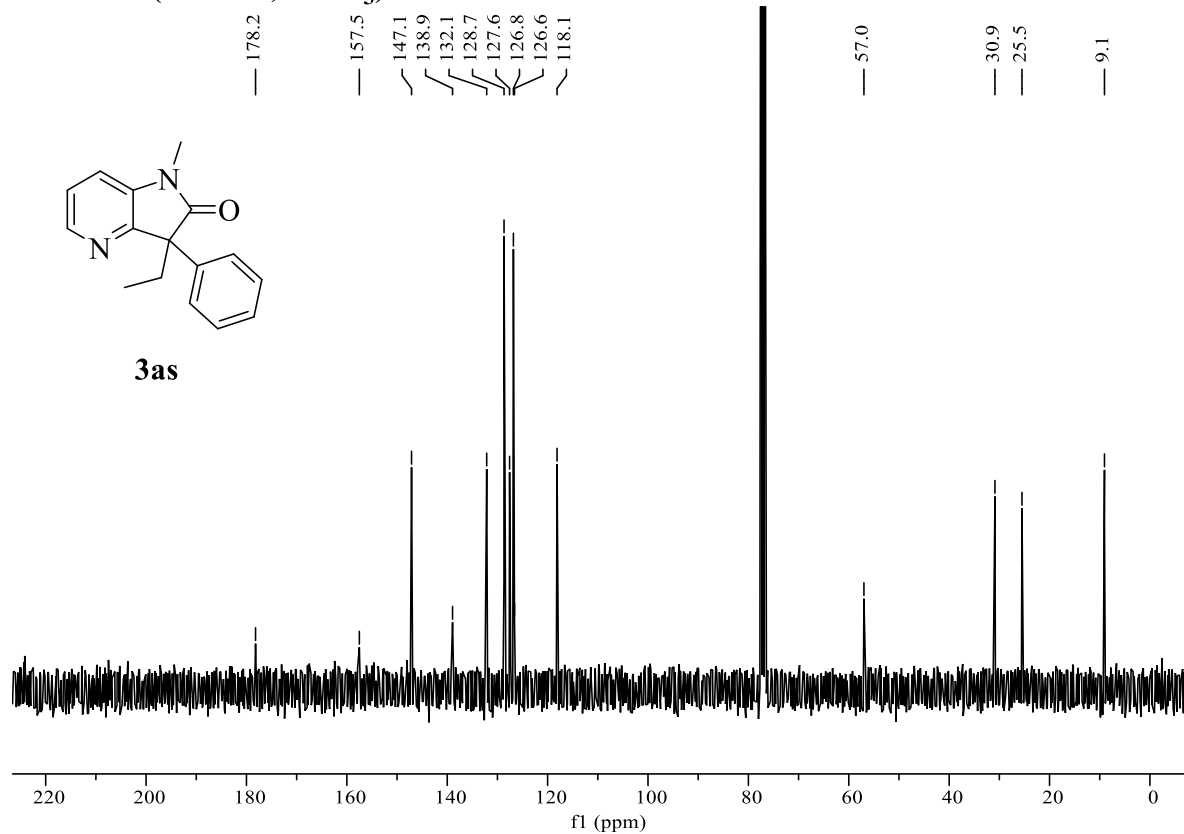


4. NMR Data of compounds

¹H NMR (300 MHz, CDCl₃):

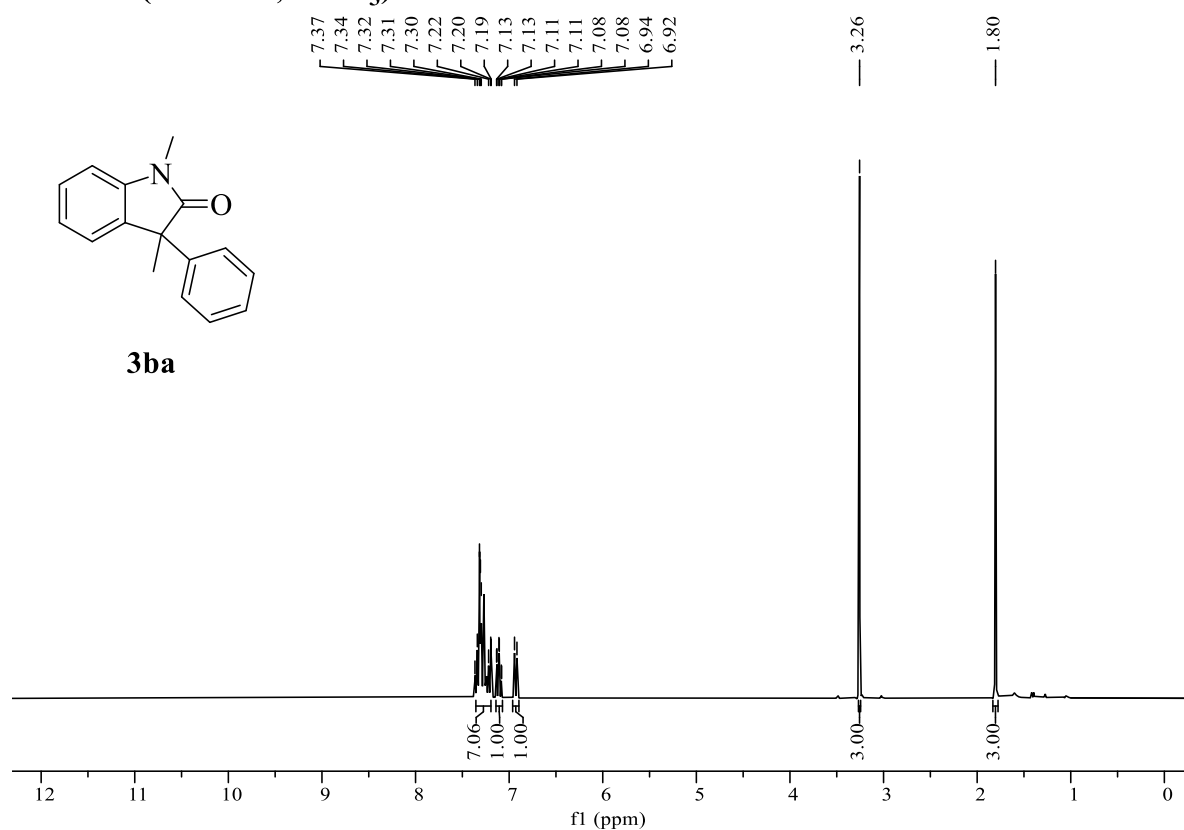


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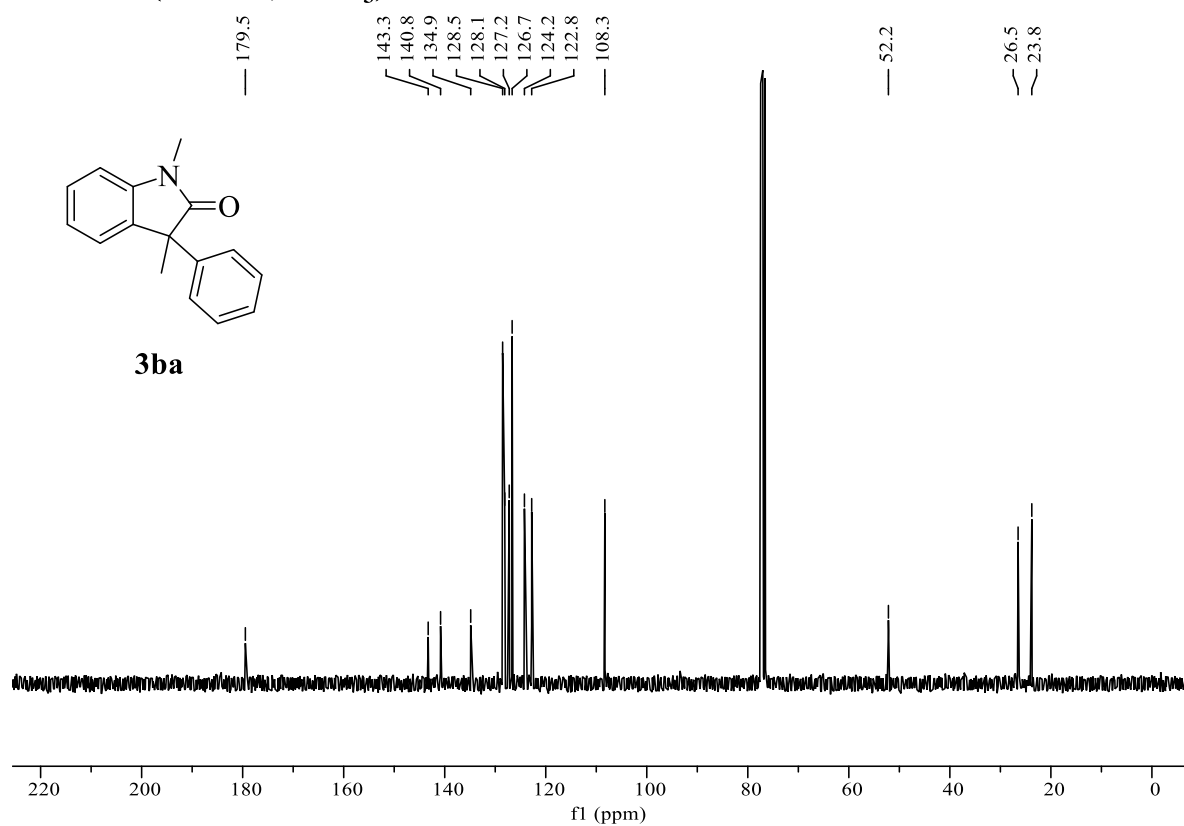


4. NMR Data of compounds

¹H NMR (300 MHz, CDCl₃):

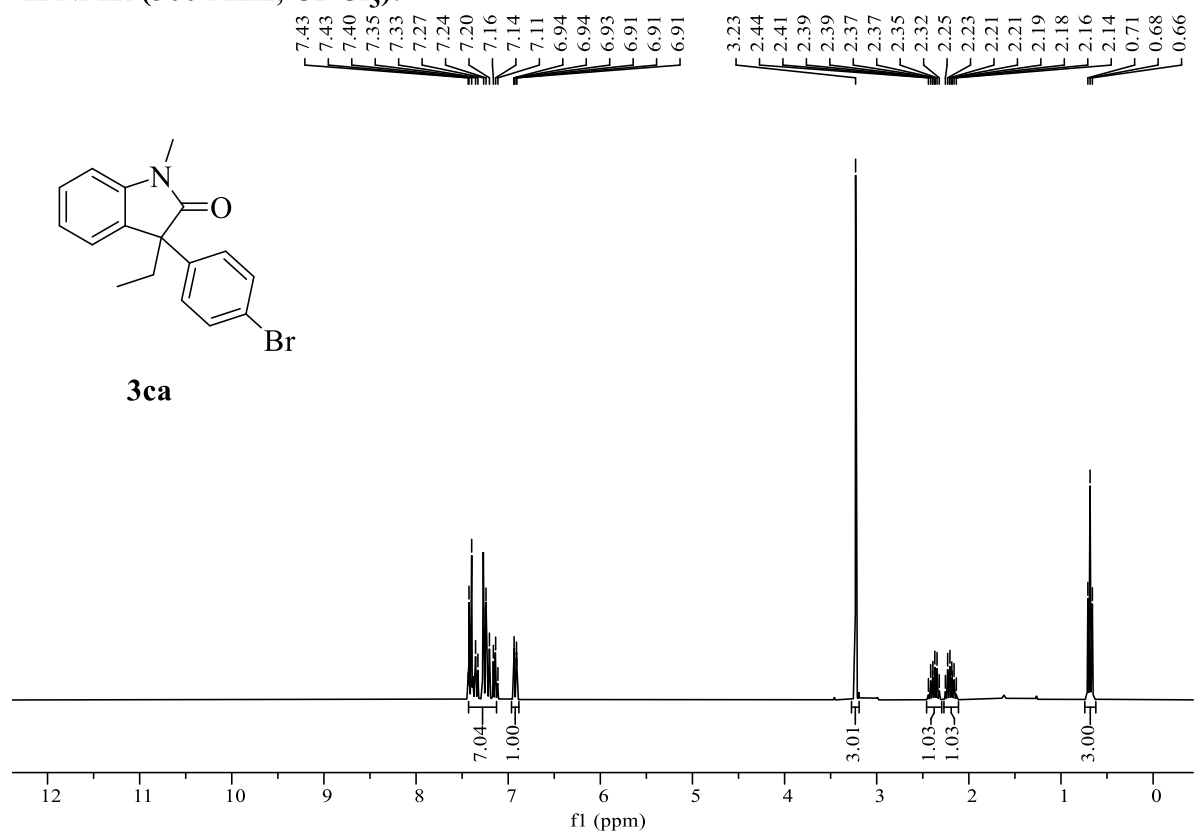


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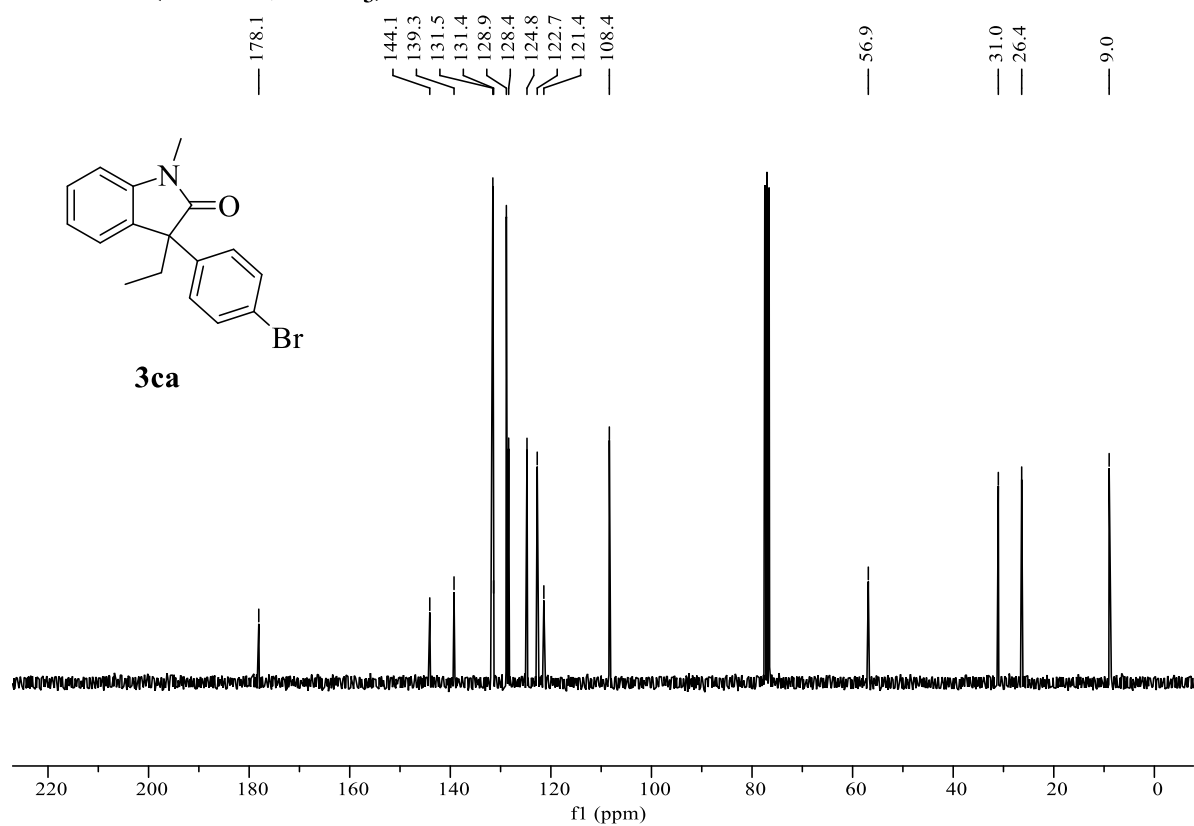


4. NMR Data of compounds

¹H NMR (300 MHz, CDCl₃):

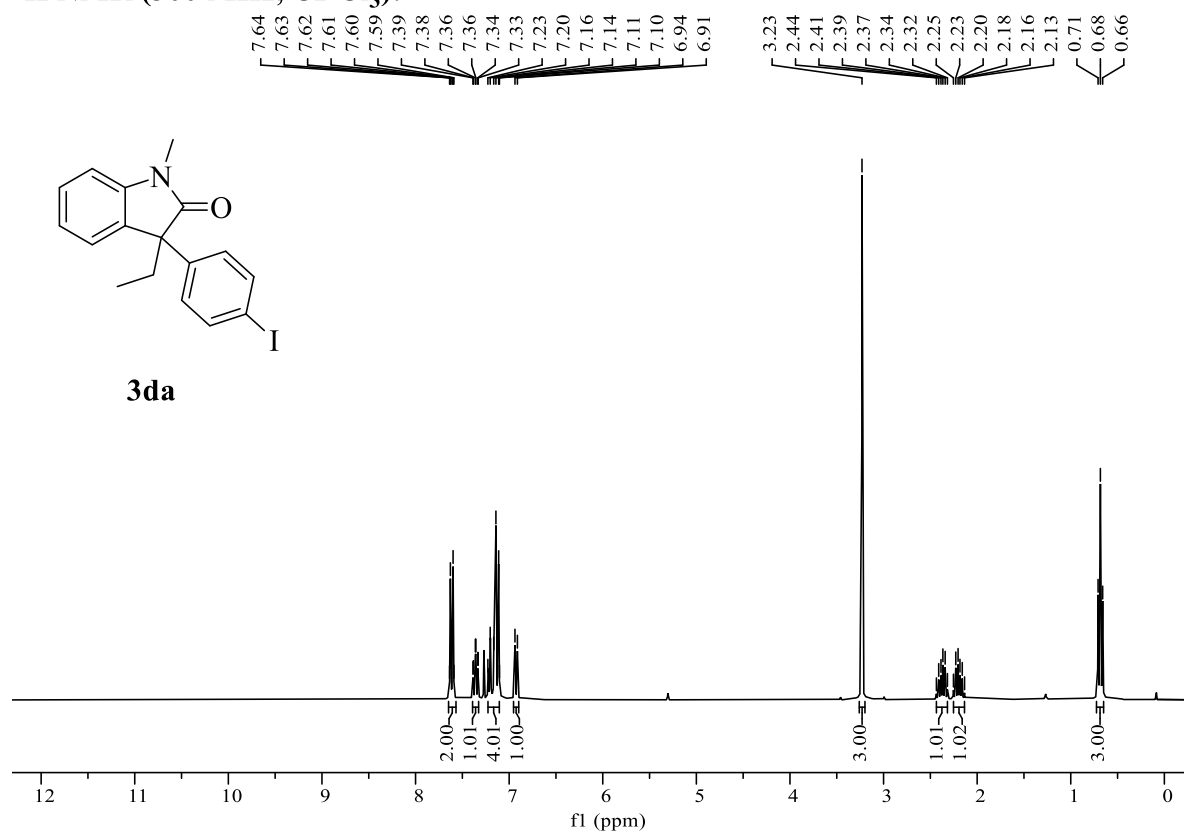


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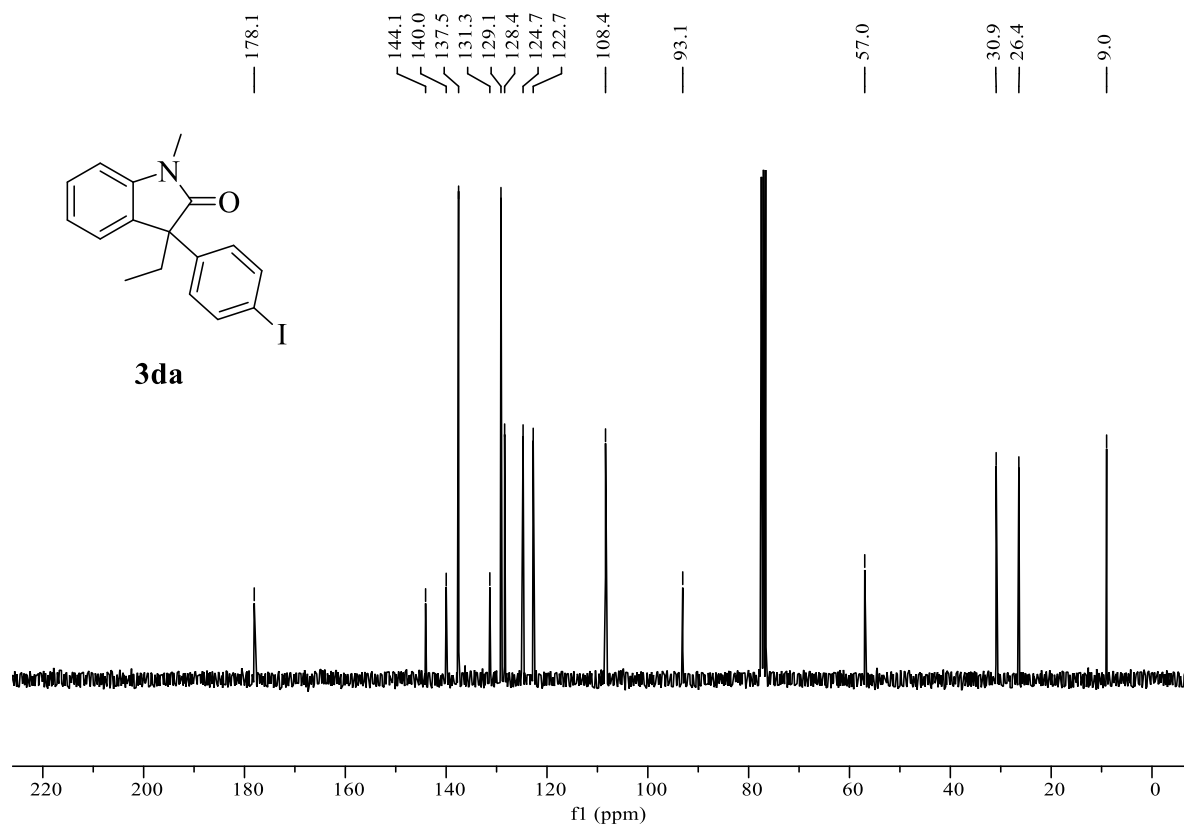


4. NMR Data of compounds

¹H NMR (300 MHz, CDCl₃):

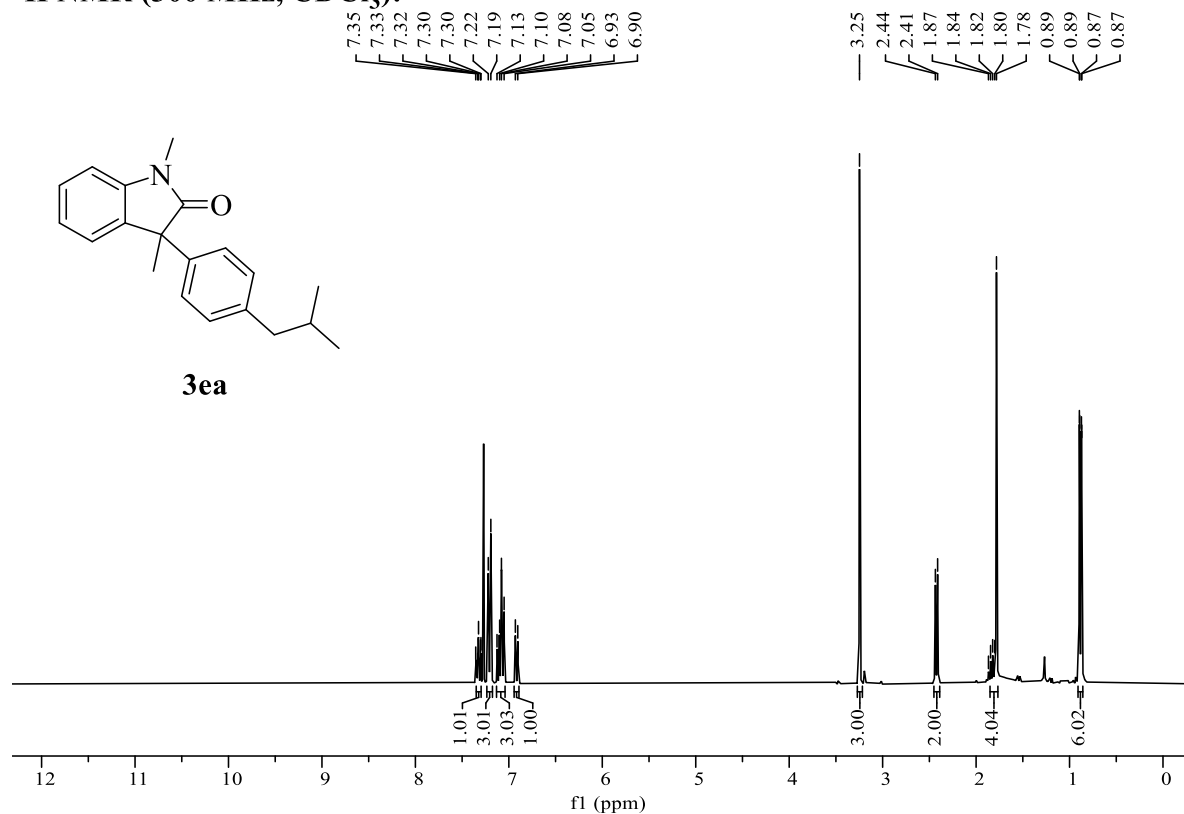


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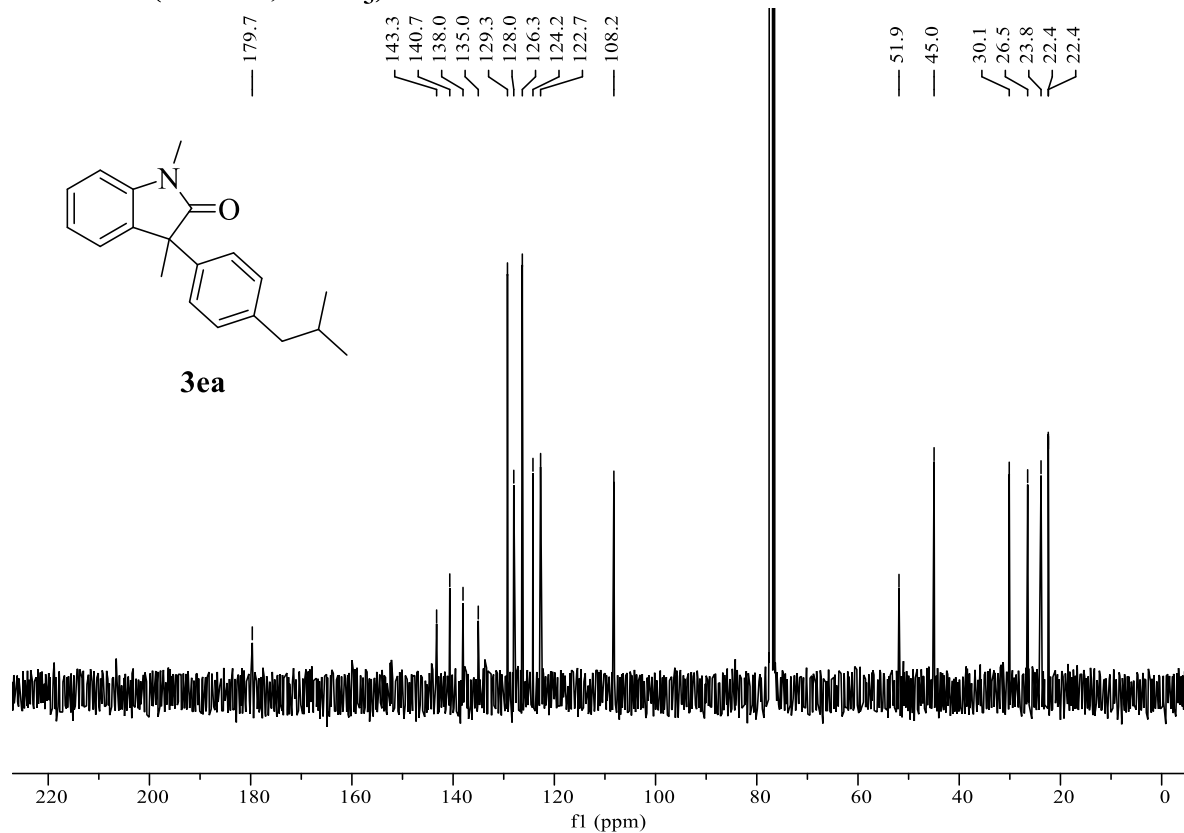


4. NMR Data of compounds

¹H NMR (300 MHz, CDCl₃):

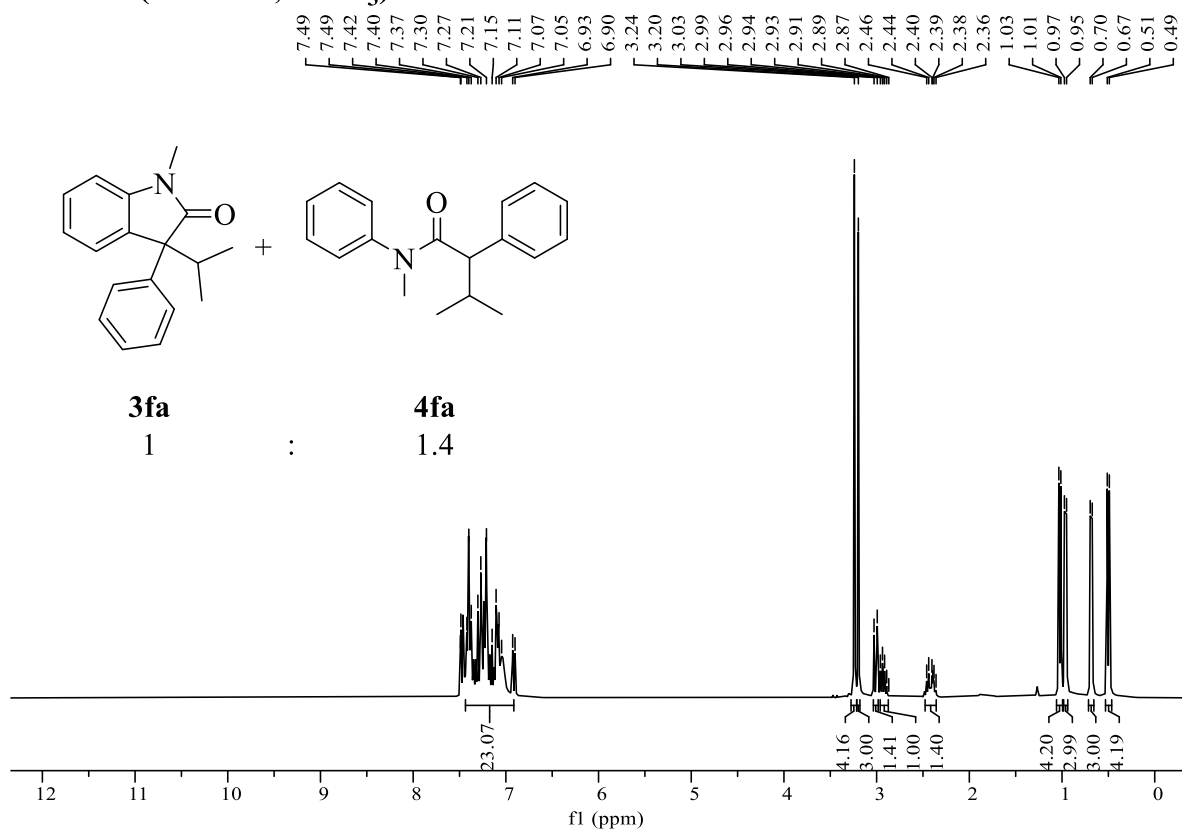


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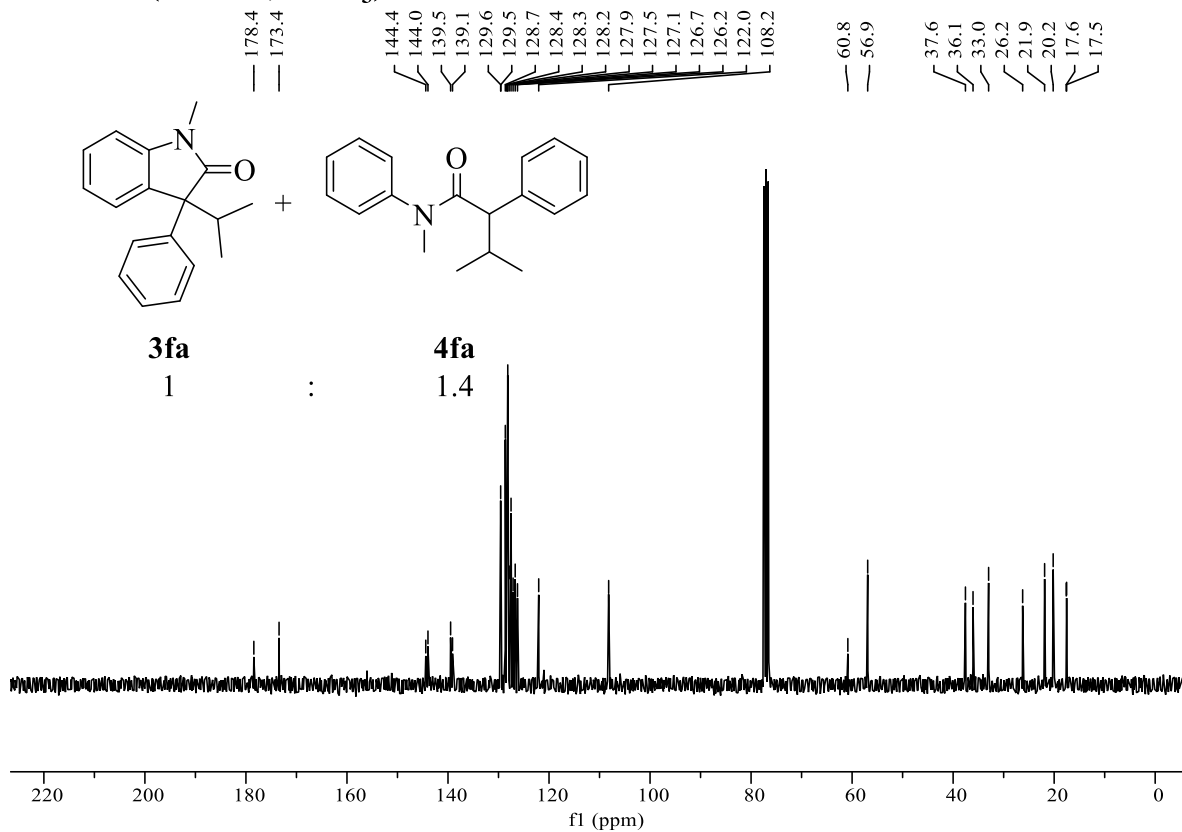


4. NMR Data of compounds

¹H NMR (300 MHz, CDCl₃):

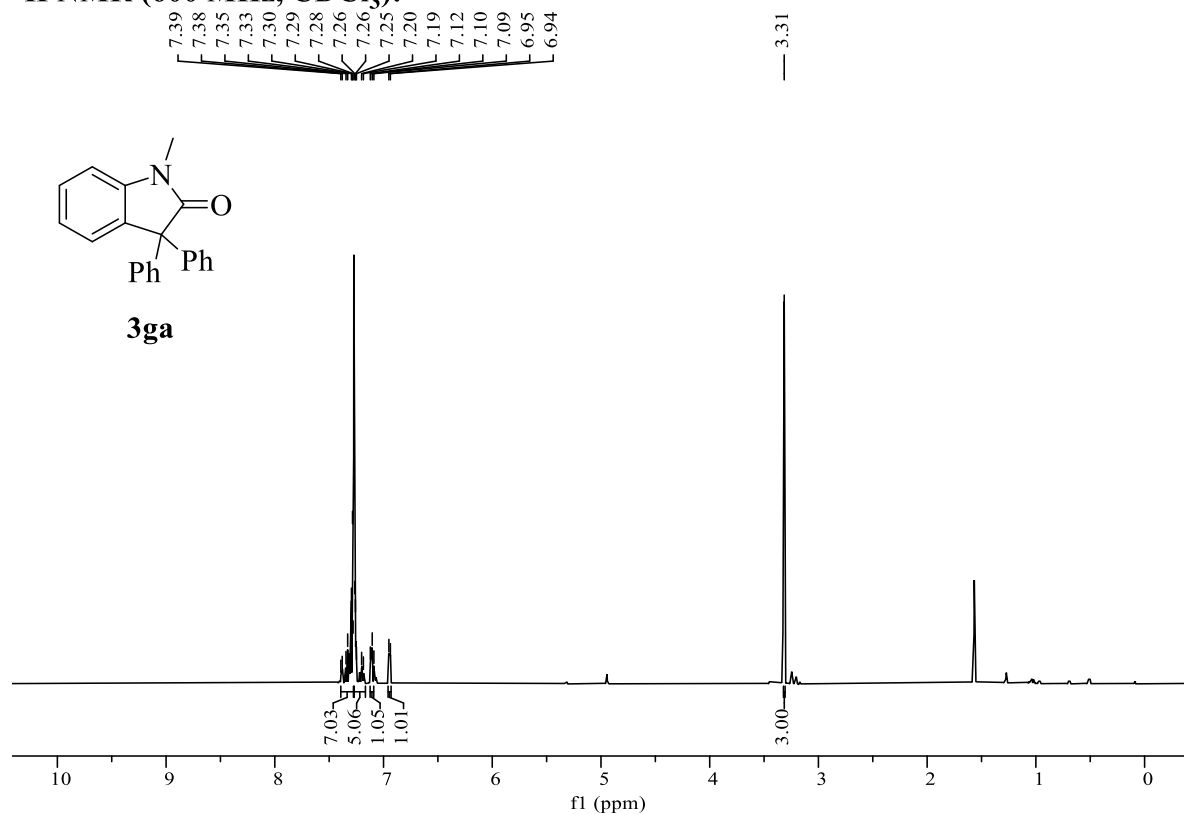


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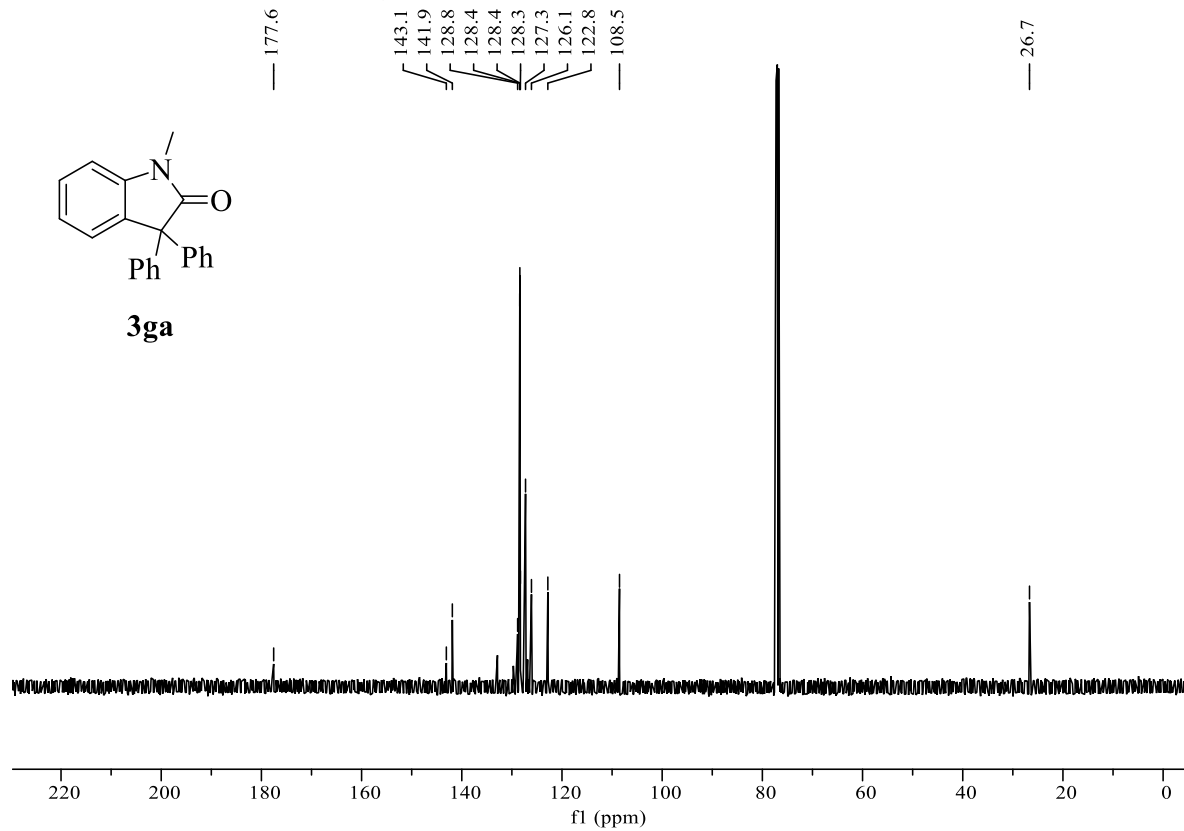


4. NMR Data of compounds

¹H NMR (600 MHz, CDCl₃):

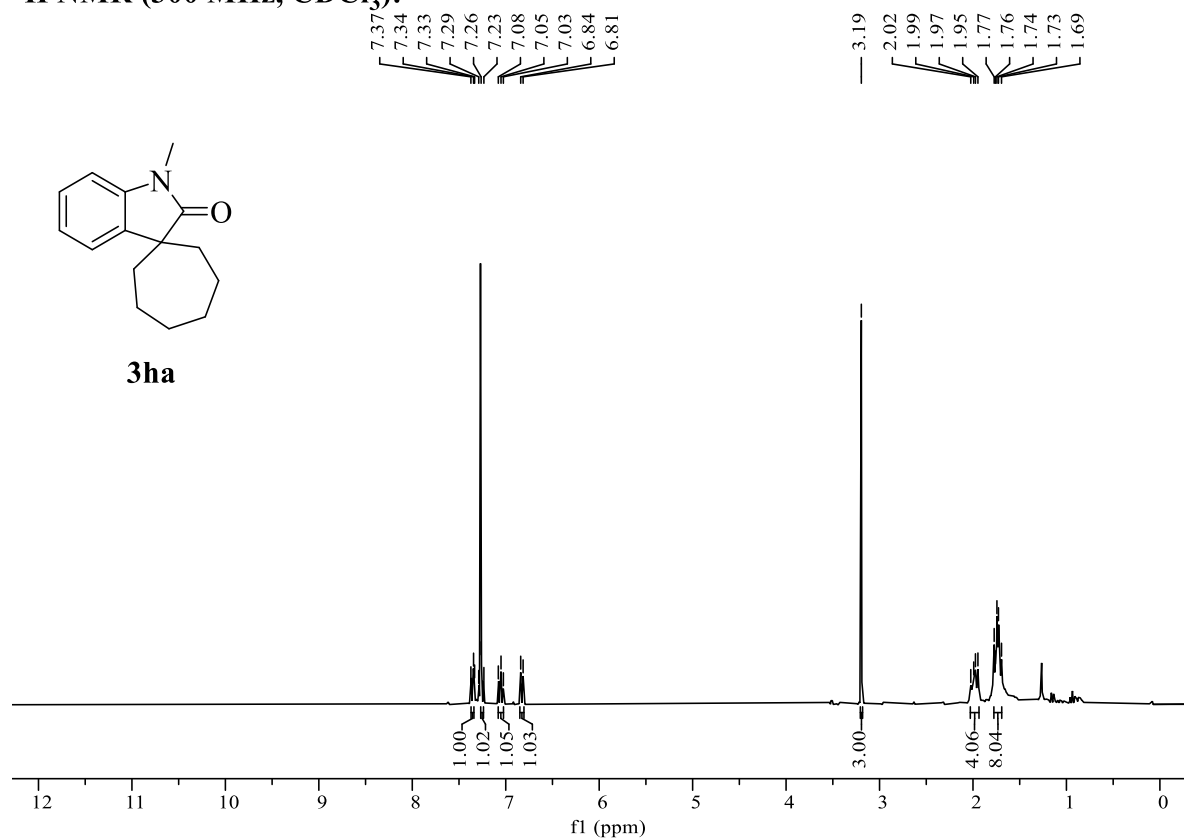


¹³C NMR (151 MHz, CDCl₃):

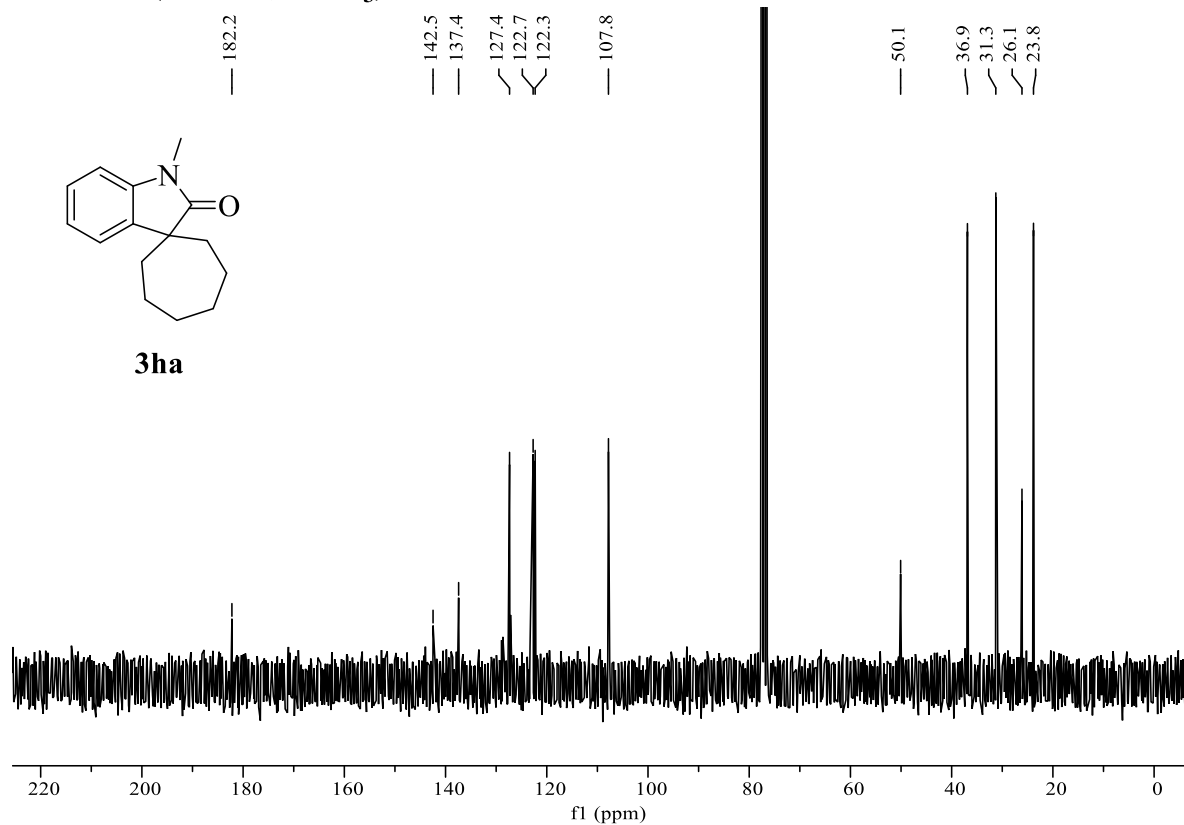


4. NMR Data of compounds

¹H NMR (300 MHz, CDCl₃):

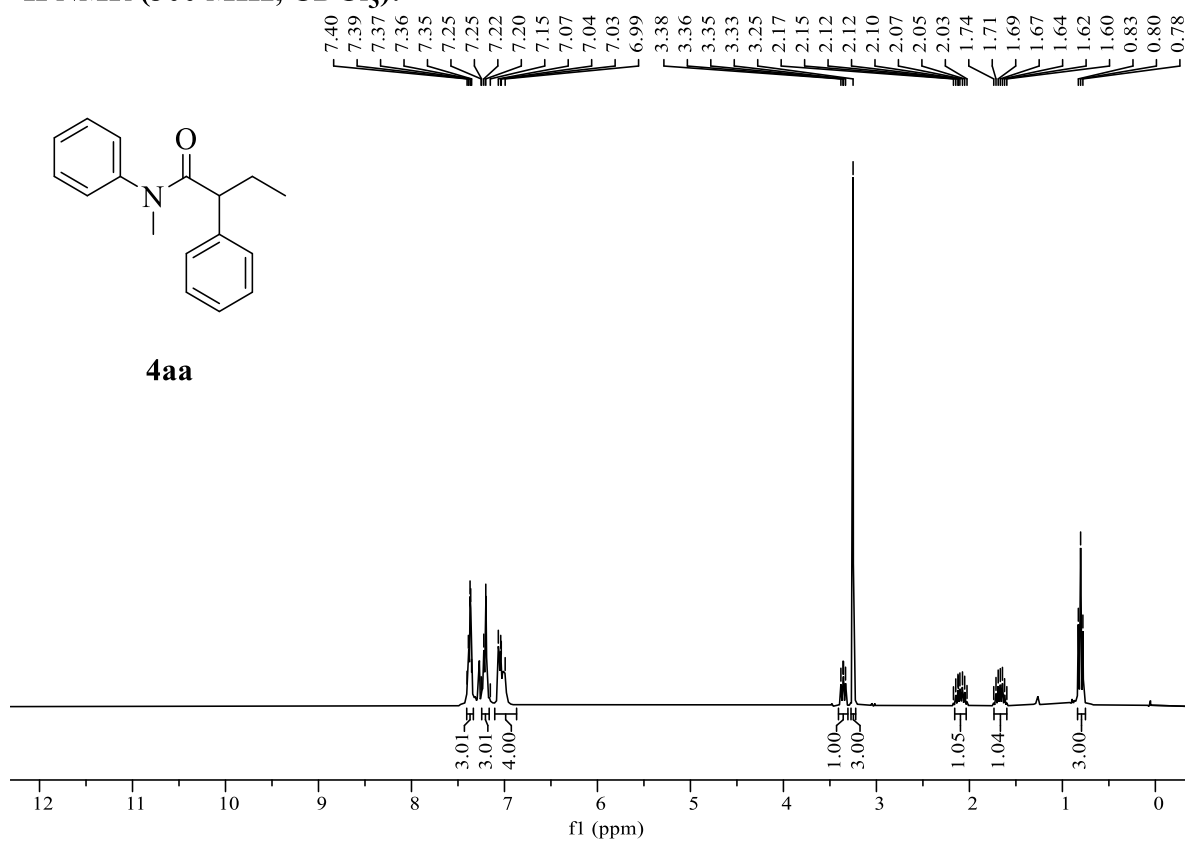


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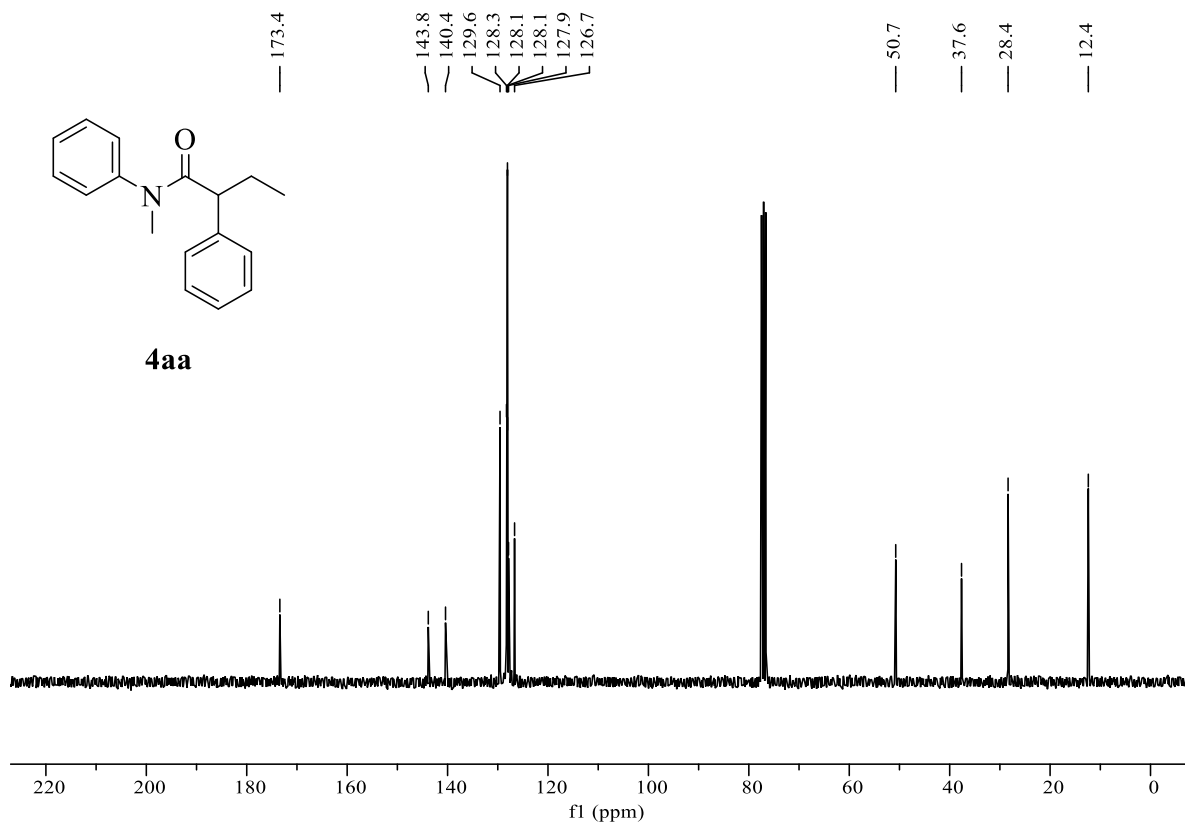


4. NMR Data of compounds

^1H NMR (300 MHz, CDCl_3):

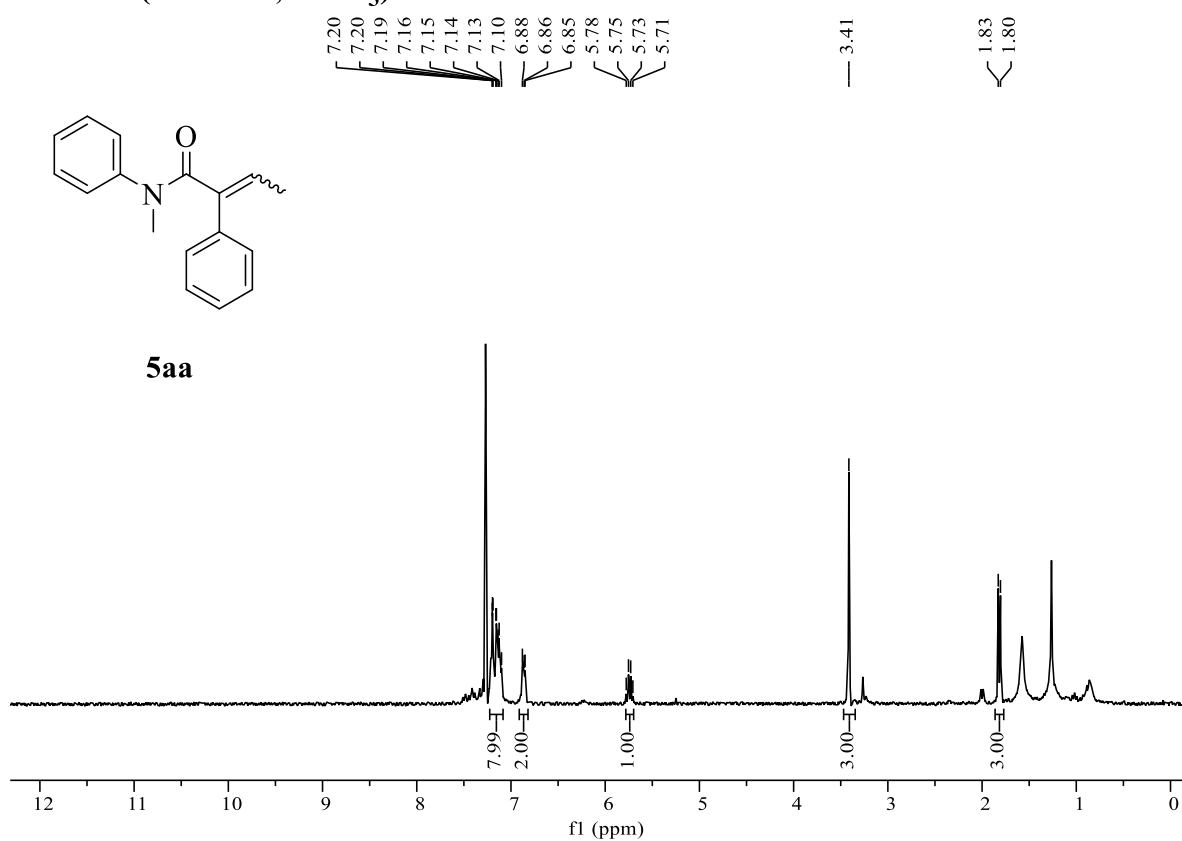


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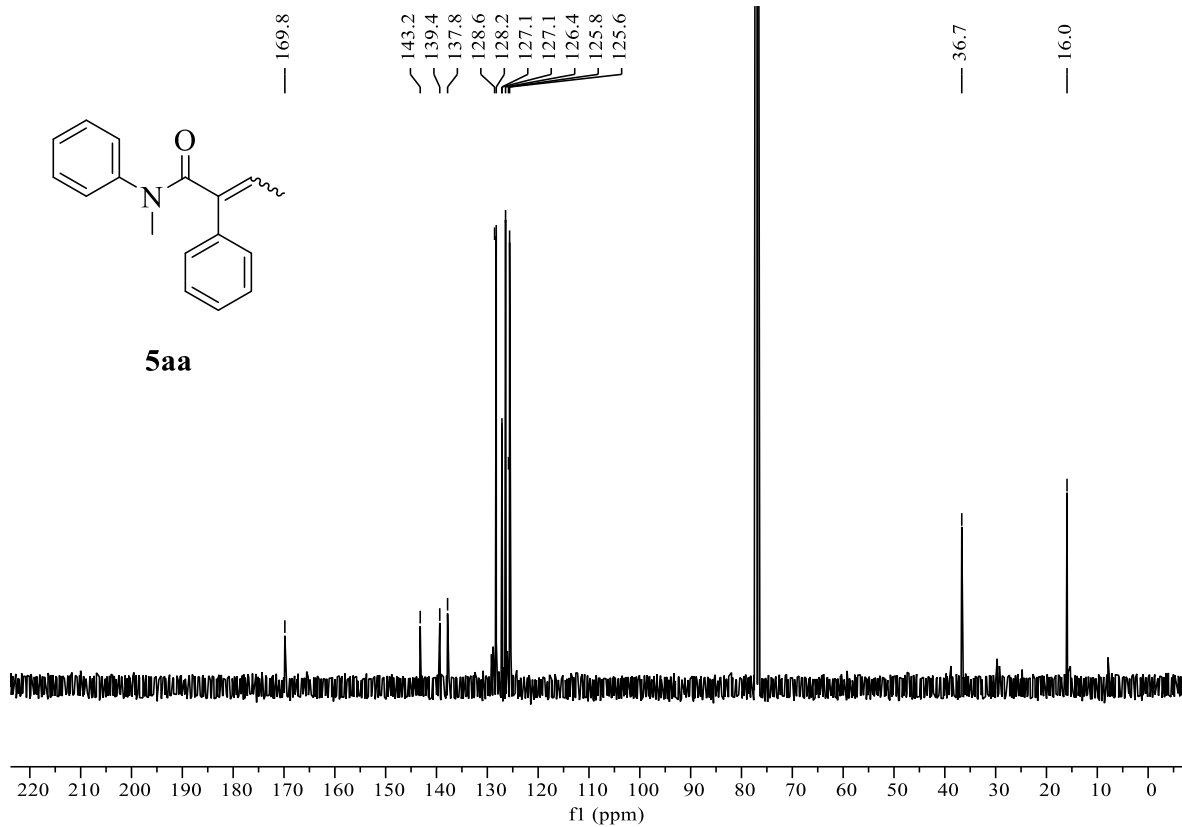


4. NMR Data of compounds

^1H NMR (300 MHz, CDCl_3):

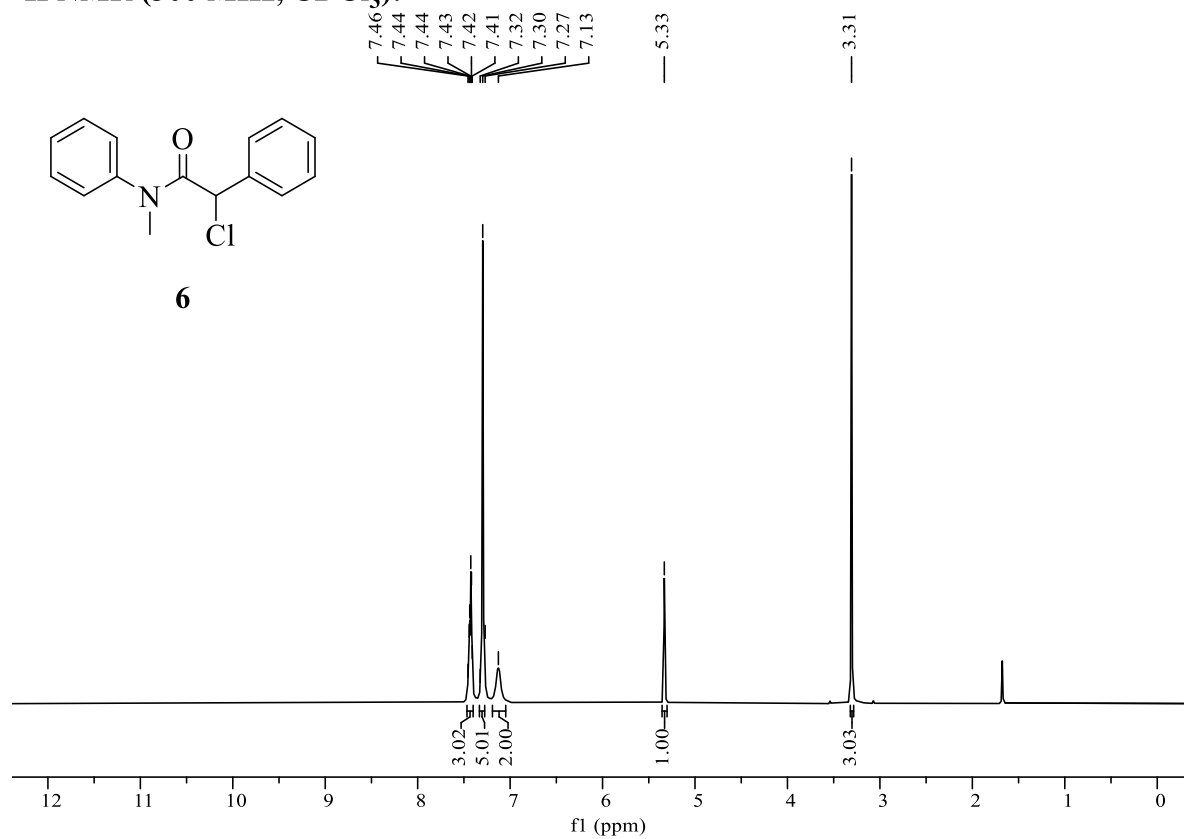


^{13}C NMR (126 MHz, CDCl_3):

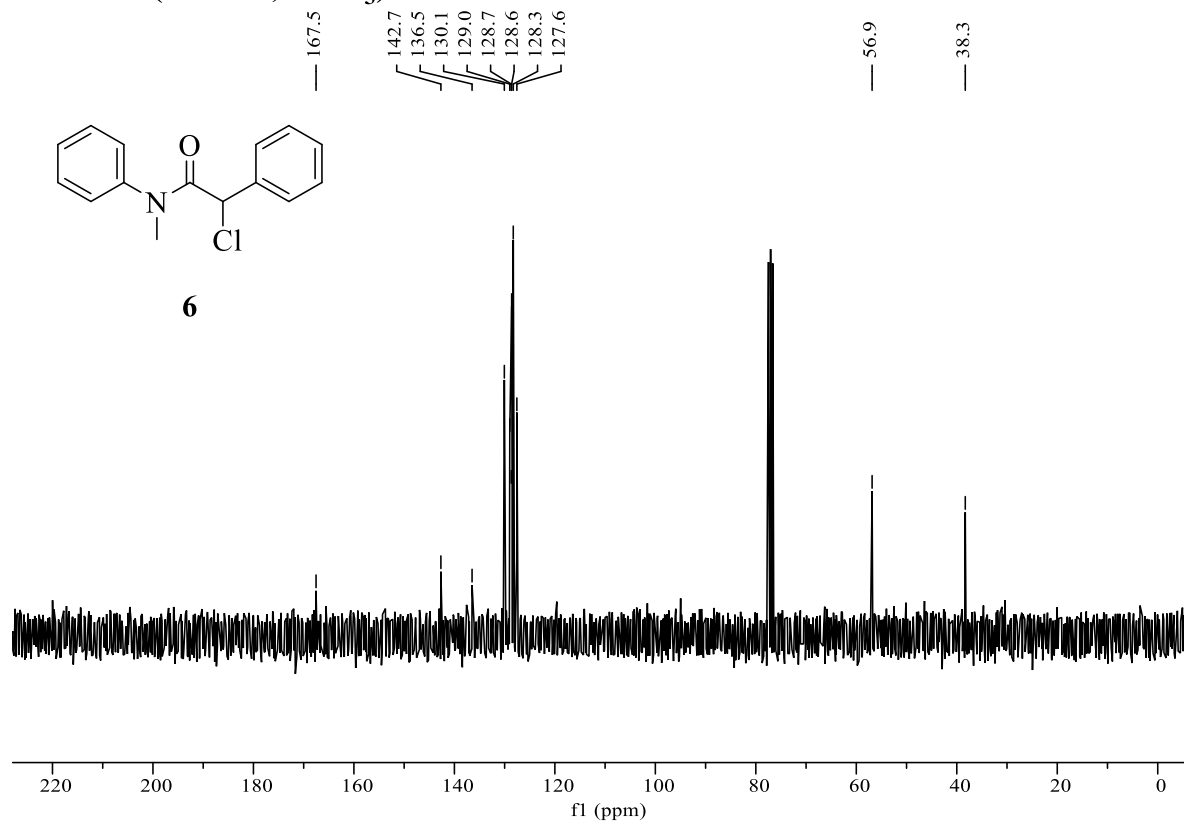


4. NMR Data of compounds

¹H NMR (300 MHz, CDCl₃):

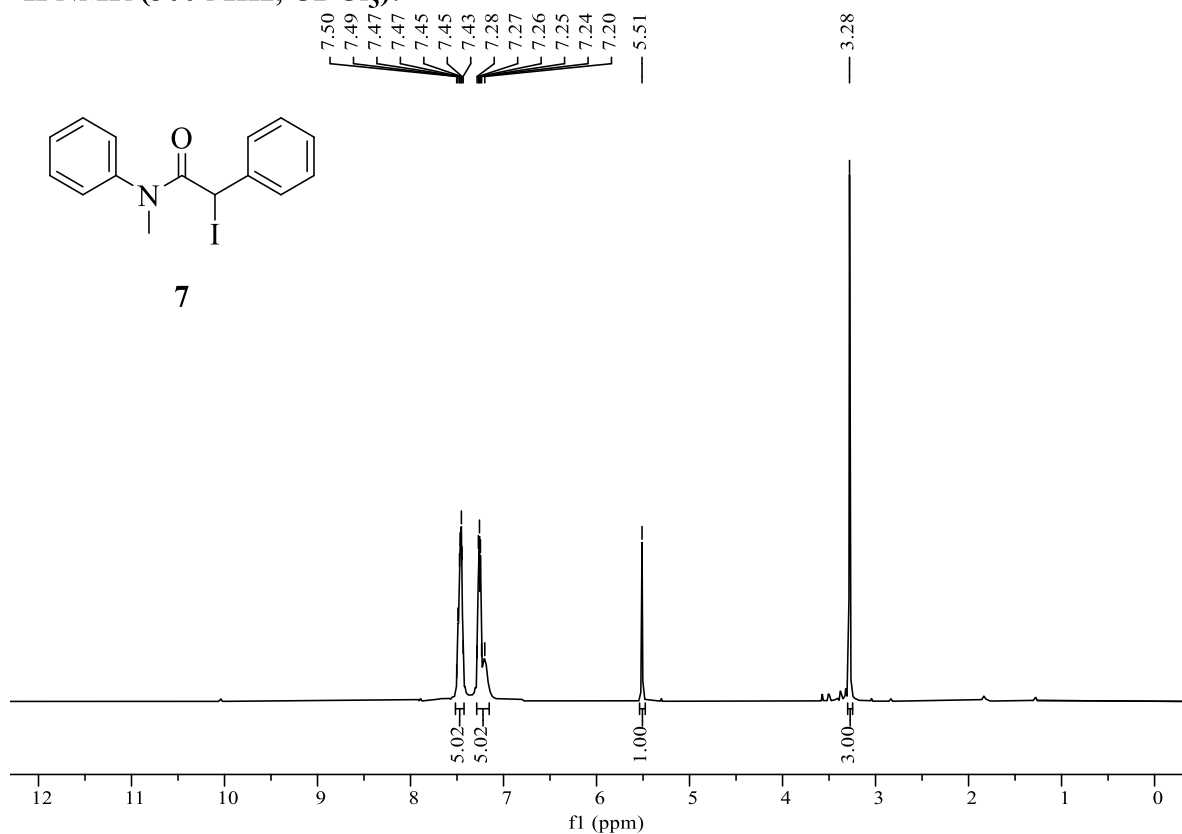


¹³C NMR (75 MHz, CDCl₃):

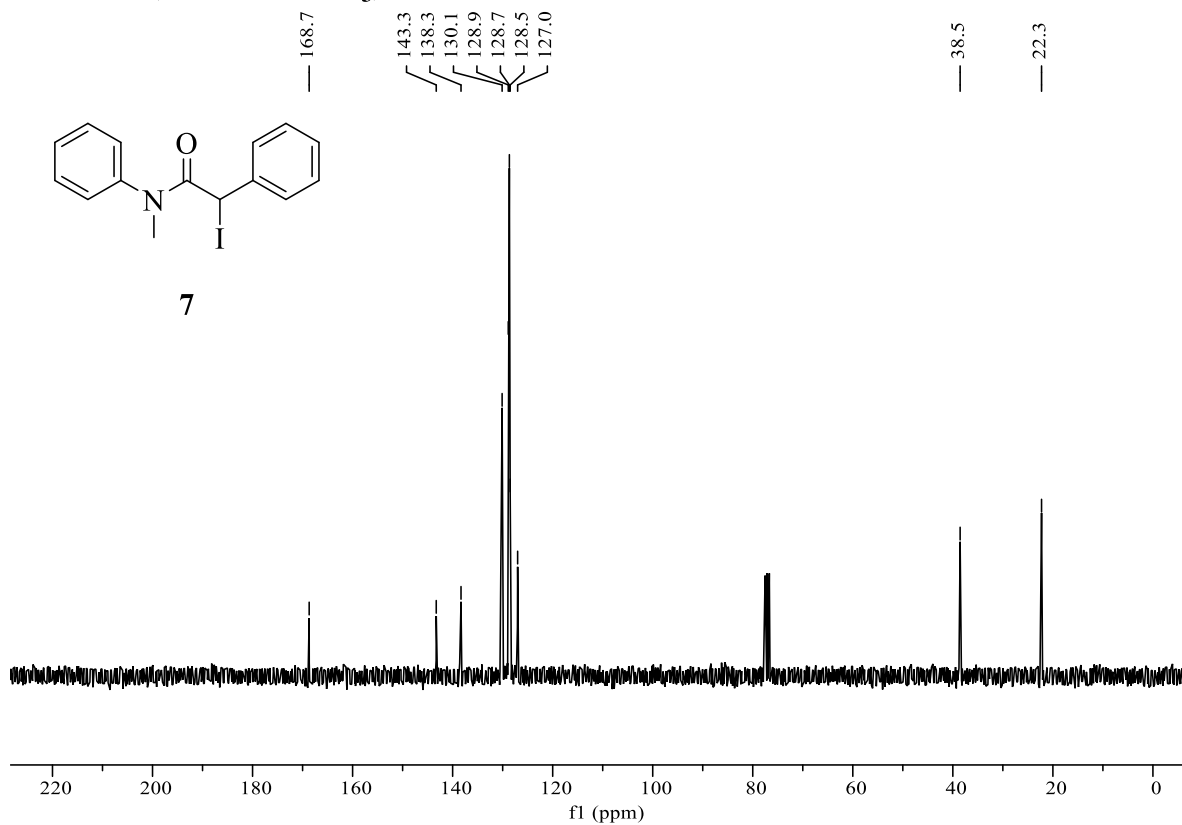


4. NMR Data of compounds

^1H NMR (300 MHz, CDCl_3):

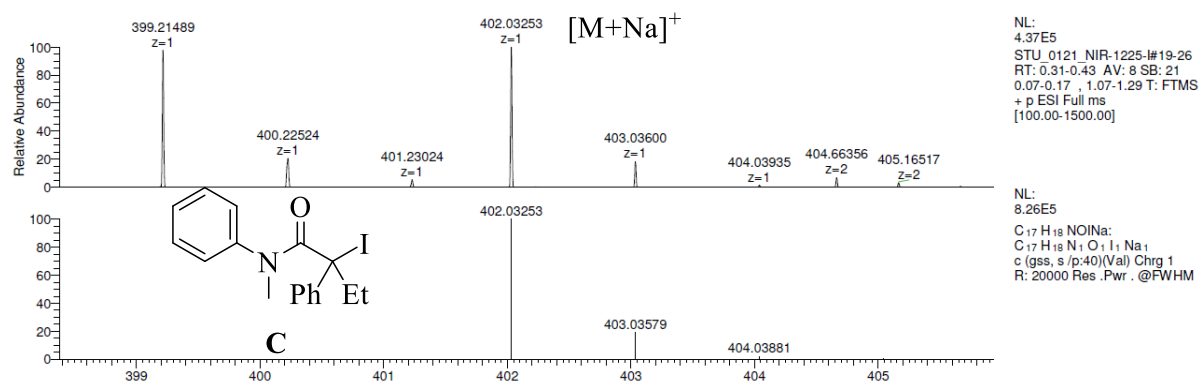


^{13}C NMR (75 MHz, CDCl_3):



5. ESI(+)-MS spectra of intermediate C

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