Supporting Information

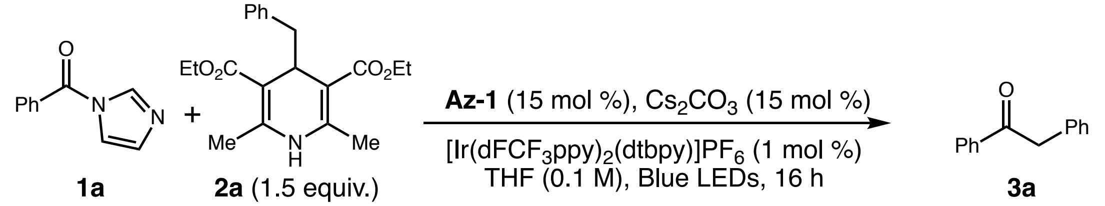
Table of Contents

General Information

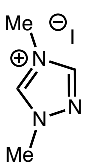
All reactions were carried out under an argon or nitrogen atmosphere in oven-dried glassware with magnetic stirring. All solvents were purified by passing through a bed of activated alumina, dried over 3Å molecular sieves, and then degassed using the freeze-pump-thaw method (3-4 cycles). Purification of reaction products was carried out by flash chromatography on Biotage Isolera 4 systems with Ultra-grade silica cartridges or by preparative HPLC. Reverse phase preparative HPLC was performed on a Gilson preparative HPLC with the following conditions: Phenomenex Kinetex C18 50 x 30 mm (short column) or 150 x 21 mm (long column). Gradients ranged from of 5-98 % acetonitrile:water with 0.1 % formic acid over 5 or 25 min, respectively, followed by 1 min at 98 % acetonitrile. The flow rate was 50 mL/min for the short column and 20 mL/min for the long column. Silicycle SiliaFlash P60 silica gel 60 (230-400 mesh) was used for column chromatography. Analytical thin layer chromatography was performed on EM Reagent 0.25 mm silica gel 60-F plates. Visualization was accomplished with UV light.

^{1}H NMR spectra were recorded on AVANCE III 500 MHz w/ direct cryoprobe (500 MHz) spectrometer and are reported in ppm using solvent as an internal standard ($CDCl_3$ at 7.26 ppm). Data are reported as (ap = apparent, s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet, b = broad; coupling constant(s) in Hz; integration.) Proton-decoupled ^{13}C NMR spectra were recorded on an AVANCE III 500 MHz w/ direct cryoprobe (125 MHz) spectrometer and are reported in ppm using solvent as an internal standard ($CDCl_3$ at 77.16 ppm). Reactions were monitored by LCMS or GCMS using a WATERS Acquity-H UPLC-MS with a single quad detector (ESI) or an Agilent 7890 gas chromatograph equipped with a 5975C single quadrupole EI-MS, respectively. High-resolution mass spectrometry (HRMS) was obtained using an Agilent 6201 MSLC-TOF (ESI). All photocatalytic reactions were carried out in a SynLED Parallel Photoreactor (465-470 nm) purchased from Sigma-Aldrich. Enantioselectivity measurements were made on an Agilent 1290 Infinity SFC using Chiralpak IA-3, IB-3, IC-3, ID-3, IG-3 chiral stationary phases. Electrochemical measurements were recorded on a NuVant EZstat Pro using platinum working, platinum counter, and Ag/Ag^+ pseudoreference electrodes in a 0.04 M solution in MeCN with 0.1M $N(bu)_4PF_6$ electrolyte. Voltages are reported relative to SCE based on an internal ferrocene standard. $[Ir(dF(CF_3)ppy)_2(dtbpy)]PF_6$ (IrdF, **PC-1**) was purchased from Strem Chemicals and used as received or synthesized according to the literature procedure.[1] No discrepancies were observed using synthesized or commercially available **PC-1**.

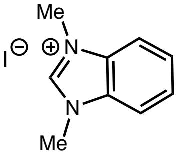
Optimization Table



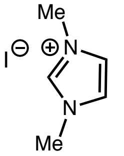
entry	deviation from standard	GC yield (%)[a,b]
1	none	63
2	**PC-2** instead of **PC-1**	11
3	**PC-3** instead of **PC-1**	0
4	**PC-4** instead of **PC-1**	42
5	**Az-2** instead of **Az-1**	14
6	**Az-3** instead of **Az-1**	0
7	**Az-4** instead of **Az-1**	0
8	**Az-5** instead of **Az-1**	11
9	**Az-7** instead of **Az-1**	0
10	**Az-8** instead of **Az-1**	0
11	CsOAc instead of Cs_2CO_3	38
12	K_2CO_3 instead of Cs_2CO_3	8
13	Li_2CO_3 instead of Cs_2CO_3	0
14	+ LiCl	0
15	+ $Mg(OTf)_2$	26
16	+ 4 Å MS	12
17	CH_3CN instead of THF	72
18	CH_2Cl_2 instead of THF	41
19	DMF instead of THF	65



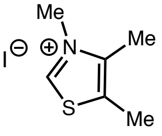
Az-1



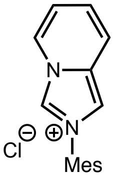
Az-2



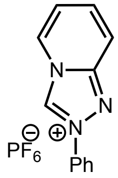
Az-3



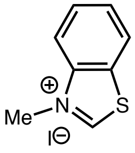
Az-4



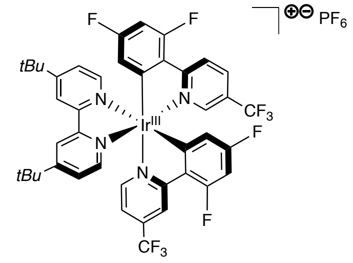
Az-5



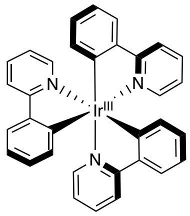
Az-7



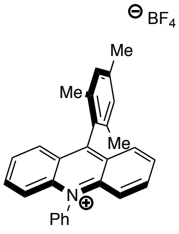
Az-8



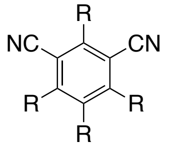
$[Ir(dFCF_3ppy)_2(dtbpy)]PF_6$
(**PC-1**)



fac-$Ir(ppy)_3$
(**PC-2**)



Ph-Mes-Acr
(**PC-3**)

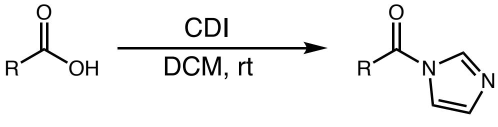


R = carbazole
4-CzIPN
(**PC-4**)

[a] GC yield based on calibration curve using 1,3,5-trimethoxybenzene as internal standard. [b] Reactions performed at a 0.1 mmol scale.

General Synthetic Procedures and Spectral Data for New Compounds

General procedure for the synthesis of acyl imidazoles:

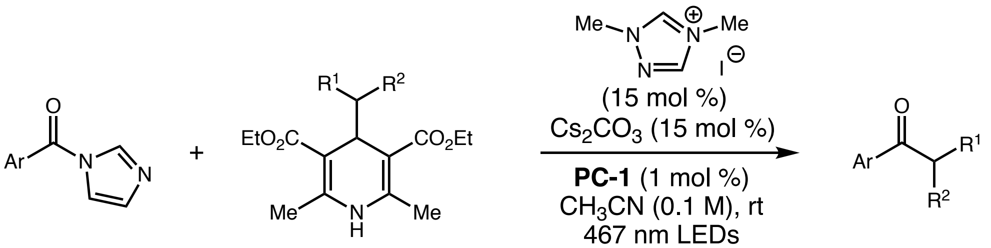


4 **1a-x**

Acyl imidazoles **1a-x** were prepared based on the method of Lee and Scheidt:[2] The appropriate acid (10 mmol, 1.0 equiv) was dissolved in dry dichloromethane (0.3 M), and CDI (carbonyldiimidazole, 15 mmol, 1.5 equiv) was added slowly (caution, exothermic). The resulting mixture was stirred for 12 h at room temperature. Upon completion, the solution was transferred to a separatory funnel and washed with deionized water (2x25 mL), and then the organic layer was dried over $MgSO_4$. Concentration under reduced pressure afforded the acyl imidazole, which was used in the following reaction without further purification.

All alkyl radical precursors (Hantzsch esters and Meyer nitriles) were synthesized according to the established literature procedure and matched the reported spectral data.[3-5]

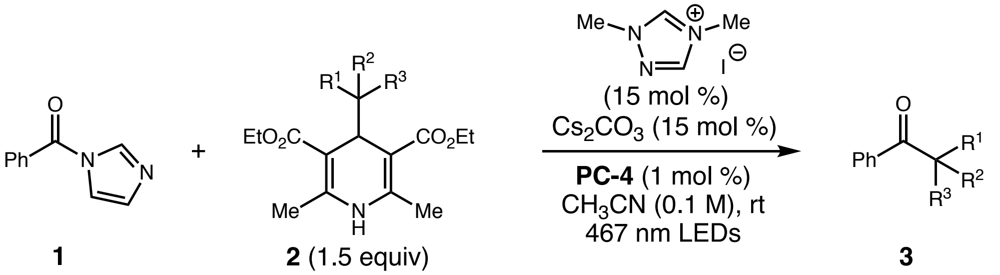
General Procedure (1) for the alkylation of acyl azoliums using Hantzsch esters:



1 **2** (1.5 equiv) **3**

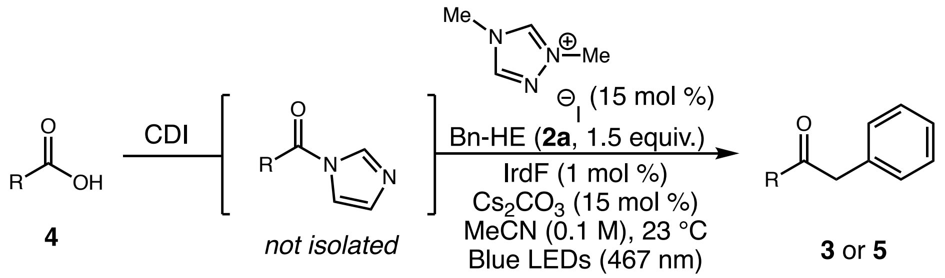
All reactions were set up inside a glovebox under N_2 atmosphere. To an oven-dried 2-dram vial containing a stir bar was added the respective benzyl Hantzsch ester (1.5 equiv, 0.38 mmol), respective acyl imidazole (1.0 equiv, 0.25 mmol), **PC-1** (2.50 µmol, 1 mol %), dimethyltriazolium iodide NHC precursor (8.8 mg, 0.15 equiv, 38 µmol), and cesium carbonate (12 mg, 0.15 equiv, 38 µmol). Acetonitrile (2.5 mL, 0.1M) was added, and the reaction was capped and taken out of the glovebox. Parafilm was wrapped around the cap to prevent air from entering and the vial was stirred in a SynLED Parallel Photoreactor (blue LEDs) with monitoring by GCMS or LCMS. When complete consumption of the acyl imidazole was observed (typically 4–16 h), the reactions were concentrated under reduced pressure and then purified by column chromatography or preparative HPLC.

General Procedure (2) for the alkylation of acyl azoliums using Meyer nitriles:

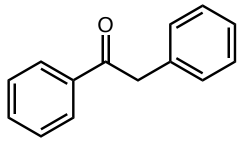


All reactions were set up inside a glovebox under a nitrogen atmosphere. To an oven-dried 2-dram vial containing a stir bar was added the respective Meyer nitrile (1.5 equiv, 0.38 mmol), appropriate acyl imidazole (1.0 equiv, 0.25 mmol), 4-CzIPN (0.01 equiv, 1 mol %), dimethyltriazolium iodide NHC precursor (8.8 mg, 0.15 equiv, 38 μmol), and cesium carbonate (12 mg, 0.15 equiv, 38 μmol). Acetonitrile (2.5 mL, 0.1M) was added to the vial, and the reaction was capped and taken out of the glovebox. Parafilm was wrapped around the cap to prevent air from entering and the vial was in a SynLED Parallel Photoreactor (blue LEDs) with monitoring by GCMS or LCMS. When complete consumption of the acyl imidazole was observed (typically 4–16 h), the reactions were concentrated under reduced pressure and then purified by column chromatography.

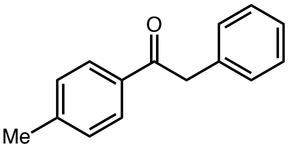
General Procedure (3) for the in situ activation reactions:



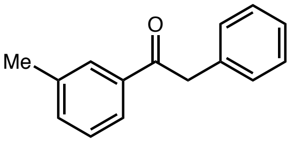
All reactions were set up inside a glovebox under nitrogen atmosphere. To an oven-dried 2-dram vial containing a stir bar were added CDI (1.0 equiv., 0.25 mmol) and the appropriate carboxylic acid (1.0 equiv., 0.25 mmol). The solids were dissolved in acetonitrile (2.5 mL, 0.1 M) and the reaction was allowed to stir in the glovebox at room temperature for 2 h or until the solution became homogenous. **Note**: If the reaction did not become homogenous, 0.400 mL of DMF was added to the vial to help solubilize the carboxylic acid, and the reaction was allowed to stir for another 4 h. At this time, to a separate vial containing a stirbar was added the respective benzyl Hantzsch ester (1.5 equiv., 0.38 mmol), **PC-1** (0.01 equiv., 1 mol %), and dimethyltriazolium iodide NHC precursor (8.8 mg, 0.15 equiv., 38 μmol). The vial containing the *in situ* generated acyl imidazole was added to the vial containing the solids, followed by the addition of cesium carbonate (12 mg, 0.15 equiv., 38 μmol). The vial was capped and taken out of the glovebox. Parafilm was wrapped around the cap to prevent air from entering and the vial was stirred in a SynLED Parallel Photoreactor (blue LEDs). The reaction was allowed to stir for 24 h unless otherwise noted. Following completion, the reactions were concentrated under reduced pressure and then purified by column chromatography.



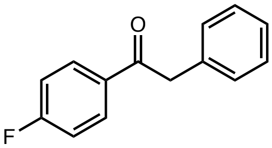
1,2-diphenylethan-1-one (**3a**). Prepared according to the general procedure **(1)** for the alkylation of acyl azoliums using the respective acyl imidazole (43 mg, 1.0 equiv.) and benzyl Hantzsch ester. **PC-1** was used as the photocatalyst. The reaction mixture was purified by column chromatography (wet loaded with toluene, 5-15% ethyl acetate/hexanes) to yield the desired product as a white solid (63%). Can also be prepared with general procedure **(3)** using benzoic acid to afford the desired material (31 mg, 65%). Product is a known substrate and matched the literature data.[6]



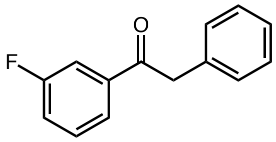
2-phenyl-1-(*p*-tolyl)ethan-1-one (**3b**). Prepared according to the general procedure **(1)** for the alkylation of acyl azoliums using the respective acyl imidazole (46.5 mg, 1.0 equiv.) and benzyl Hantzsch ester. **PC-1** was used as the photocatalyst. The reaction mixture was purified by column chromatography (wet loaded with toluene, 2-20% ethyl acetate/hexanes) to yield the product as a white solid (42 mg, 80%). Product is a known substrate and matched the literature data.[6]



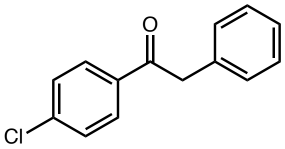
2-phenyl-1-(*m*-tolyl)ethan-1-one (**3c**). Prepared according to the general procedure **(1)** for the alkylation of acyl azoliums using the respective acyl imidazole (46.5 mg, 1.0 equiv.) and benzyl Hantzsch ester. **PC-1** was used as the photocatalyst. The reaction mixture was purified by column chromatography (0-5% ethyl acetate/hexanes) to yield the product as an off-white solid (34 mg, 65%). Product is a known substrate and matched the literature data.[9]



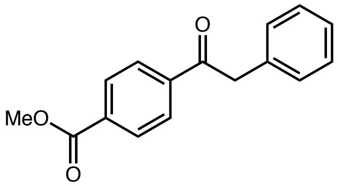
1-(4-fluorophenyl)-2-phenylethan-1-one (**3d**). Prepared according to the general procedure **(1)** for the alkylation of acyl azoliums using the respective acyl imidazole (47.5 mg, 1.0 equiv.) and benzyl Hantzsch ester. **PC-1** was used as the photocatalyst. The reaction mixture was purified by column chromatography (wet loaded with toluene, 2-20% ethyl acetate/hexanes) to yield the product as a white solid (41 mg, 76%). Product is a known substrate and matched the literature data.[6]



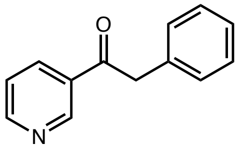
1-(3-fluorophenyl)-2-phenylethan-1-one (**3e**). Prepared according to the general procedure **(1)** for the alkylation of acyl azoliums using the respective acyl imidazole (48 mg, 1.0 equiv.) and benzyl Hantzsch ester. **PC-1** was used as the photocatalyst. The reaction mixture was purified by column chromatography (dry loaded with silica, 2-20% ethyl acetate/hexanes) to yield the desired product as a white solid (32 mg, 60%). Product is a known substrate and matched the literature data.[10]



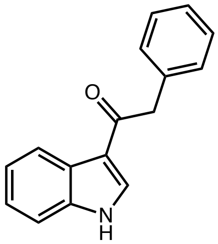
1-(4-chlorophenyl)-2-phenylethan-1-one (**3f**). Prepared according to the general procedure **(1)** for the alkylation of acyl azoliums using the respective acyl imidazole (51.6 mg, 1.0 equiv.) and benzyl Hantzsch ester. **PC-1** was used as the photocatalyst. The reaction mixture was purified by column chromatography (wet loaded with toluene, 2-20% ethyl acetate/hexanes) to yield the product as a white solid (57.7 mg, 76%). Product is a known substrate and matched the literature data.[7]



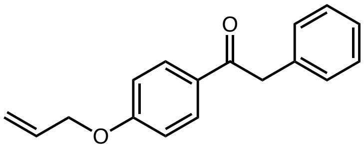
methyl 4-(2-phenylacetyl)benzoate (**3g**). Prepared according to the general procedure **(1)** for the alkylation of acyl azoliums using the respective acyl imidazole (57.6 mg, 1.0 equiv.) and benzyl Hantzsch ester. **PC-1** was used as the photocatalyst. The reaction mixture was purified by preparative HPLC (long column, 20-90% MeCN/H_2O) to yield the desired product as an off-white solid (40.2 mg, 63%). Product is a known substrate and matched the literature data.[8]



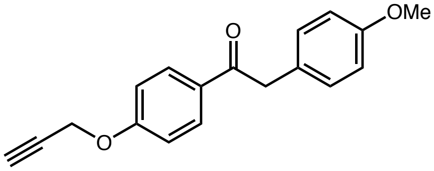
2-phenyl-1-(pyridin-3-yl)ethan-1-one (**3h**). Prepared according to the general procedure **(1)** for the alkylation of acyl azoliums using the respective acyl imidazole (43.0 mg, 1.0 equiv.) and benzyl Hantzsch ester. **PC-1** was used as the photocatalyst. The reaction mixture was purified by preparative HPLC (short column, 10-90% MeCN/H_2O) to yield the desired product (34.0 mg, 69%). Product is a known substrate and matched the literature data.[12]



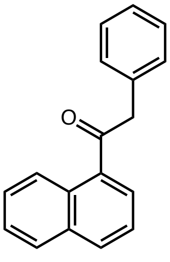
1-(1*H*-indol-3-yl)-2-phenylethan-1-one (**3i**). Prepared according to the general procedure **(1)** for the alkylation of acyl azoliums using the respective acyl imidazole (53 mg, 1.0 equiv.) and benzyl Hantzsch ester. **PC-1** was used as the photocatalyst. The reaction mixture was purified by column chromatography (wet loaded with toluene, 20-60% ethyl acetate/hexanes) to yield the desired product as a white solid (29.5 mg, 50%). ^{1}H NMR (500 MHz, DMSO-*d*$_6$) δ 11.99 (s, 1H), 8.52 (d, *J* = 3.0 Hz, 1H), 8.22 – 8.11 (m, 1H), 7.46 (dt, *J* = 8.1, 1.0 Hz, 1H), 7.37 – 7.33 (m, 2H), 7.32 – 7.27 (m, 2H), 7.23 – 7.14 (m, 3H), 4.15 (s, 2H). ^{13}C NMR (126 MHz, DMSO-*d*$_6$) δ 192.6, 136.7, 136.5, 134.6, 129.3, 128.2, 126.1, 125.5, 122.8, 121.7, 121.3, 116.0, 112.1, 45.7. HRMS (ESI/TOF) m/z: [M+Na]$^+$ Calcd. for $C_{16}H_{13}NONa$ 258.0895; Found 258.0895. IR has been reported for this compound.[11]



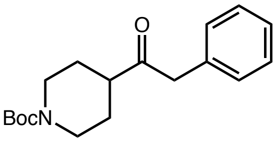
1-(4-(allyloxy)phenyl)-2-phenylethan-1-one (**3j**). Prepared according to the general procedure **(1)** for the alkylation of acyl azoliums using the respective acyl imidazole (57 mg, 1.0 equiv.) and benzyl Hantzsch ester. **PC-1** was used as the photocatalyst. The reaction mixture was purified by column chromatography (dry loaded with silica, 2-20% ethyl acetate/hexanes) to yield the desired product as a white solid (39.7 mg, 69%). Analytical data for **3j**: Note NMR contains a mixture of tautomers. ^{1}H NMR (500 MHz, Chloroform-*d*) Ketone form: δ 8.03 – 7.96 (m, 2H), 7.32 (dd, *J* = 8.1, 6.8 Hz, 2H), 7.29 – 7.22 (m, 3H), 6.97 – 6.90 (m, 2H), 6.04 (ddt, *J* = 17.3, 10.5, 5.3 Hz, 1H), 5.47 – 5.29 (m, 2H), 4.59 (dt, *J* = 5.3, 1.5 Hz, 2H), 4.23 (s, 2H). Enol form: δ 9.89 (s, 0.04 H), 7.84 (m, 0.12 H), 7.02 (m, 0.12 H), 4.63 (m, 0.08 H). ^{13}C NMR (126 MHz, Chloroform-*d*) δ 196.3, 162.6, 135.0, 132.5, 131.0, 129.8, 129.5, 128.7, 126.9, 118.4, 114., 69.02, 45.3. HRMS (ESI/TOF) m/z: [M+H]$^+$ Calcd. for $C_{17}H_{17}O_2$ 253.1228; Found 253.1223. FTIR (ATR) cm^{-1}: 3098, 3061, 3034, 2901, 1680.



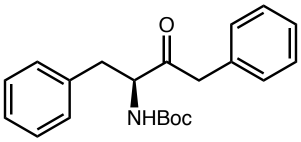
2-(4-methoxyphenyl)-1-(4-(prop-2-yn-1-yloxy)phenyl)ethan-1-one (**3k**). Prepared according to the general procedure **(1)** for the alkylation of acyl azoliums using the respective acyl imidazole (53 mg, 1.0 equiv.) and benzyl Hantzsch ester. **PC-1** was used as the photocatalyst. The reaction mixture was purified by column chromatography (dry loaded with silica, 2-10% ethyl acetate/hexanes) to yield the desired product as a white solid (34 mg, 52%). Analytical data for **3k**: ^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.05 – 7.96 (m, 2H), 7.23 – 7.15 (m, 2H), 7.05 – 6.98 (m, 2H), 6.91 – 6.83 (m, 2H), 4.75 (d, *J* = 2.4 Hz, 2H), 4.17 (s, 2H), 3.78 (s, 3H), 2.55 (t, *J* = 2.4 Hz, 1H). ^{13}C NMR (126 MHz, Chloroform-*d*) δ 196.7, 161.5, 158.7, 131.0, 130.6, 127.0, 114.8, 114.3, 77.9, 76.4, 56.0, 55.4, 44.6. HRMS (ESI/TOF) m/z: $[M+H]^+$ Calcd. for $C_{18}H_{17}O_3$ 281.1177; Found 281.1175. FTIR (ATR) cm^{-1}: 3305, 3263, 2994, 1684.



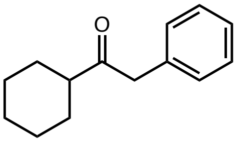
1-(naphthalen-2-yl)-2-phenylethan-1-one (**3l**). Prepared according to the general procedure **(1)** for the alkylation of acyl azoliums using the respective acyl imidazole (55.6 mg, 1.0 equiv.) and benzyl Hantzsch ester. **PC-1** was used as the photocatalyst. The reaction mixture was purified by column chromatography (wet loaded with toluene, 2-20% ethyl acetate/hexanes) to yield the desired product as a white solid (38 mg, 62%). Product is a known substrate and matched the literature data.[6]



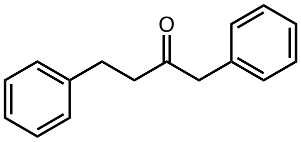
tert-butyl 4-(2-phenylacetyl)piperidine-1-carboxylate (**3m**). Prepared according to the general procedure **(1)** for the alkylation of acyl azoliums using the respective acyl imidazole (69.8 mg, 1.0 equiv.) and benzyl Hantzsch ester. **PC-1** was used as the photocatalyst. The reaction mixture was purified by column chromatography (wet loaded with toluene, 2-20% ethyl acetate/hexanes) to yield the desired product as a clear oil (31 mg, 41%). Analytical data for **3m**: ^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.38 – 7.29 (m, 2H), 7.30 – 7.26 (m, 1H), 7.19 (dd, *J* = 7.2, 1.7 Hz, 2H), 4.11 (m, 2H), 3.75 (s, 2H), 2.74 (t, *J* = 12.7 Hz, 2H), 2.59 (tq, *J* = 11.4, 3.8 Hz, 1H), 1.74 (m, 2H), 1.55 (dtd, *J* = 13.4, 11.7, 4.3 Hz, 2H), 1.44 (s, 9H). ^{13}C NMR (126 MHz, Chloroform-*d*) δ 209.5, 154.7, 134.0, 129.5, 128.8, 127.2, 79.7, 48.0, 47.9, 28.5, 27.7. HRMS (ESI/TOF) m/z: $[M+Na]^+$ Calcd. for $C_{18}H_{25}NO_3Na$ 326.1732; Found 326.1732. FTIR (ATR) cm^{-1}: 3006, 2977, 2929, 1680.



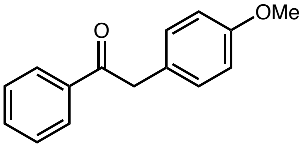
tert-butyl (*S*)-(3-oxo-1,4-diphenylbutan-2-yl)carbamate (**3n**). Prepared according to the general procedure **(1)** for the alkylation of acyl azoliums using the respective acyl imidazole (78.8 mg, 1.0 equiv.) and benzyl Hantzsch ester. **PC-1** was used as the photocatalyst. The reaction mixture was purified by preparative HPLC (short column, 30-95% MeCN/H_2O) to yield the product as an off-white solid (34 mg, 40%). Analytical data for **3n**: ^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.38 – 7.22 (m, 6H), 7.11 (dd, *J* = 16.5, 7.3 Hz, 4H), 5.10 (d, *J* = 7.8 Hz, 1H), 4.63 (q, *J* = 7.0 Hz, 1H), 3.77 – 3.58 (m, 2H), 3.00 (qd, *J* = 13.8, 6.7 Hz, 2H), 1.41 (s, 9H). ^{13}C NMR (126 MHz, Chloroform-*d*) δ 206.7, 155.2, 136.3, 133.2, 129.7, 129.0, 128.84, 128.7, 127.2, 127.1, 80.1, 59.6, 48.0, 37.9, 28.4. HRMS (ESI/TOF) m/z: $[M+Na]^+$ Calcd. for $C_{21}H_{25}NO_3Na$ 362.1732; Found 362.1730. FTIR (ATR) cm^{-1}: 3379, 3029, 2978, 1723, 1681.



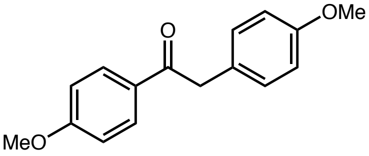
1-cyclohexyl-2-phenylethan-1-one (**3o**). Prepared according to the general procedure **(1)** for the alkylation of acyl azoliums using the respective acyl imidazole (46.6 mg, 1.0 equiv.) and benzyl Hantzsch ester. **PC-1** was used as the photocatalyst. The reaction mixture was purified by column chromatography (wet loaded with toluene, 0-10% ethyl acetate/hexanes) to yield the desired product as a clear oil (24 mg, 47%). Product is a known substrate and matched the literature data.[13]



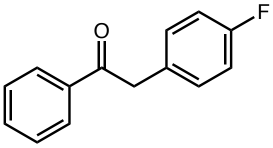
1,4-diphenylbutan-2-one (**3p**). Prepared according to the general procedure **(1)** for the alkylation of acyl azoliums using the respective acyl imidazole (50 mg, 1.0 equiv.) and benzyl Hantzsch ester. **PC-1** was used as the photocatalyst. The reaction mixture was purified by preparative HPLC (short column, 30-95% MeCN/H_2O) to yield the product as a clear oil (23 mg, 41%). Product is a known substrate and matched the literature data.[14]



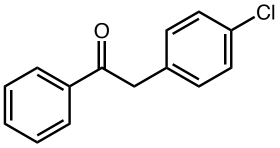
2-(4-methoxyphenyl)-1-phenylethan-1-one (**3q**). Prepared according to the general procedure **(1)** for the alkylation of acyl azoliums using the respective acyl imidazole (43.0 mg, 1.0 equiv.) and benzyl Hantzsch ester. **PC-1** was used as the photocatalyst. The reaction mixture was purified by column chromatography (dry loaded with silica, 0-10% ethyl acetate/hexanes) to yield the desired product as a white solid (36 mg, 64%). Product is a known substrate and matched the literature data.[15]



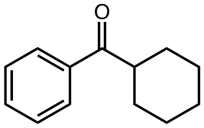
1,2-bis(4-methoxyphenyl)ethan-1-one (**3r**). Prepared according to the general procedure **(1)** for the alkylation of acyl azoliums using the respective acyl imidazole (51 mg, 1.0 equiv.) and benzyl Hantzsch ester. **PC-1** was used as the photocatalyst. The reaction mixture was purified by column chromatography (dry loaded with silica, 2-10% ethyl acetate/hexanes) to yield the desired product as a white solid (37 mg, 58%). Product is a known substrate and matched the literature data.[15]



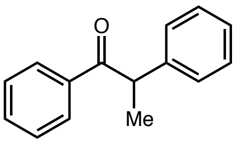
2-(4-fluorophenyl)-1-phenylethan-1-one (**3s**). Prepared according to the general procedure **(1)** for the alkylation of acyl azoliums using the respective acyl imidazole (43 mg, 1.0 equiv.) and benzyl Hantzsch ester. **PC-1** was used as the photocatalyst. The reaction mixture was purified by column chromatography (dry loaded with silica, 2-20% ethyl acetate/hexanes) to yield the desired product as a white solid (65 mg, 66%). Product is a known substrate and matched the literature data.[17]



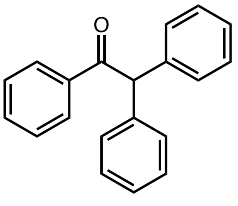
2-(4-chlorophenyl)-1-phenylethan-1-one (**3t**). Prepared according to the general procedure **(1)** for the alkylation of acyl azoliums using the respective acyl imidazole 43 mg, 1.0 equiv.) and benzyl Hantzsch ester. **PC-1** was used as the photocatalyst. The reaction mixture was purified by column chromatography (dry loaded with silica, 0-10% ethyl acetate/hexanes) to yield the desired product as a white solid (44 mg, 76%). Product is a known substrate and matched the literature data.[16]



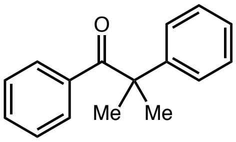
cyclohexyl(phenyl)methanone (**3u**). Prepared according to the general procedure **(1)** for the alkylation of acyl azoliums using the respective acyl imidazole (43 mg, 1.0 equiv.) and Hantzsch ester. **PC-1** was used as the photocatalyst. The reaction mixture was purified by column chromatography (wet loaded with toluene, 2-20% ethyl acetate/hexanes) to yield the desired product (24 mg, 50%). Product is a known substrate and matched the literature data.[18]



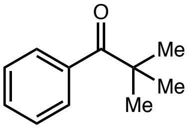
1,2-diphenylpropan-1-one (**3v**). Prepared according to the general procedure **(1)** for the alkylation of acyl azoliums using the respective acyl imidazole (43 mg, 1.0 equiv.) and benzyl Hantzsch ester. **PC-1** was used as the photocatalyst. The reaction mixture was purified by column chromatography (dry loaded with silica, 2-20% ethyl acetate/hexanes) to yield the desired product as a clear oil (40 mg, 76%). Product is a known substrate and matched the literature data.[19] **Az-6** was used for the enantioselective variant of this reaction (see below). For entry 2, the SynLED photoreactor was placed inside a cold room registering 5 °C. Enantiomeric ratio was measured by chiral phase SFC (Chiralpak IG-3, 5% MeOH/CO_2, flow rate = 2.5 mL/min, 250 nm, Rt (major) = 3.6 min, Rt (minor) = 4.1 min; Entry 1 er: 60:40, Entry 2 er: 66:34.



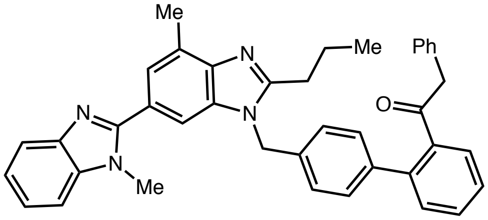
1,2,2-triphenylethan-1-one (**3w**). Prepared according to the general procedure **(2)** for the alkylation of acyl azoliums using the respective acyl imidazole (43 mg, 1.0 equiv.) and Meyer nitrile. 4-CzIPN was used as the photocatalyst. The reaction mixture was purified by column chromatography (wet loaded with toluene, 0-20% ethyl acetate/hexanes) to yield the desired product as a white solid (44 mg, 50%). Product is a known substrate and matched the literature data.[12]



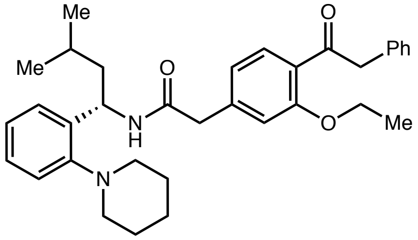
2-methyl-1,2-diphenylpropan-1-one (**3x**). Prepared according to the general procedure **(2)** for the alkylation of acyl azoliums using the respective acyl imidazole (43 mg, 1.0 equiv.) and Meyer nitrile. 4-CzIPN was used as the photocatalyst. The reaction mixture was purified by column chromatography (wet loaded with toluene, 0-20% ethyl acetate/hexanes) to yield the desired product as a clear oil (28 mg, 50%). Product is a known substrate and matched the literature data.[20]



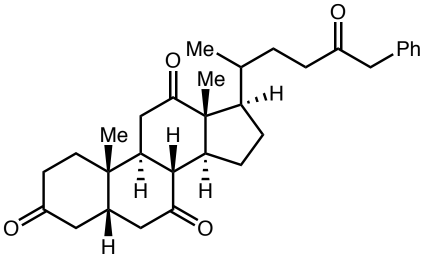
2,2-dimethyl-1-phenylpropan-1-one (**3y**). Prepared according to the general procedure **(2)** for the alkylation of acyl azoliums using the respective acyl imidazole (43 mg, 1.0 equiv.) and Meyer nitrile. Note: **PC-1** was used as the photocatalyst for this reaction. The reaction mixture was purified by column chromatography (dry loaded with silica, 2-10% ethyl acetate/hexanes) to yield the desired product as a clear oil (14 mg, 35%). Product is a known substrate and matched the literature data.[20]



1-(4'-((1,7'-dimethyl-2'-propyl-1*H*,3'*H*-[2,5'-bibenzo[*d*]imidazol]-3'-yl)methyl)-[1,1'-biphenyl]-2-yl)-2-phenylethan-1-one (**5a**). Prepared according to the general procedure **(3)** for the alkylation of acyl azoliums (*in situ* activation) using telmisartan (51.5 mg, 1.0 equiv.) and the respective benzyl Hantzsch ester. **PC-1** was used as the photocatalyst. The reaction mixture was purified by column chromatography (wet loaded with toluene, 60-100% ethyl acetate/hexanes) to yield the desired product as an off-white solid (54 mg, 91%). Analytical data for **5a**: ^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.81 – 7.76 (m, 1H), 7.51 (d, *J* = 1.6 Hz, 1H), 7.46 (td, *J* = 7.5, 1.5 Hz, 1H), 7.44 – 7.40 (m, 2H), 7.38 – 7.24 (m, 7H), 7.15 – 7.06 (m, 5H), 6.85 – 6.80 (m, 2H), 5.45 (s, 2H), 3.73 (s, 3H), 3.55 (s, 2H), 2.98 – 2.87 (m, 2H), 2.78 (s, 3H), 1.87 (dt, *J* = 15.3, 7.5 Hz, 2H), 1.03 (t, *J* = 7.3 Hz, 3H). ^{13}C NMR (126 MHz, Chloroform-*d*) δ 204.4, 156.5, 154.7, 143.3, 142.9, 140.5, 140.3, 139.3, 136.7, 135.8, 135.2, 133.9, 130.8, 130.3, 129.7, 129.6, 129.5, 128.4, 128.23, 127.7, 126.9, 126.7, 124.1, 124.0, 122.6, 122.4, 119.6, 109.7, 108.9, 49.6, 47.0, 31.9, 29.9, 22.0, 17.0, 14.2. HRMS (ESI/TOF) m/z: [M+H]$^+$ Calcd. for $C_{40}H_{37}N_4O$ 589.2967; Found 589.2965. FTIR (ATR) cm^{-1}: 3062, 3028, 2964, 2931, 1692.



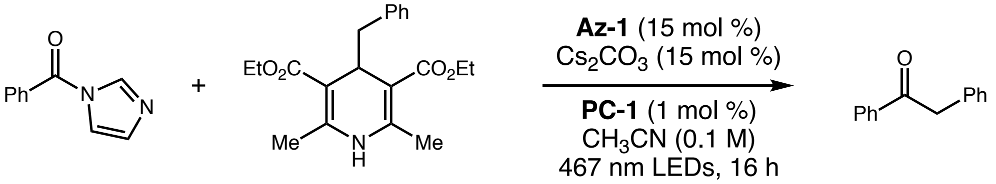
(*S*)-2-(3-ethoxy-4-(2-phenylacetyl)phenyl)-*N*-(3-methyl-1-(2-(piperidin-1-yl)phenyl)butyl)acetamide (**5b**). Prepared according to the general procedure **(3)** for the alkylation of acyl azoliums (in situ activation) using repaglinide (45.3 mg, 1.0 equiv.) and the respective benzyl Hantzsch ester. **PC-1** was used as the photocatalyst. The reaction mixture was purified by column chromatography (wet loaded with toluene, 0-40% ethyl acetate/hexanes) to yield the desired product as a white solid (27.1 mg, 52%). Analytical data for **5b**: ^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.60 (d, *J* = 7.8 Hz, 1H), 7.32 – 7.15 (m, 7H), 7.08 – 7.01 (m, 2H), 6.84 – 6.77 (m, 2H), 6.72 (d, *J* = 8.1 Hz, 1H), 5.35 (td, *J* = 8.7, 6.6 Hz, 1H), 4.30 (s, 2H), 4.11 – 3.95 (m, 2H), 3.50 (s, 2H), 2.91 (s, 2H), 2.59 (t, *J* = 10.2 Hz, 2H), 1.74 – 1.64 (m, 2H), 1.64 – 1.46 (m, 6H), 1.46 – 1.37 (m, 4H), 0.90 (d, *J* = 6.6 Hz, 6H). ^{13}C NMR (126 MHz, Chloroform-*d*) δ 199.8, 168.9, 158.3, 152.7, 141.5, 138.8, 135.4, 131.4, 129.8, 128.5, 128.1, 127.9, 127.2, 126.7, 125.2, 123.0, 121.5, 113.1, 64.3, 50.2, 50.1, 46.8, 44.3, 26.9, 25.5, 24.3, 22.9, 22.7, 14.9. HRMS (ESI/TOF) m/z: [M+H]$^+$ Calcd. for $C_{34}H_{43}N_2O_3$ 527.3273; Found 527.3273. FTIR (ATR) cm^{-1}: 3300 (br), 3029, 2980, 2955, 2876, 1676, 1640.



(5*S*,8*R*,9*S*,10*S*,13*R*,14*S*,17*R*)-10,13-dimethyl-17-(5-oxo-6-phenylhexan-2-yl)dodecahydro-3*H*-cyclopenta[*a*]phenanthrene-3,7,12(2*H*,4*H*)-trione (**5c**). Prepared according to the general procedure **(3)** for the alkylation of acyl azoliums (in situ activation) using dehydrocholic acid (40.3 mg, 1.0 equiv.) and the respective benzyl Hantzsch ester. **PC-1** was used as the photocatalyst. The reaction mixture was purified by column chromatography (wet loaded with toluene, 20-80% ethyl acetate/hexanes) to yield the desired product as a white solid (19 mg, 40%). ^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.32 (dd, *J* = 8.1, 6.7 Hz, 2H), 7.28 – 7.23 (m, 1H), 7.22 – 7.18 (m, 2H), 3.68 (s, 2H), 2.99 – 2.77 (m, 3H), 2.52 (ddd, *J* = 17.0, 9.2, 5.1 Hz, 1H), 2.42 (ddd, *J* = 16.7, 8.7, 6.7 Hz, 1H), 2.36 – 2.18 (m, 6H), 2.17 – 2.08 (m, 2H), 2.05 – 1.91 (m, 4H), 1.87 – 1.74 (m, 2H), 1.61 (td, *J* = 14.3, 5.0 Hz, 1H), 1.39 (s, 3H), 1.35 – 1.26 (m, 2H), 1.25 – 1.17 (m, 2H), 1.03 (s, 3H), 0.76 (d, *J* = 6.6 Hz, 3H). ^{13}C NMR (126 MHz, Chloroform-*d*) δ 212.0, 209.0, 208.74, 208.69, 134.3, 129.4, 128.7, 127.0, 56.9, 51.7, 50.3, 49.0, 46.9, 45.6, 45.5, 45.0, 42.8, 39.0, 38.6, 36.5, 36.0, 35.3, 35.3, 29.2, 27.5, 25.1, 21.9, 18.7, 11.9. HRMS (ESI/TOF) m/z: [M+Na]$^+$ Calcd. for $C_{31}H_4O_4Na$ 499.2824; Found 499.2824 FTIR (ATR) cm^{-1}: 3028, 2991, 2967, 1721, 1705, 1691.

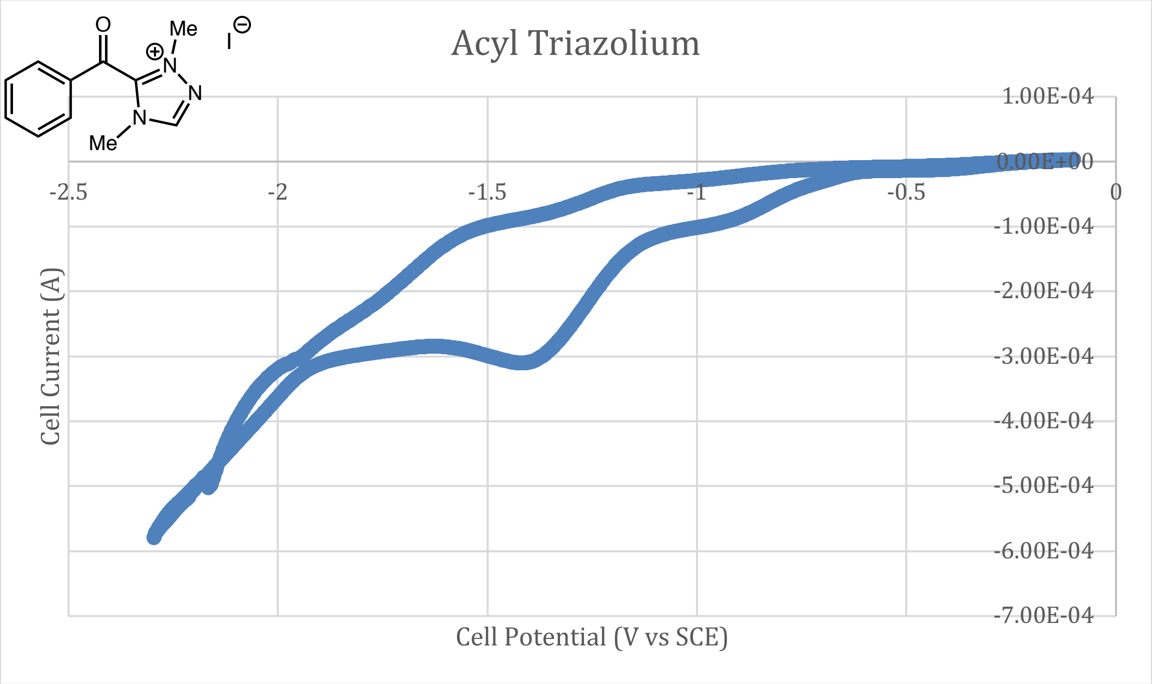
Control Experiments

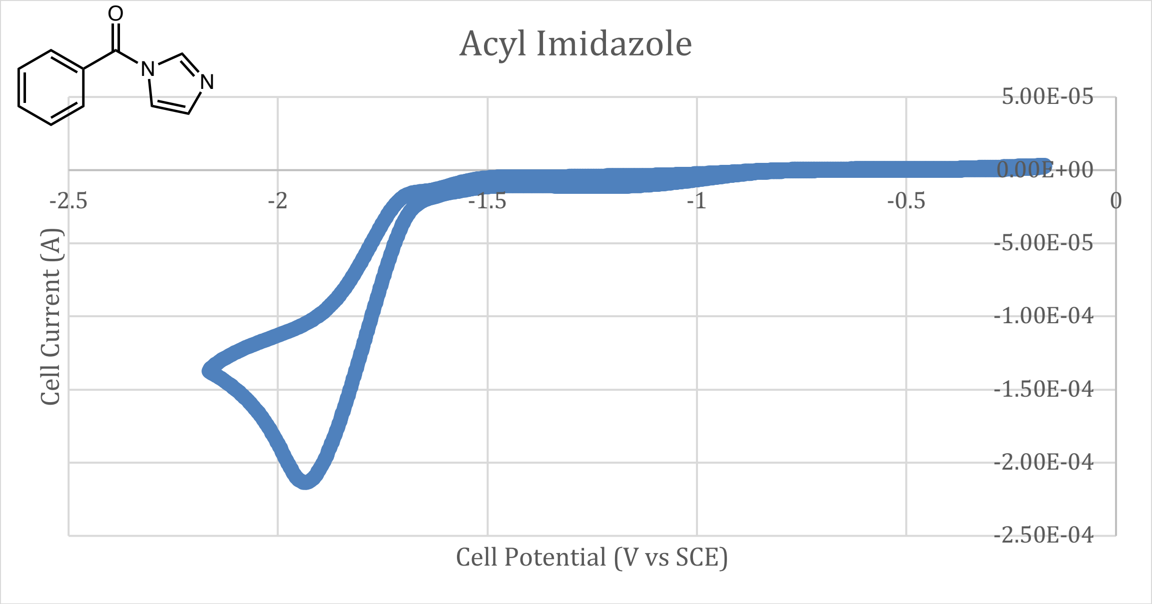
Control experiments were set up according to general procedure **(1)** for the alkylation of acyl azoliums using the respective acyl imidazole and benzyl Hantzsch ester.



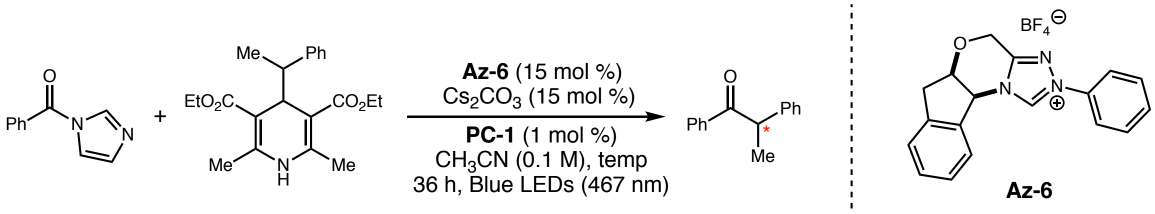
entry	deviation from standard	product
1	none	63
2	no base	0
3	no azolium	0
4	no photocatalyst	0
5	no light	0

Cyclic Voltammetry Graphs



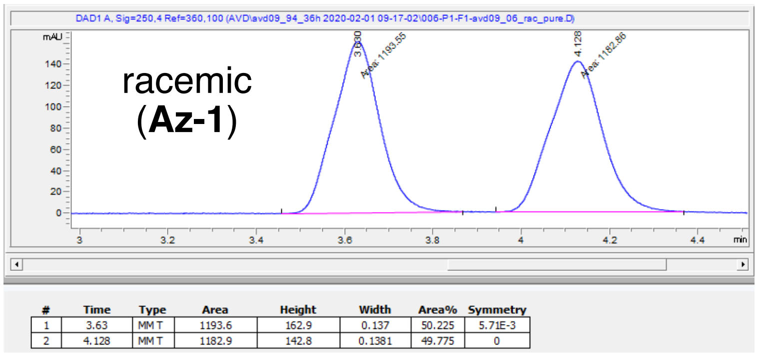


Enantioselective Variant SFC traces

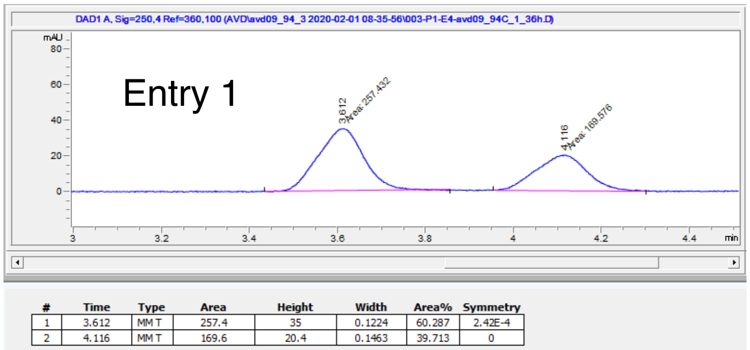


Entry	Temperature	Enantiomeric ratio
1	30 °C[a]	60:40
2	5 °C	66:34

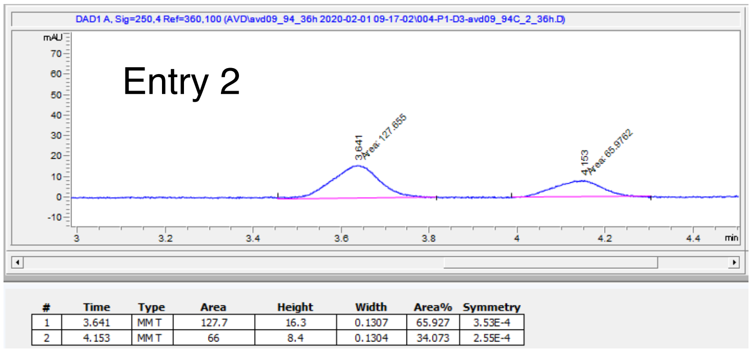
[a]Reactions in SynLED photoreactor warm to ~30 °C over time.


DAD1 A, Sig=250,4 Ref=360,100 (AVD\avd09_94_36h 2020-02-01 09-17-02\006-P1-F1-avd09_06_rac_pure.D)

#	Time	Type	Area	Height	Width	Area%	Symmetry
1	3.63	MM T	1193.6	162.9	0.137	50.225	5.71E-3
2	4.128	MM T	1182.9	142.8	0.1381	49.775	0


DAD1 A, Sig=250,4 Ref=360,100 (AVD\avd09_94_3 2020-02-01 08-35-56\003-P1-E4-avd09_94C_1_36h.D)

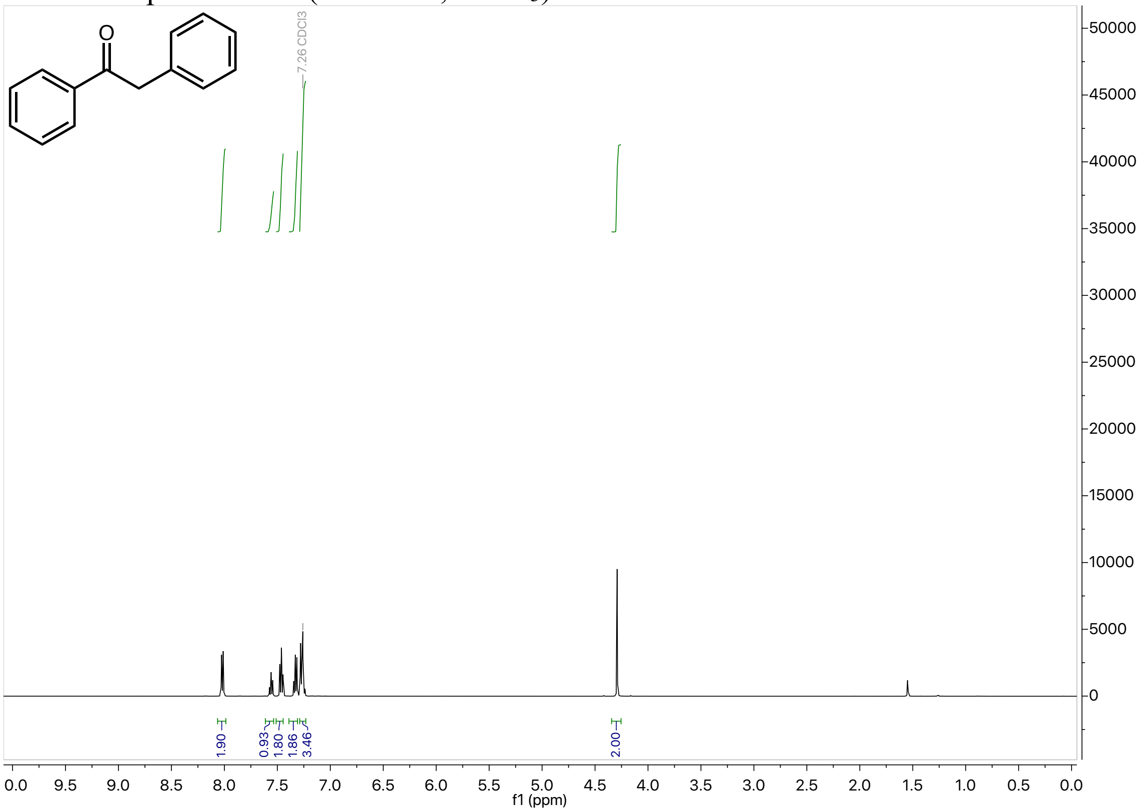
#	Time	Type	Area	Height	Width	Area%	Symmetry
1	3.612	MM T	257.4	35	0.1224	60.287	2.42E-4
2	4.116	MM T	169.6	20.4	0.1463	39.713	0


DAD1 A, Sig=250,4 Ref=360,100 (AVD\avd09_94_36h 2020-02-01 09-17-02\004-P1-D3-avd09_94C_2_36h.D)

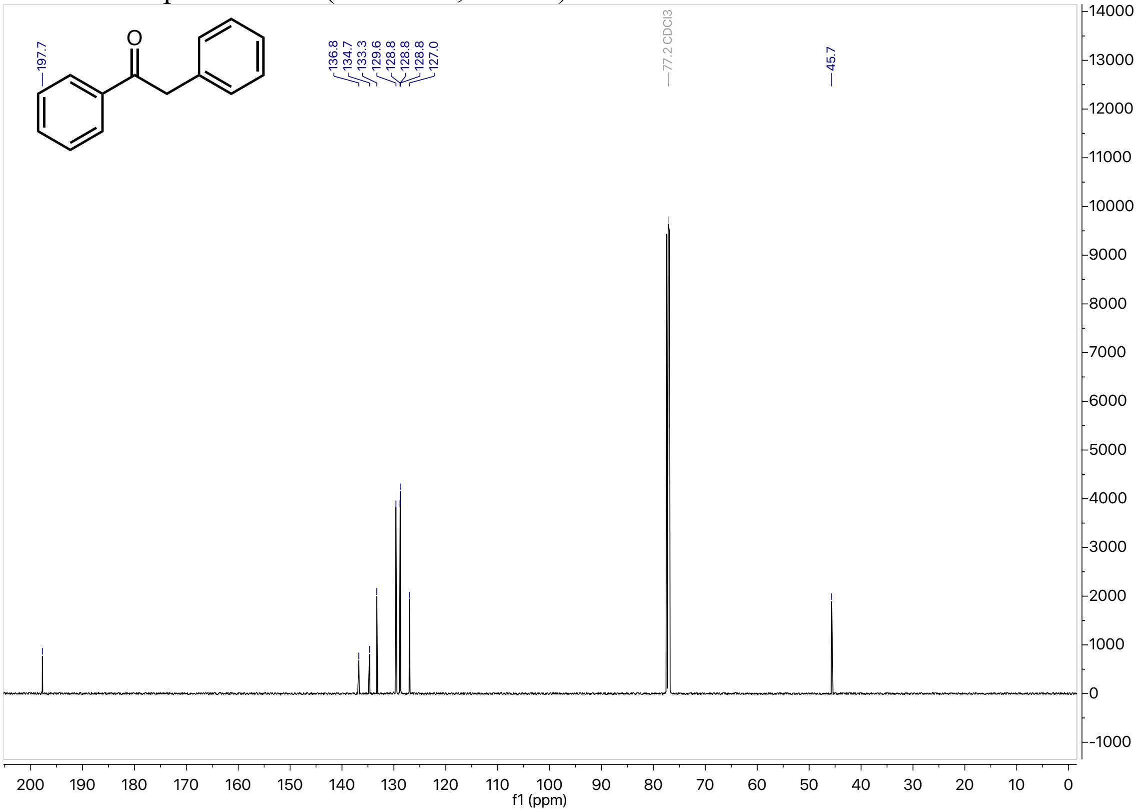
#	Time	Type	Area	Height	Width	Area%	Symmetry
1	3.641	MM T	127.7	16.3	0.1307	65.927	3.53E-4
2	4.153	MM T	66	8.4	0.1304	34.073	2.55E-4

Selected NMR Spectra

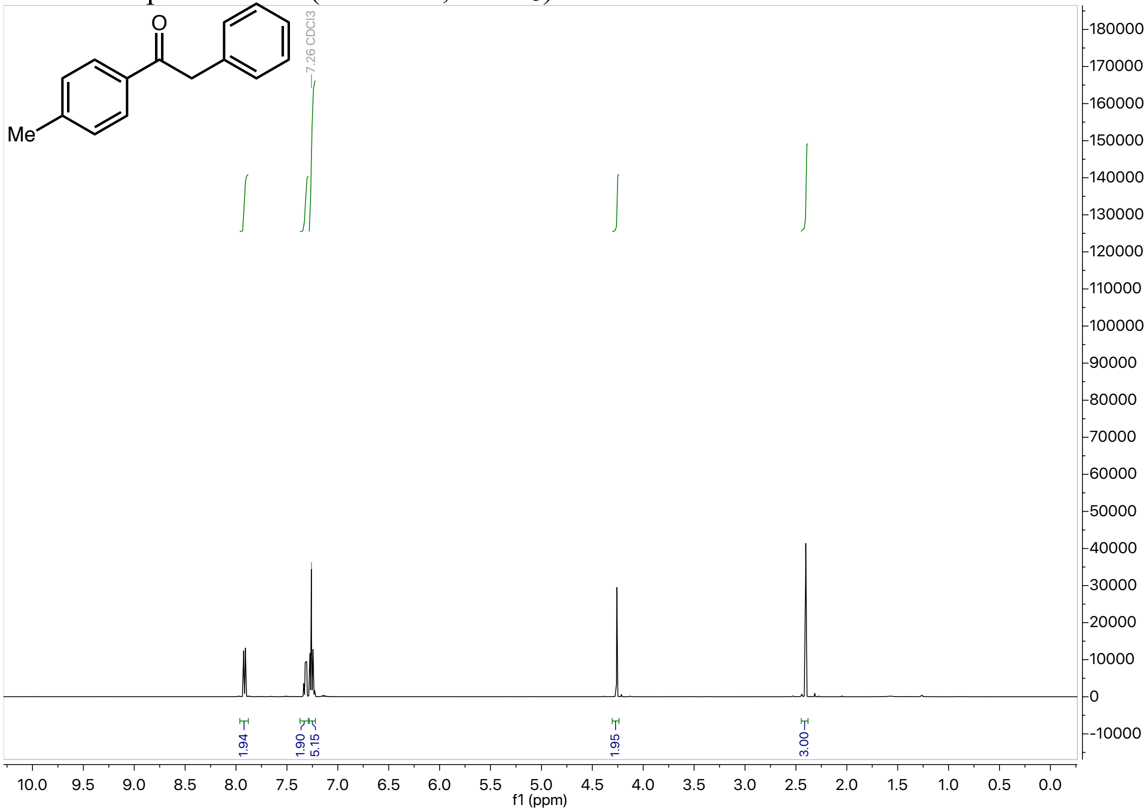
^{1}H NMR spectra of **3a** (500 MHz, $CDCl_3$)



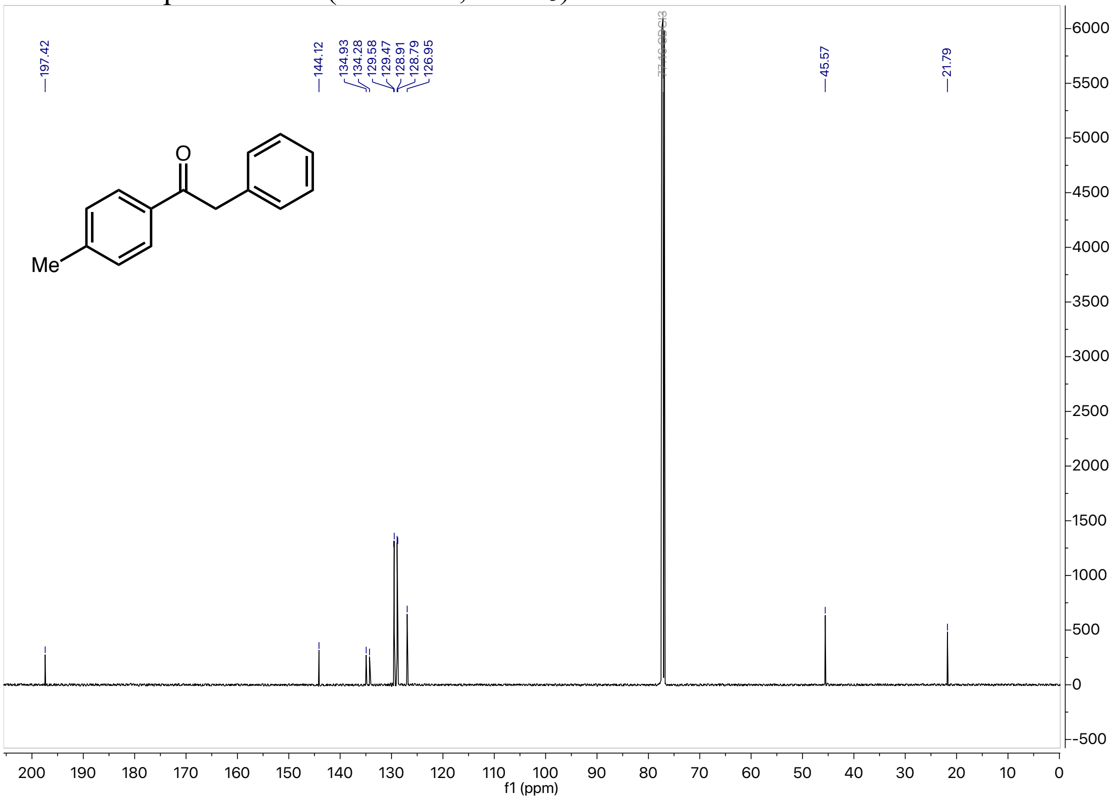
^{13}C NMR spectra of **3a** (126 MHz, $CDCl_3$)



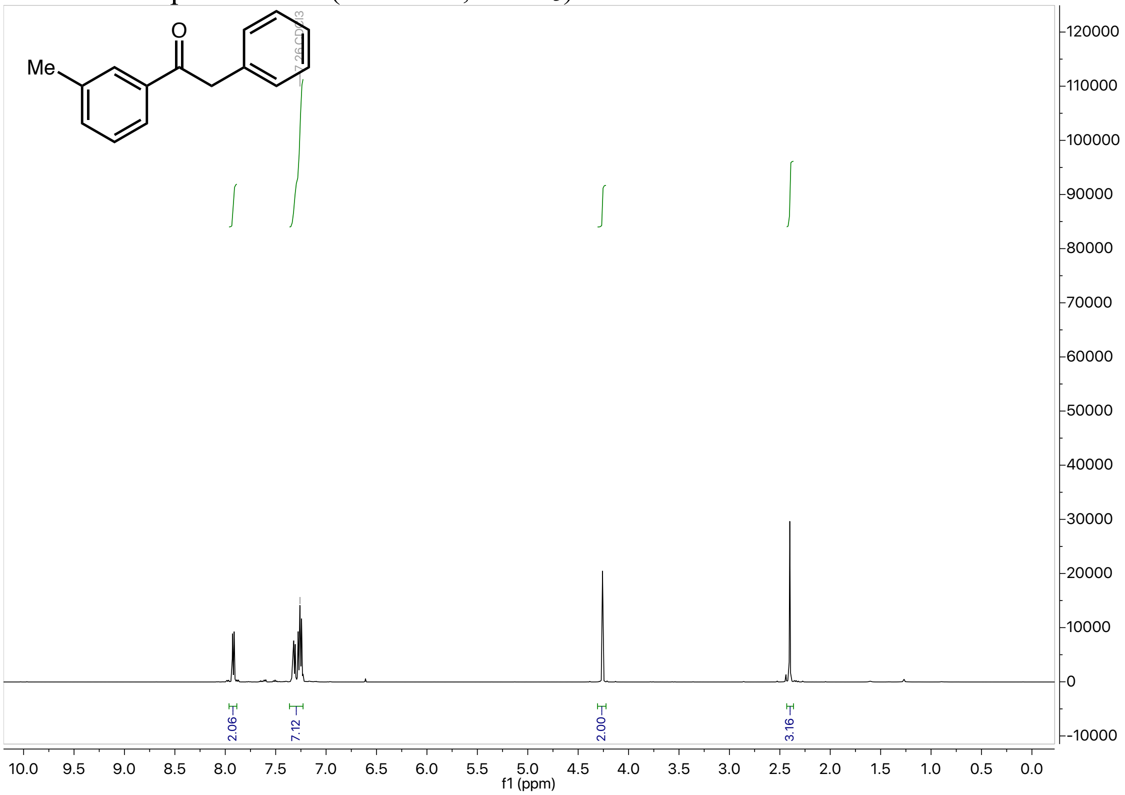
^{1}H NMR spectra of **3b** (500 MHz, CDCl$_3$)



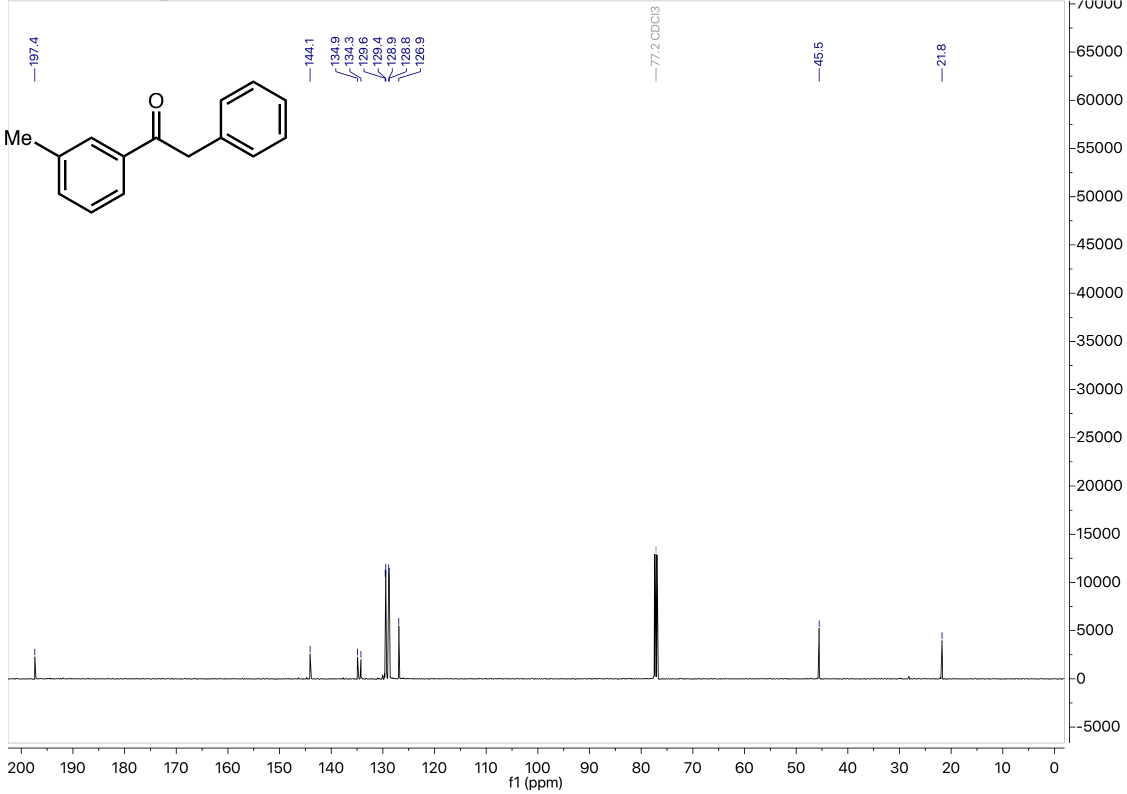
^{13}C NMR spectra of **3b** (126 MHz, CDCl$_3$)



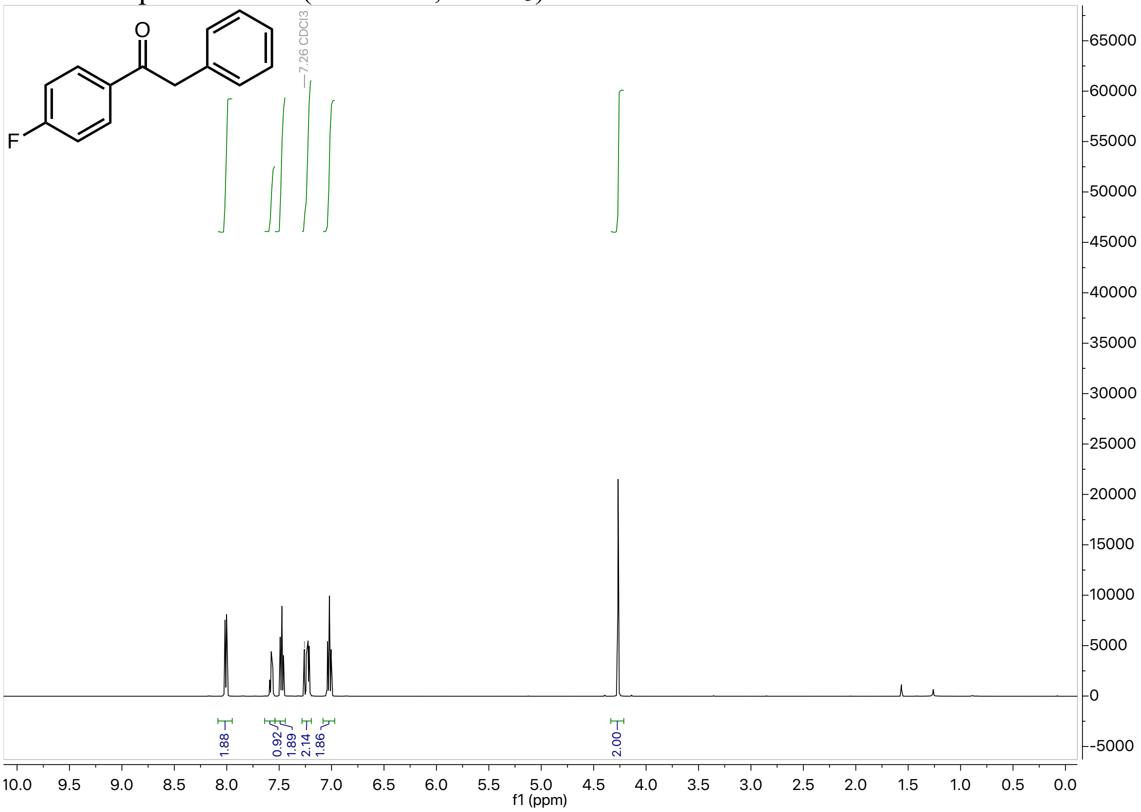
^{1}H NMR spectra of **3c** (500 MHz, $CDCl_3$)



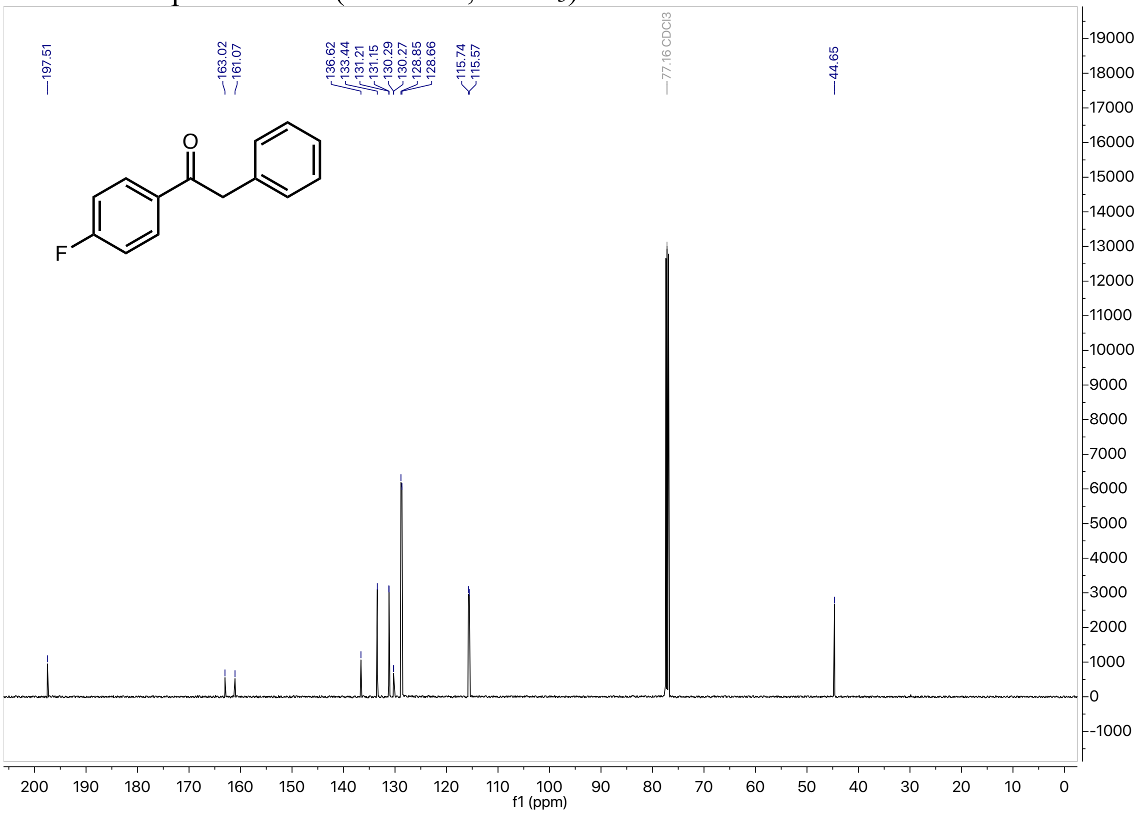
^{13}C NMR spectra of **3c** (126 MHz, $CDCl_3$)



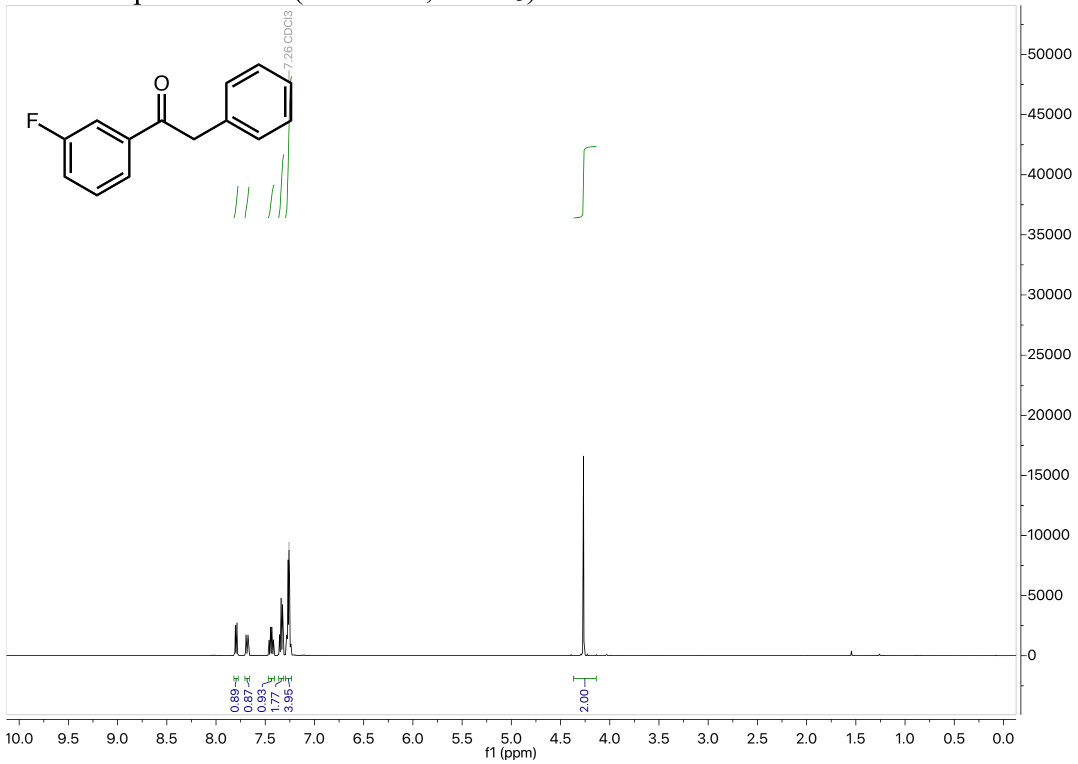
^{1}H NMR spectra of **3d** (500 MHz, $CDCl_3$)



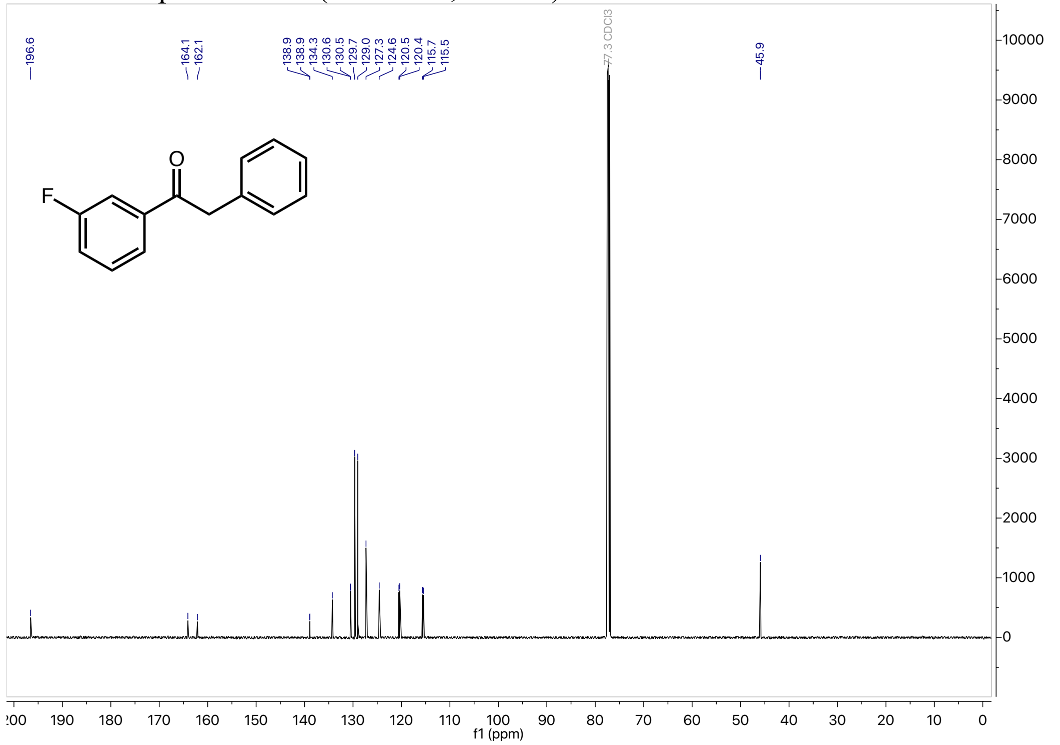
^{13}C NMR spectra of **3d** (126 MHz, $CDCl_3$)



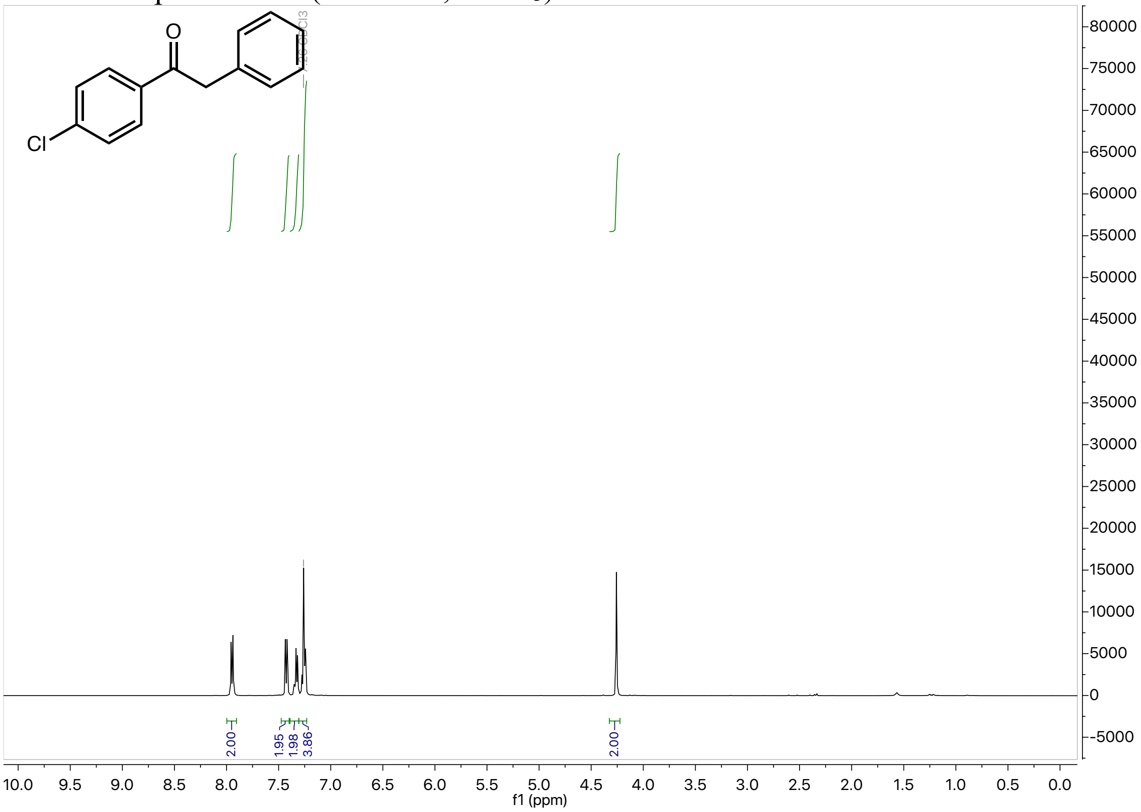
^{1}H NMR spectra of **3e** (500 MHz, $CDCl_3$)



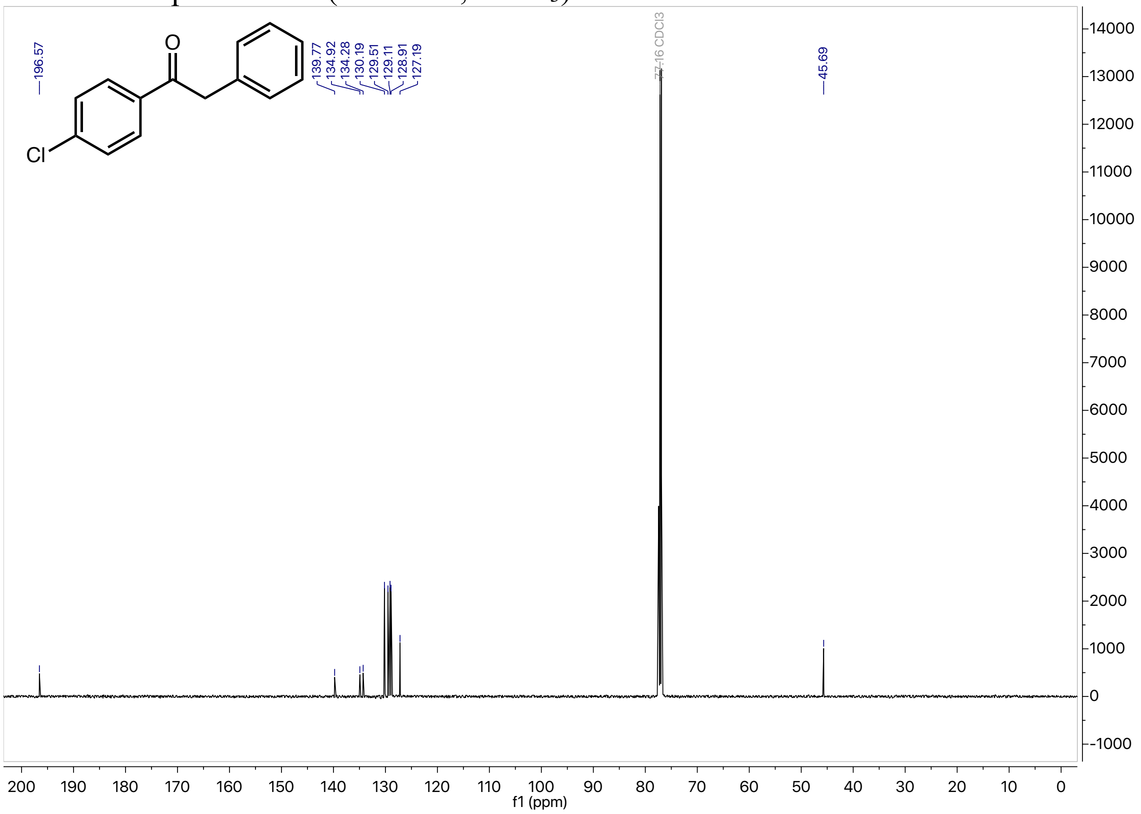
^{13}C NMR spectra of **3e** (126 MHz, $CDCl_3$)



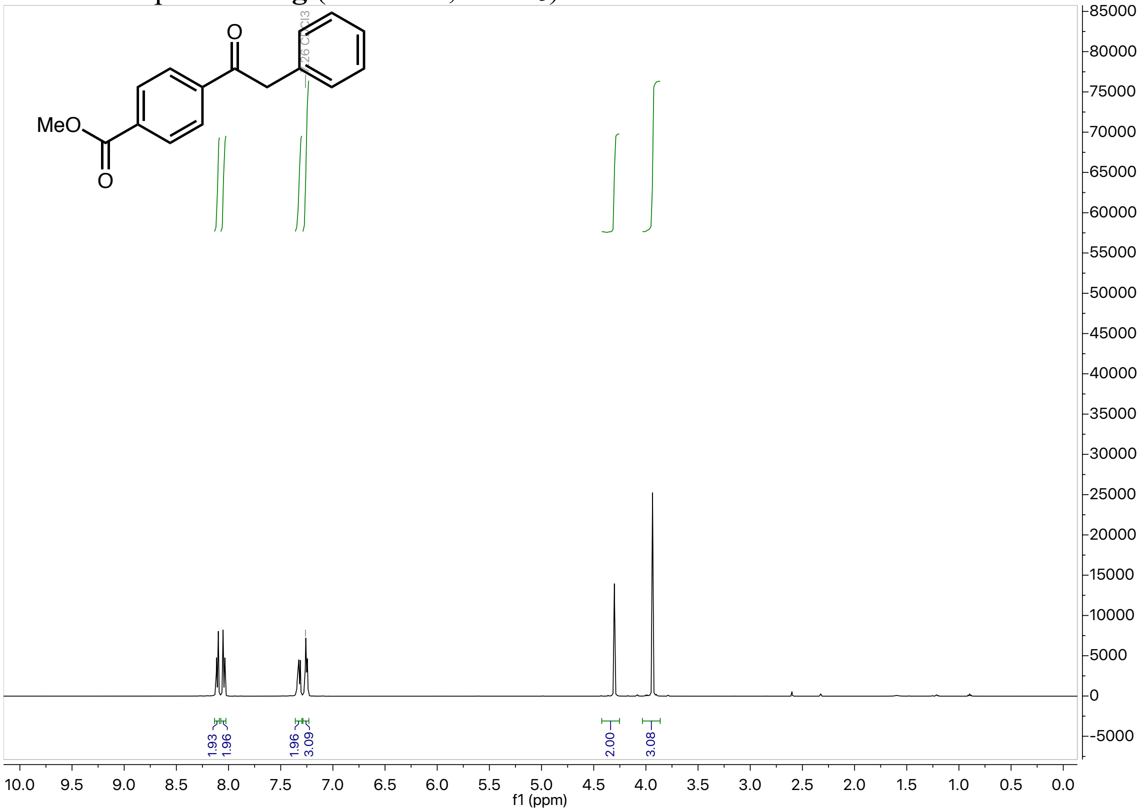
^{1}H NMR spectra of **3f** (500 MHz, CDCl$_3$)



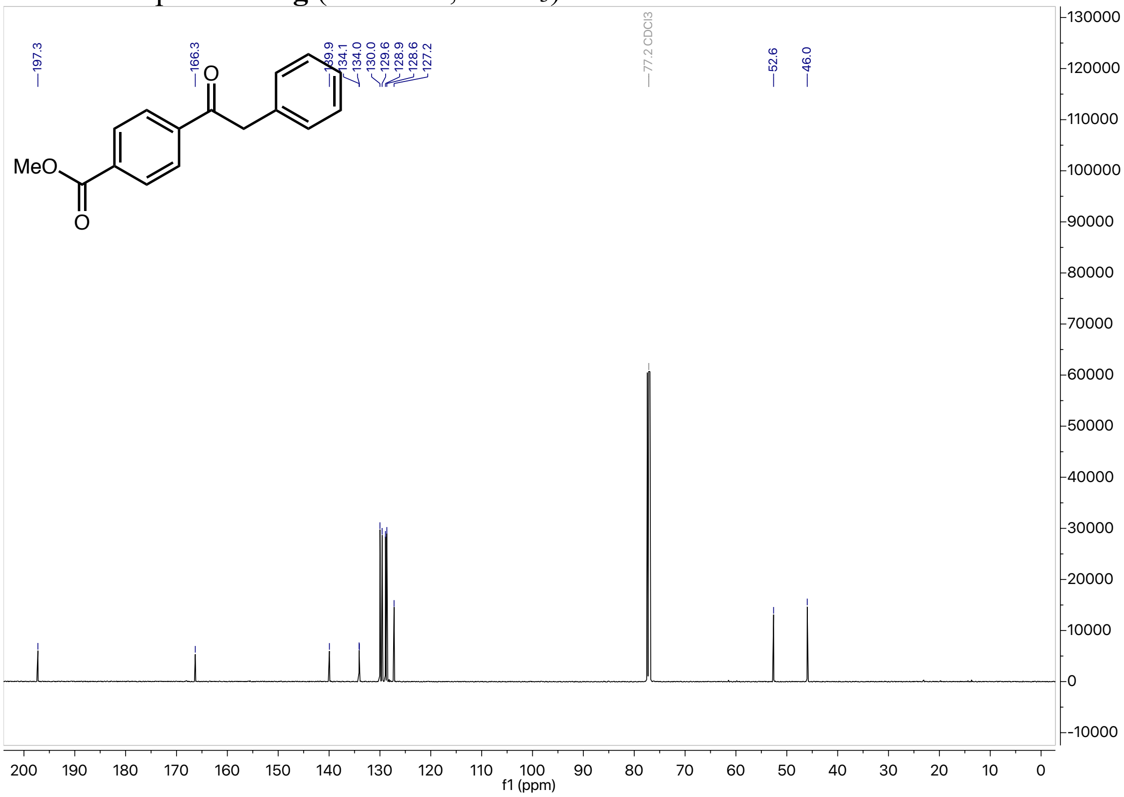
^{13}C NMR spectra of **3f** (126 MHz, CDCl$_3$)



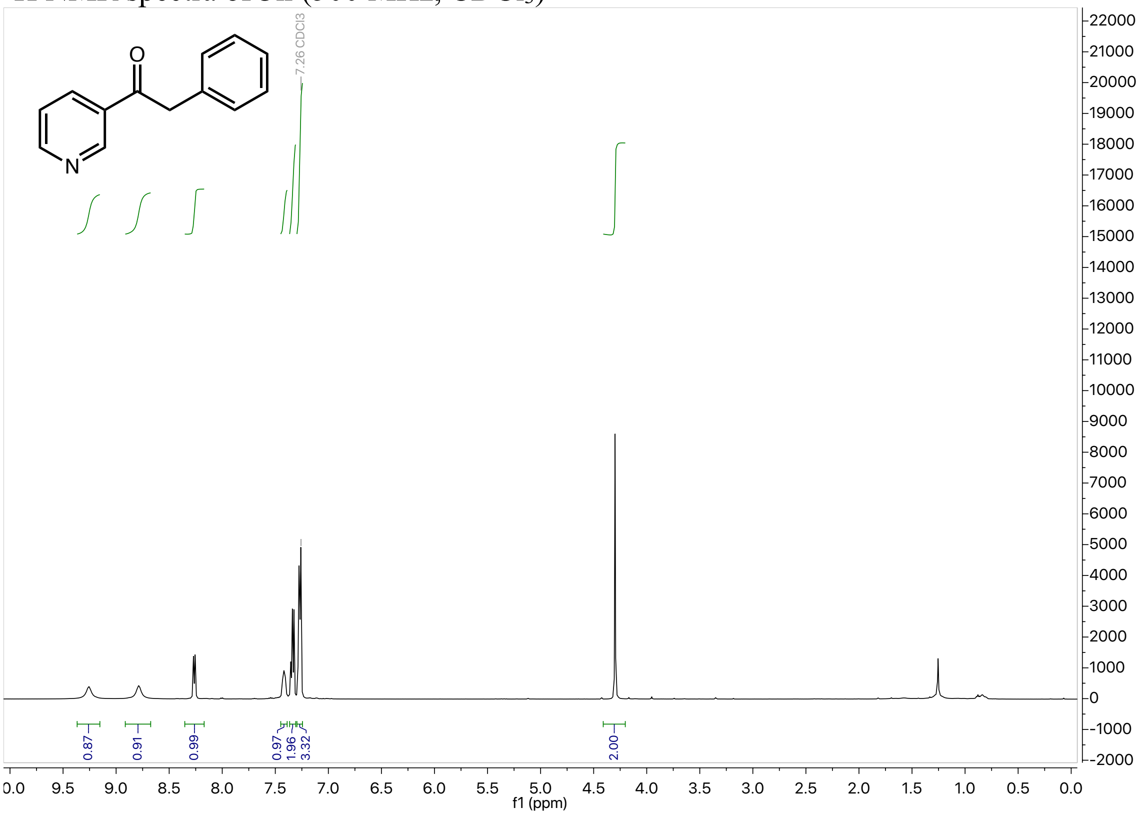
^{1}H NMR spectra of **3g** (500 MHz, CDCl$_3$)



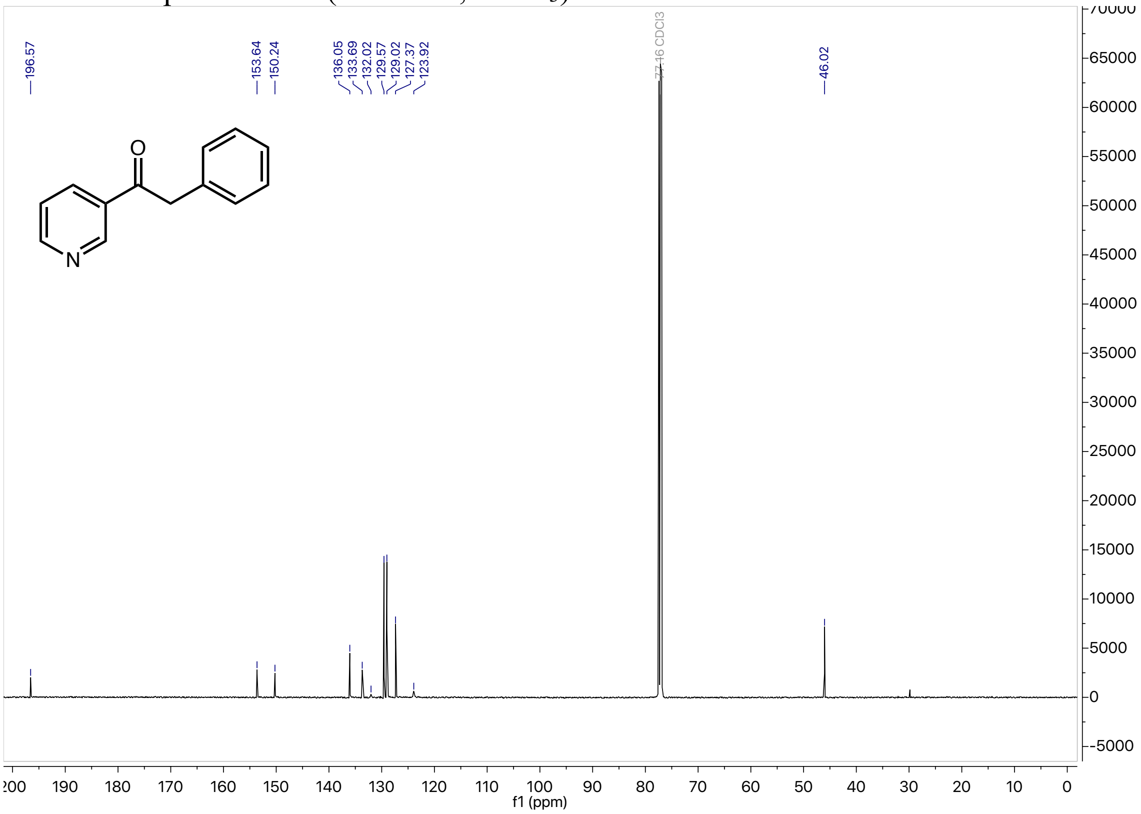
^{13}C NMR spectra of **3g** (126 MHz, CDCl$_3$)



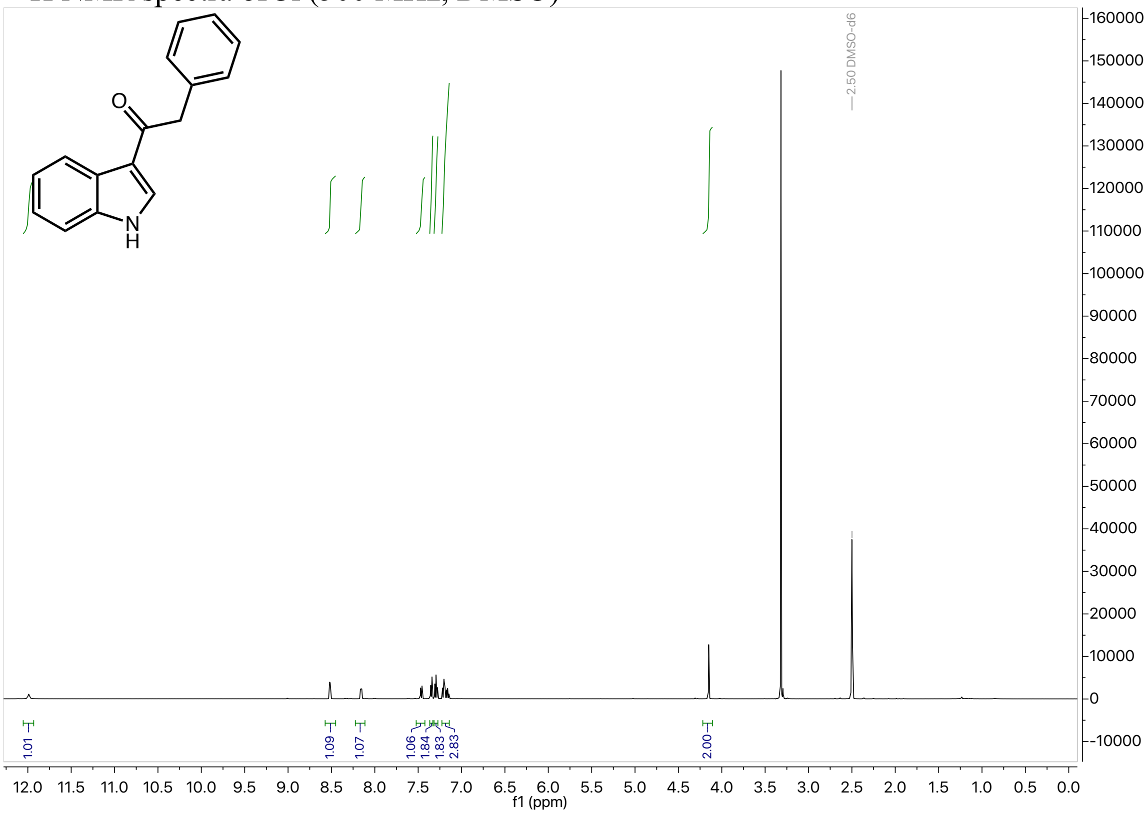
^{1}H NMR spectra of **3h** (500 MHz, CDCl$_3$)



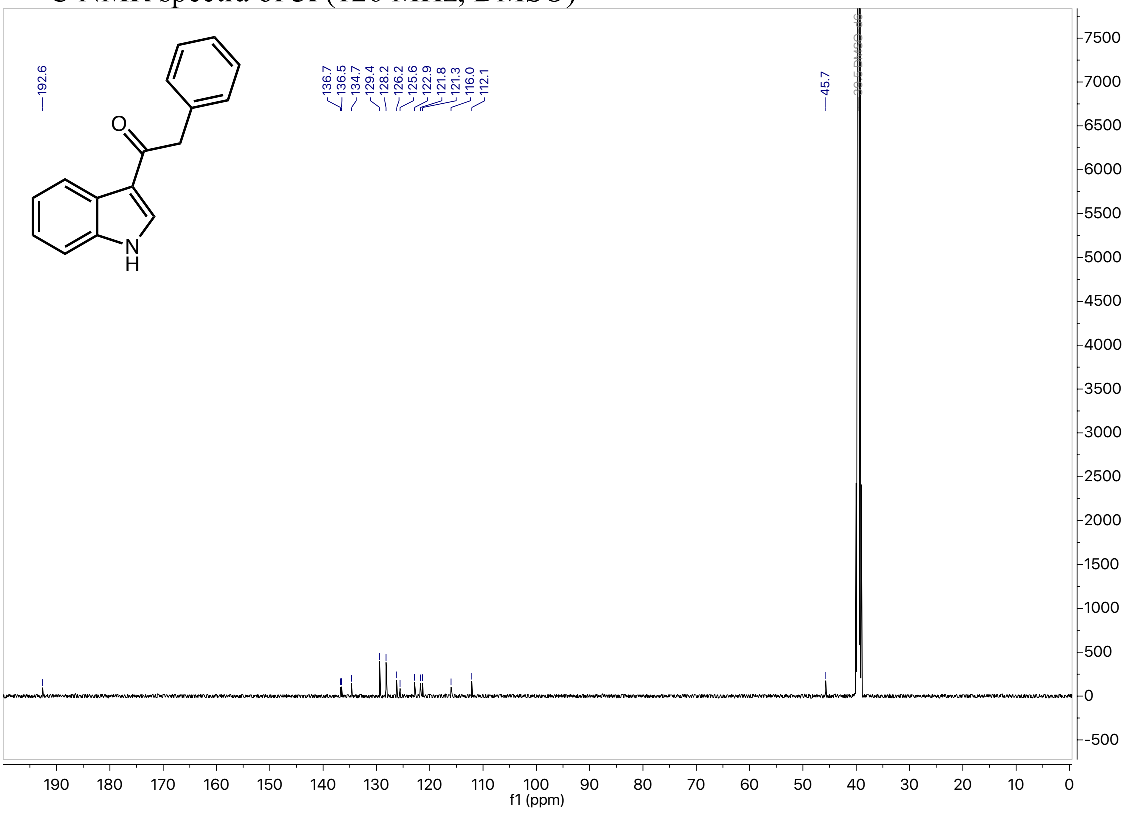
^{13}C NMR spectra of **3h** (126 MHz, CDCl$_3$)



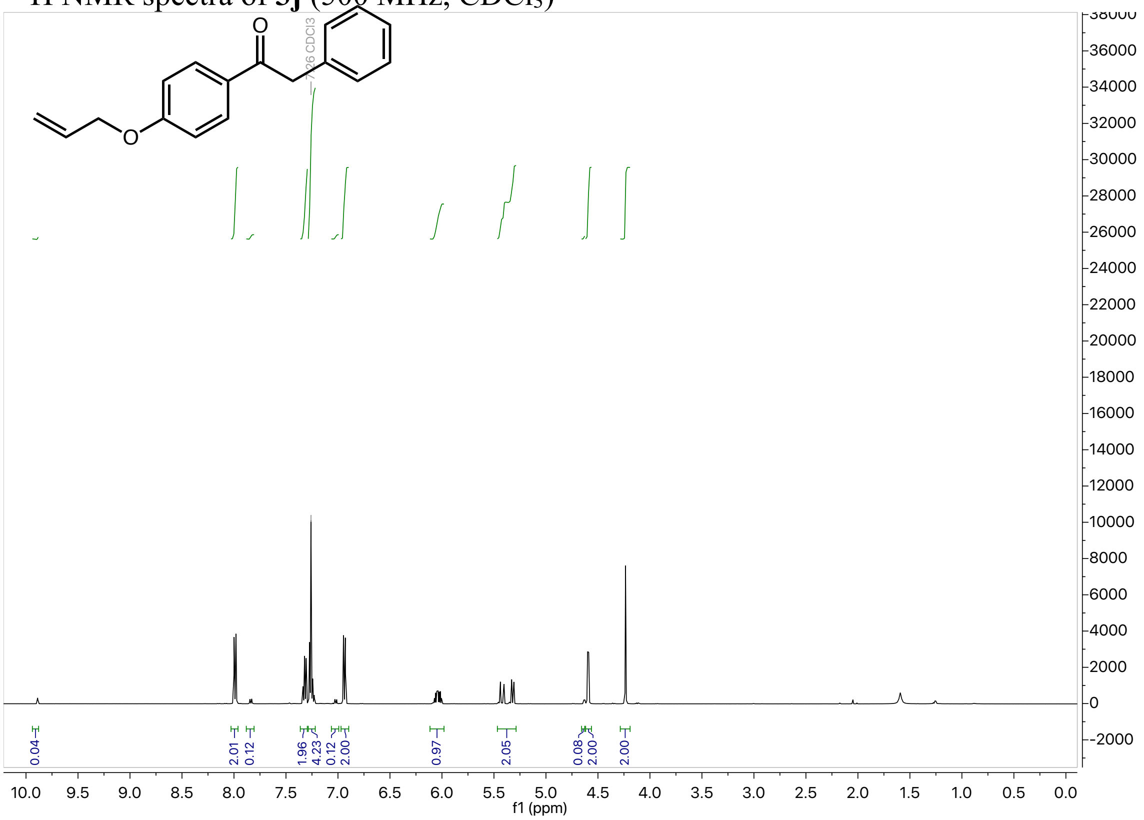
^{1}H NMR spectra of **3i** (500 MHz, DMSO)



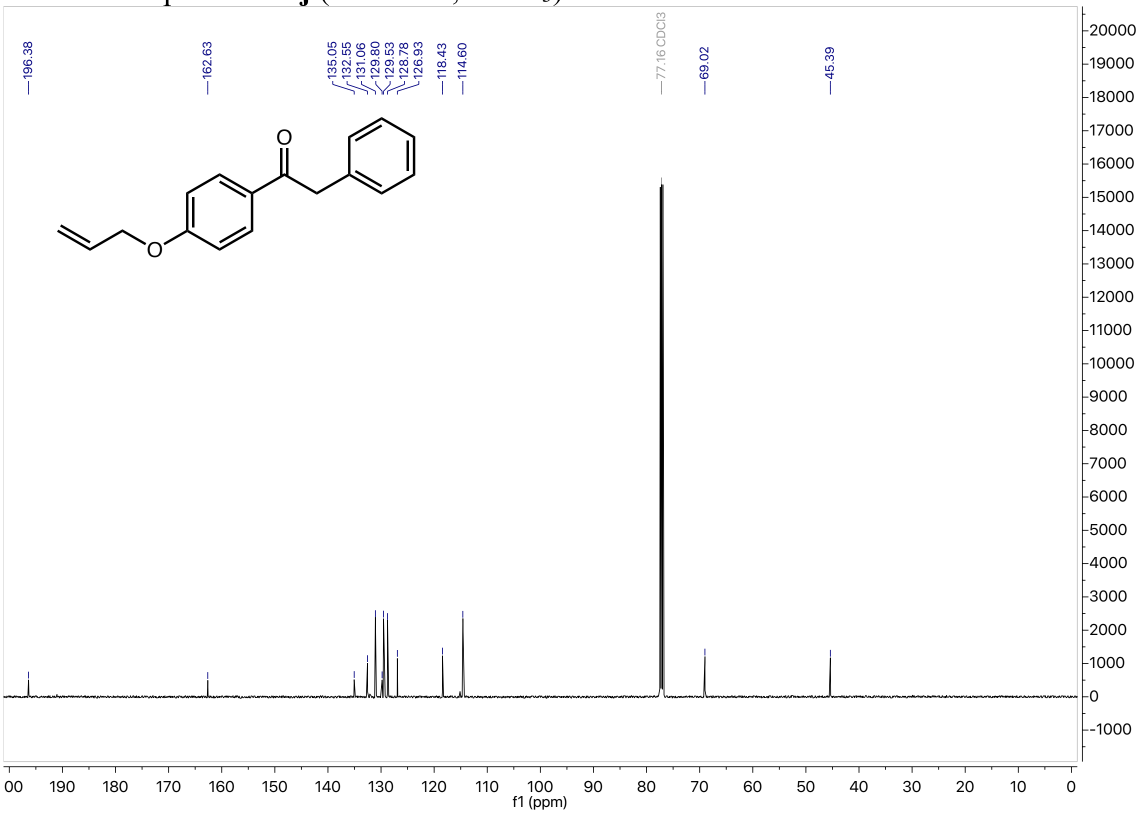
^{13}C NMR spectra of **3i** (126 MHz, DMSO)



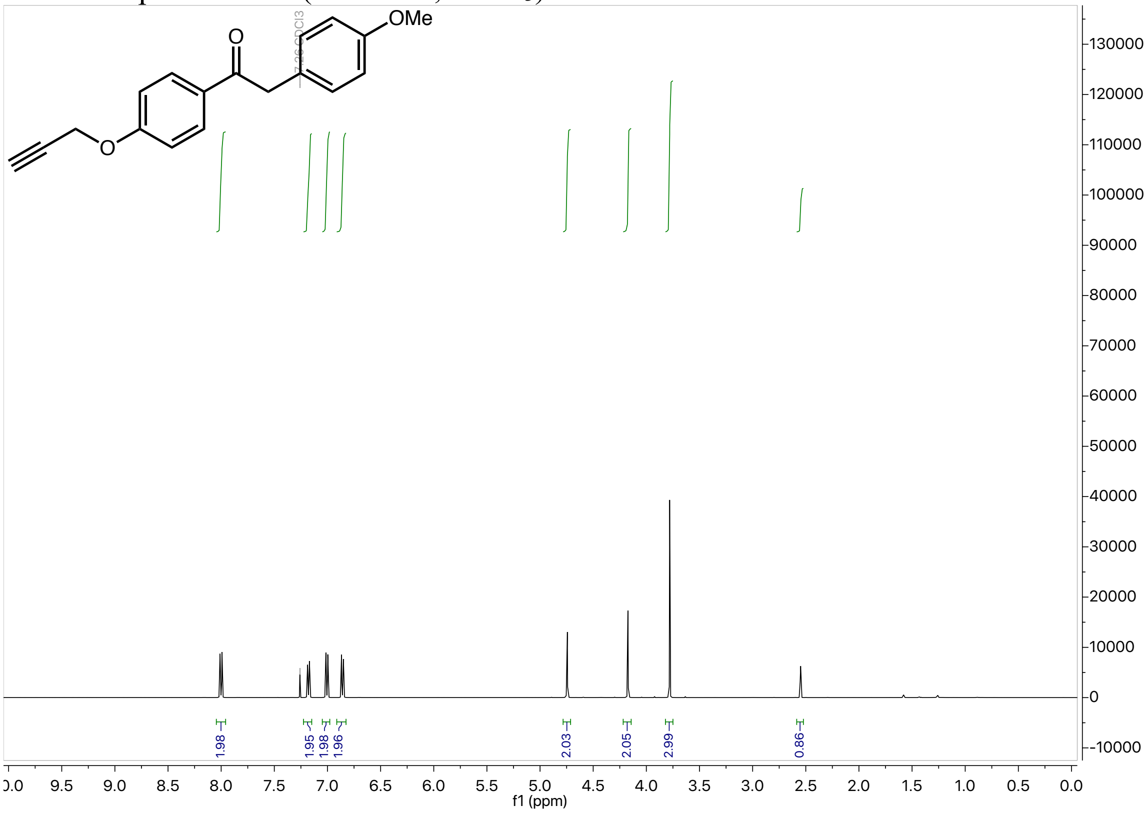
^{1}H NMR spectra of **3j** (500 MHz, CDCl$_3$)



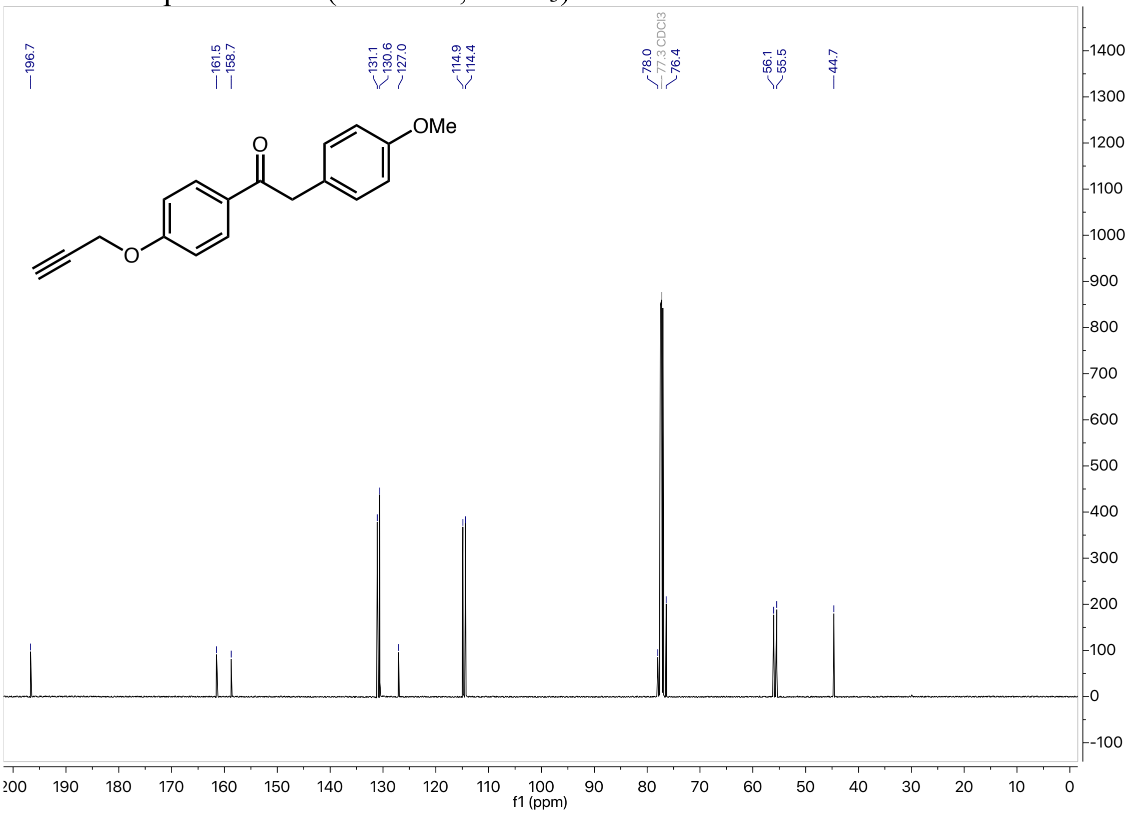
^{13}C NMR spectra of **3j** (126 MHz, CDCl$_3$)



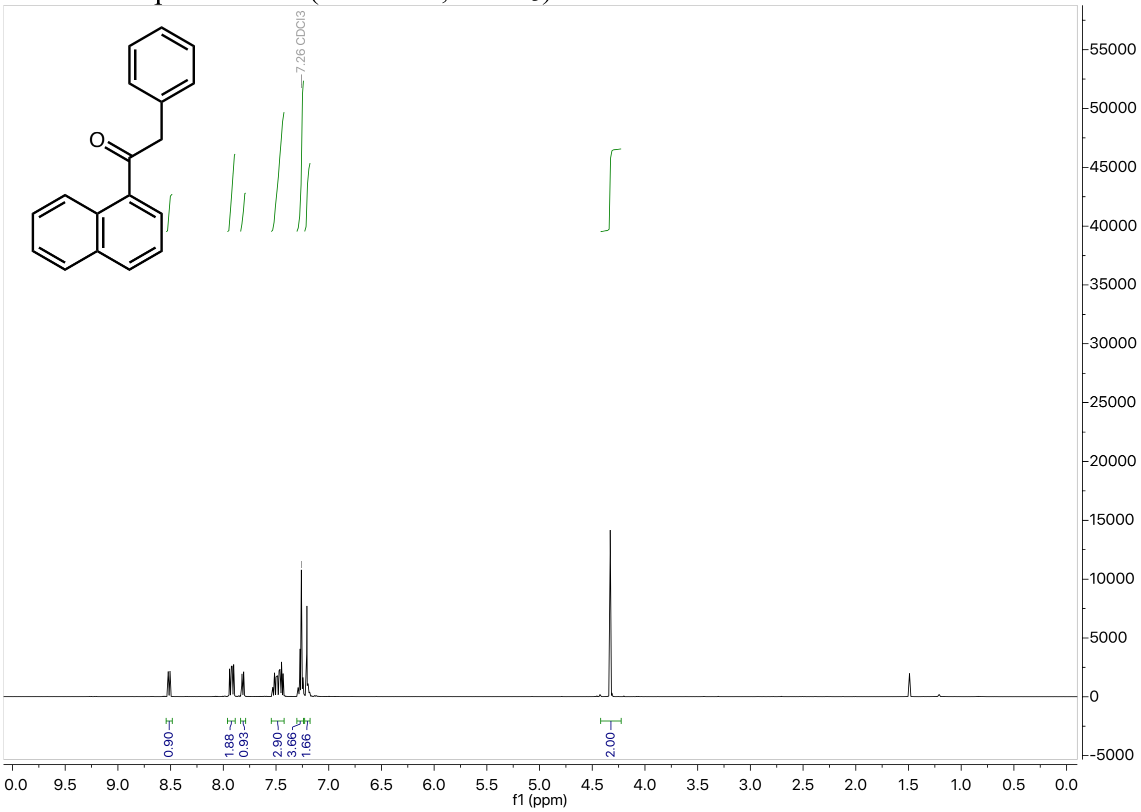
^{1}H NMR spectra of **3k** (500 MHz, $CDCl_3$)



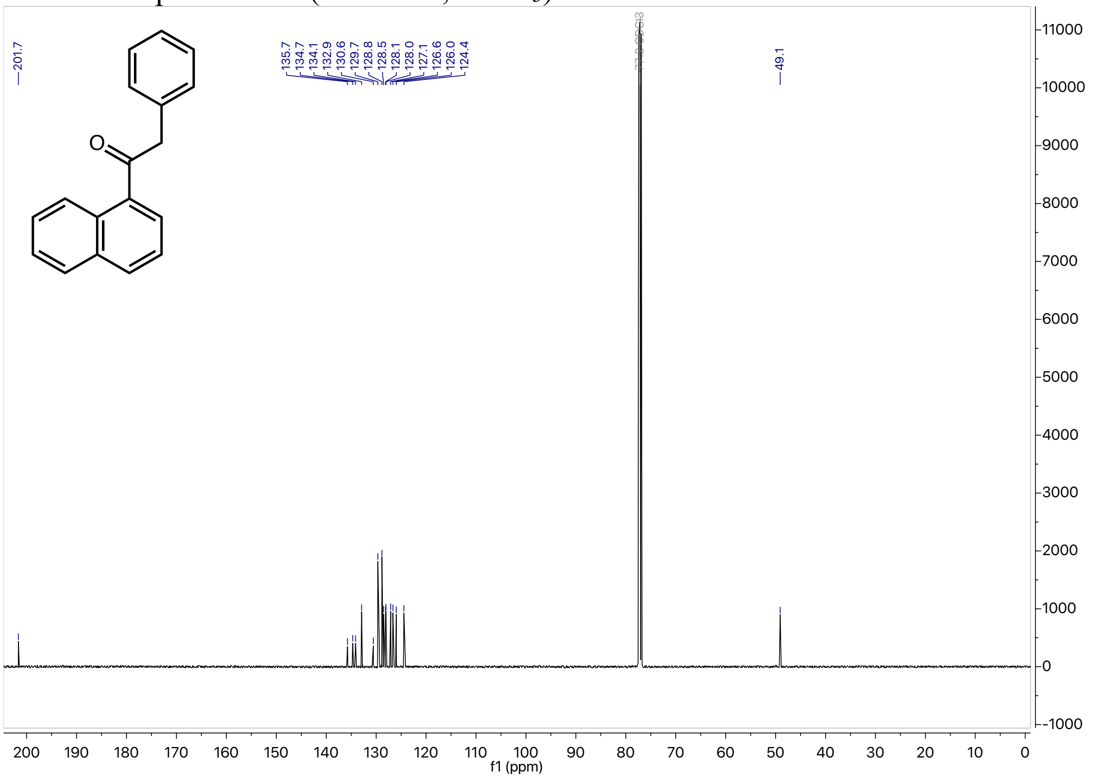
^{13}C NMR spectra of **3k** (126 MHz, $CDCl_3$)



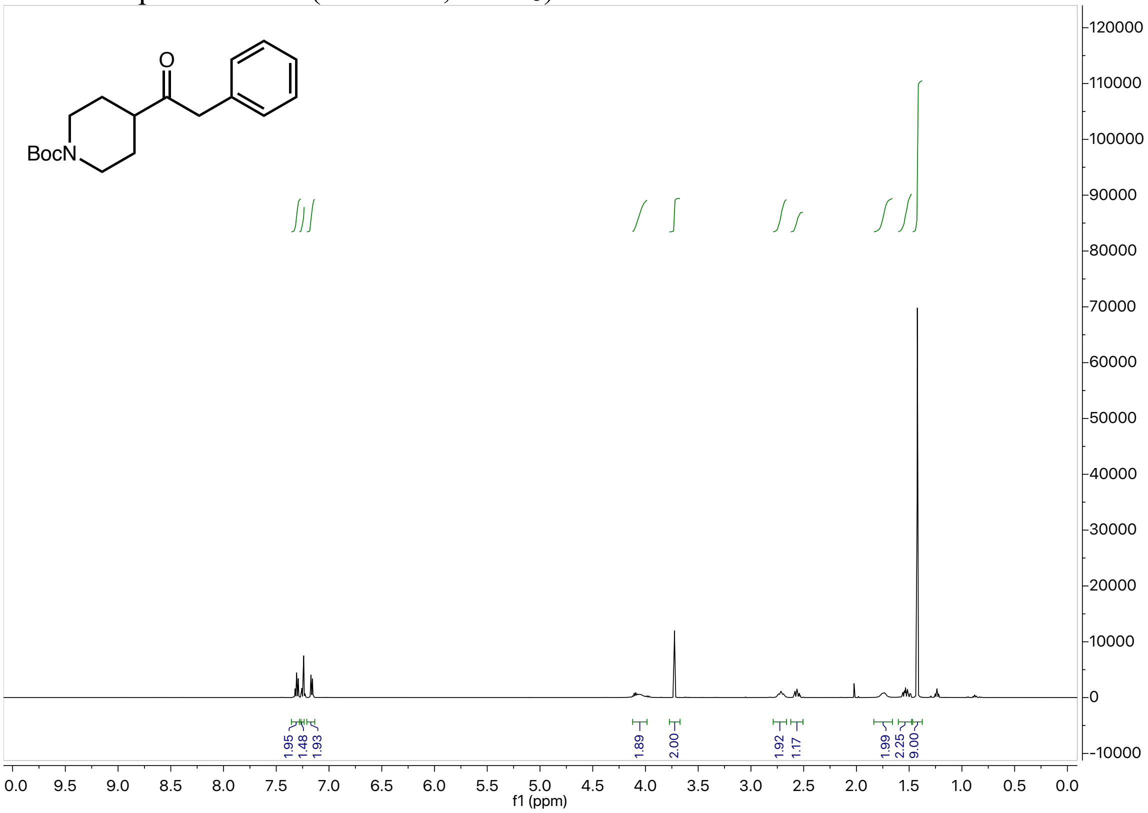
^{1}H NMR spectra of **3l** (500 MHz, CDCl$_3$)



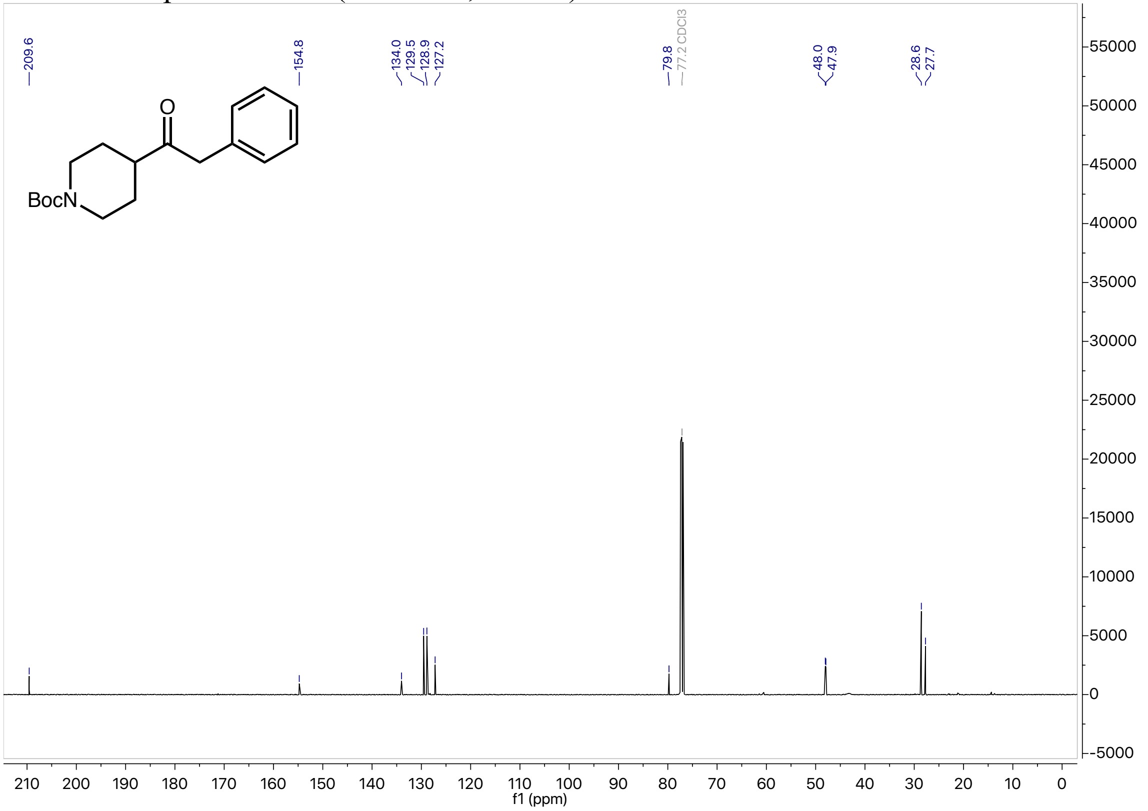
^{13}C NMR spectra of **3l** (126 MHz, CDCl$_3$)



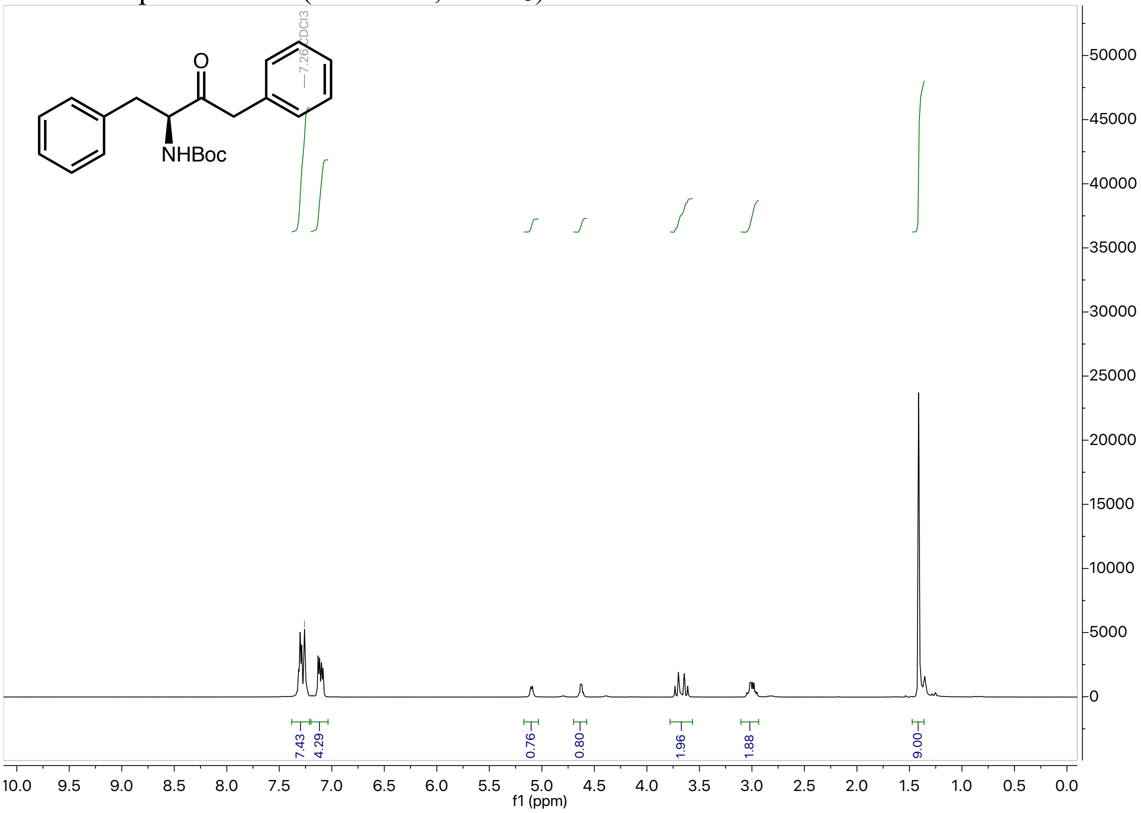
^{1}H NMR spectra of **3m** (500 MHz, CDCl$_3$)



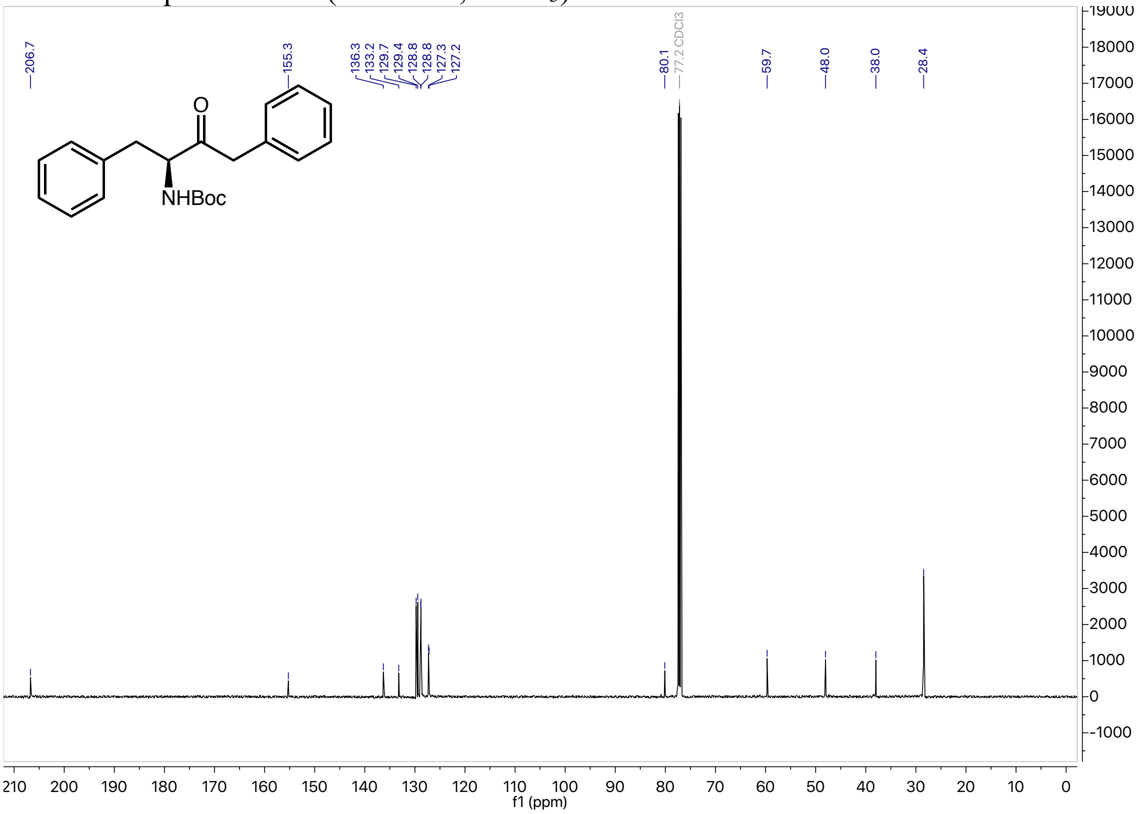
^{13}C NMR spectra of **3m** (126 MHz, CDCl$_3$)



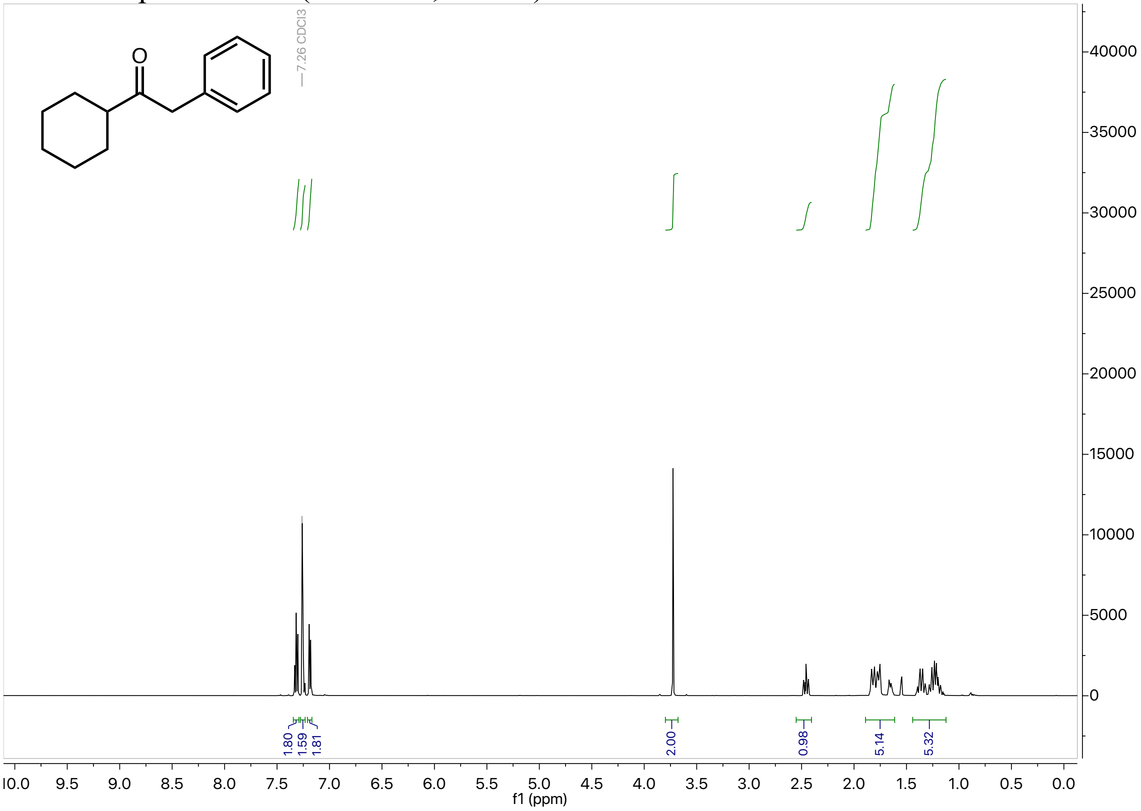
^{1}H NMR spectra of **3n** (500 MHz, CDCl$_3$)



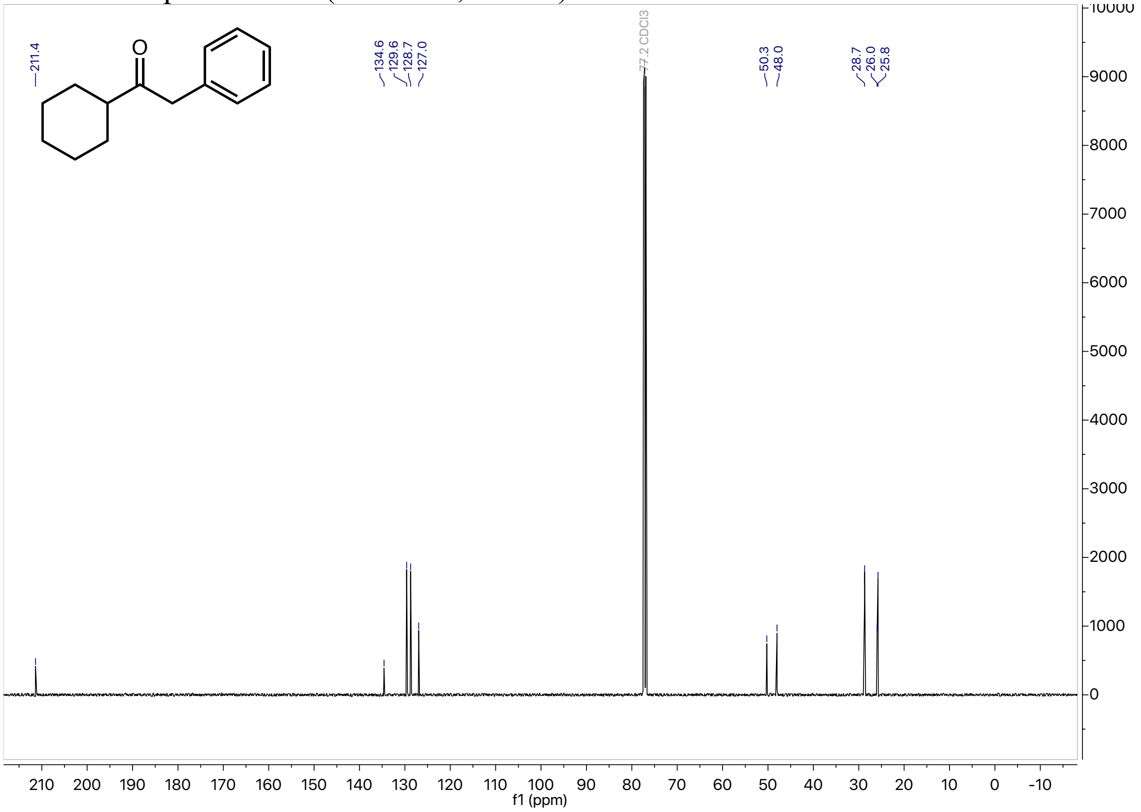
^{13}C NMR spectra of **3n** (126 MHz, CDCl$_3$)



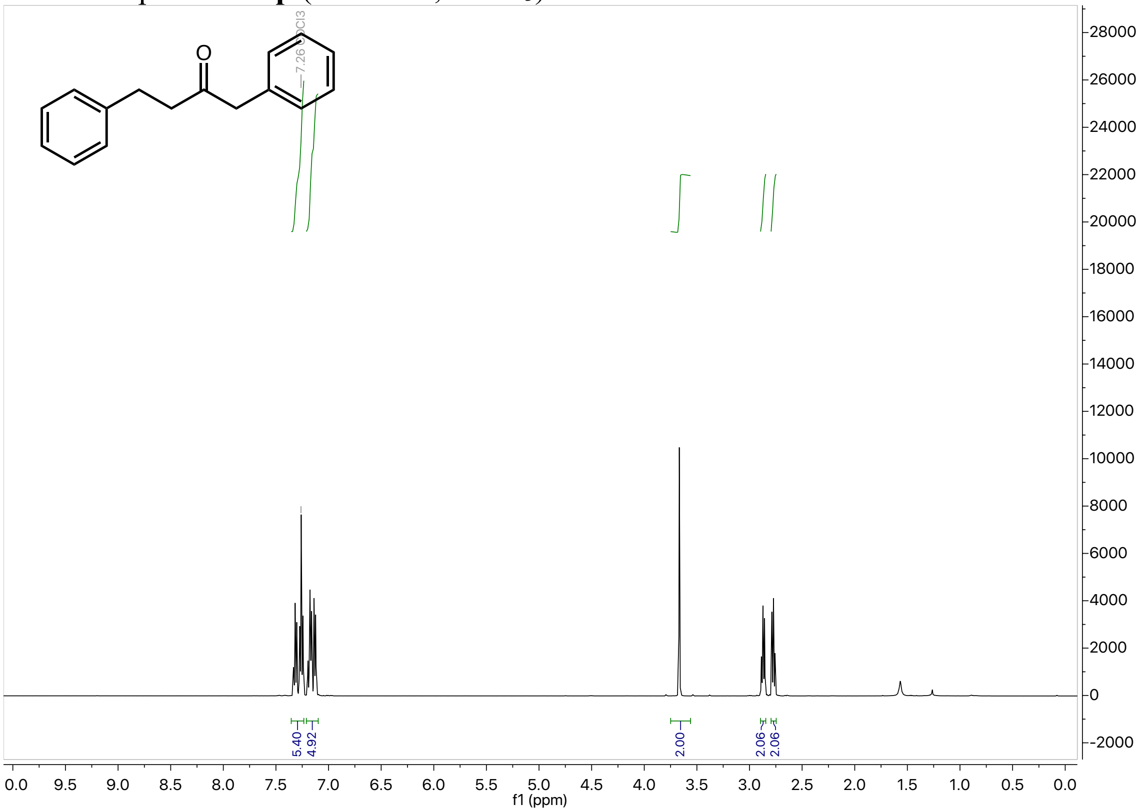
^{1}H NMR spectra of **3o** (500 MHz, CDCl$_3$)



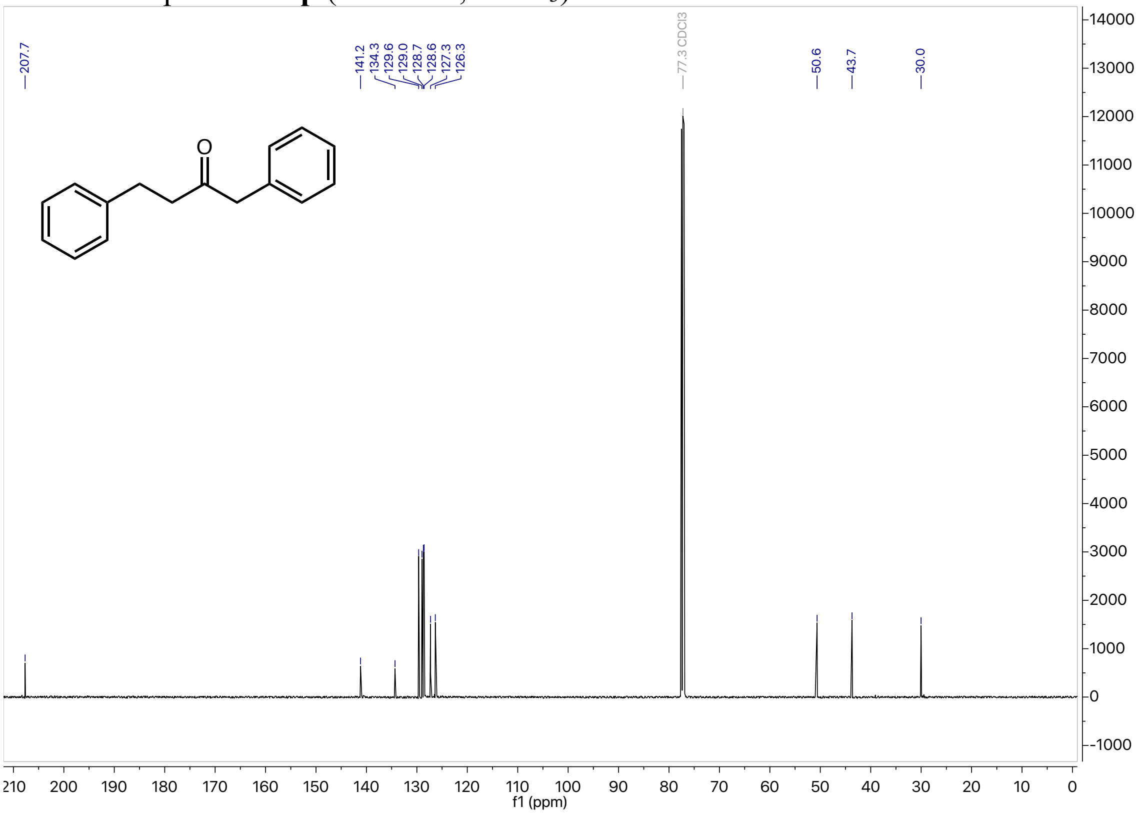
^{13}C NMR spectra of **3o** (126 MHz, CDCl$_3$)



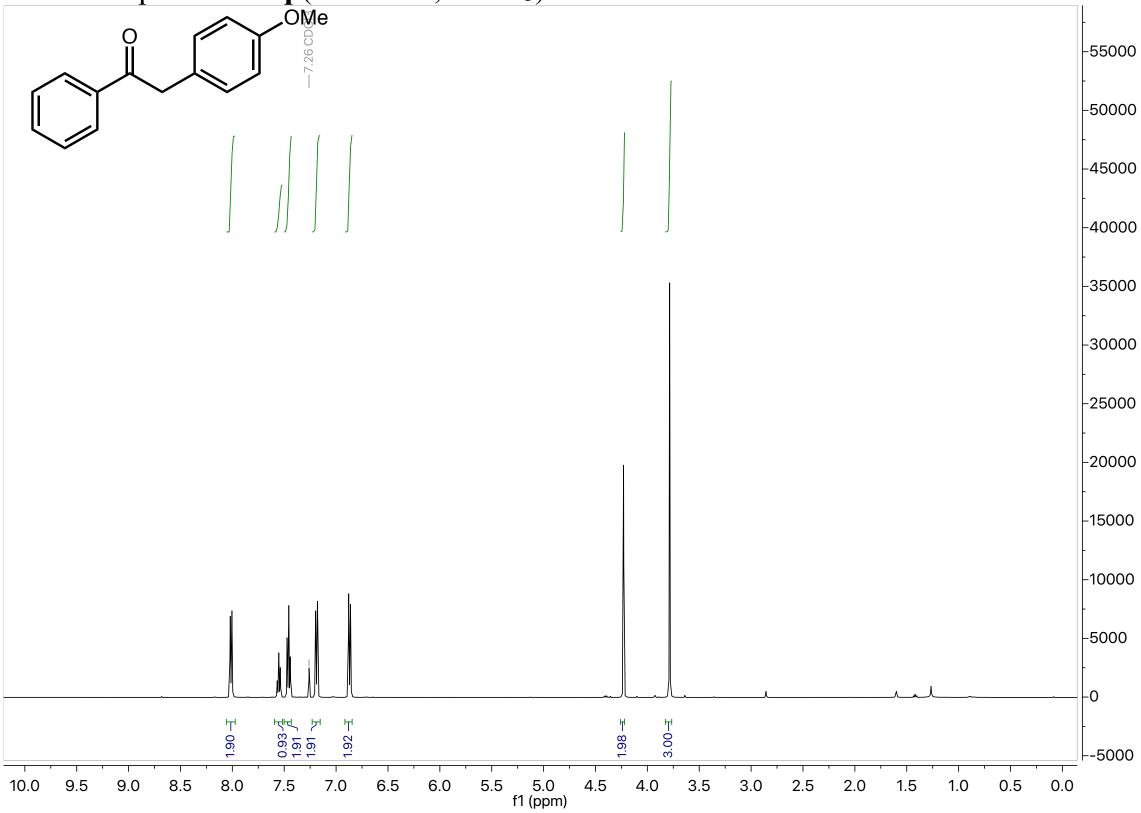
^{1}H NMR spectra of **3p** (500 MHz, $CDCl_3$)



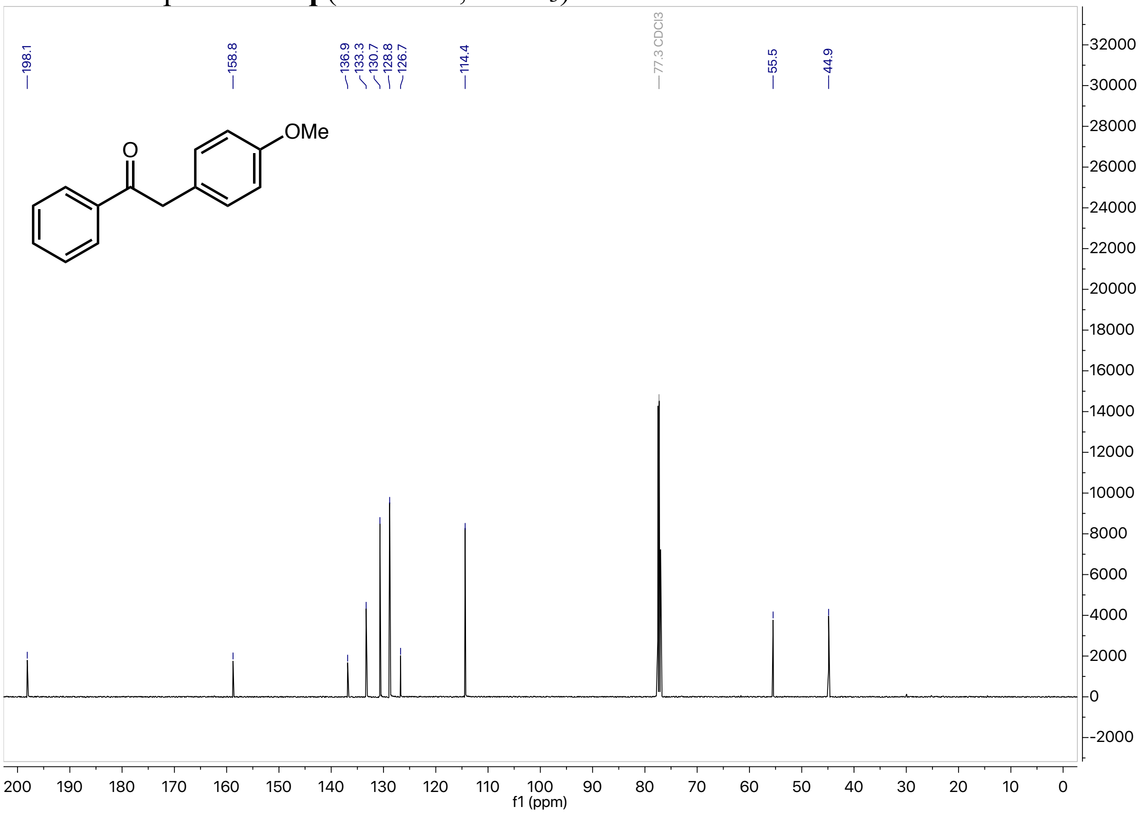
^{13}C NMR spectra of **3p** (126 MHz, $CDCl_3$)



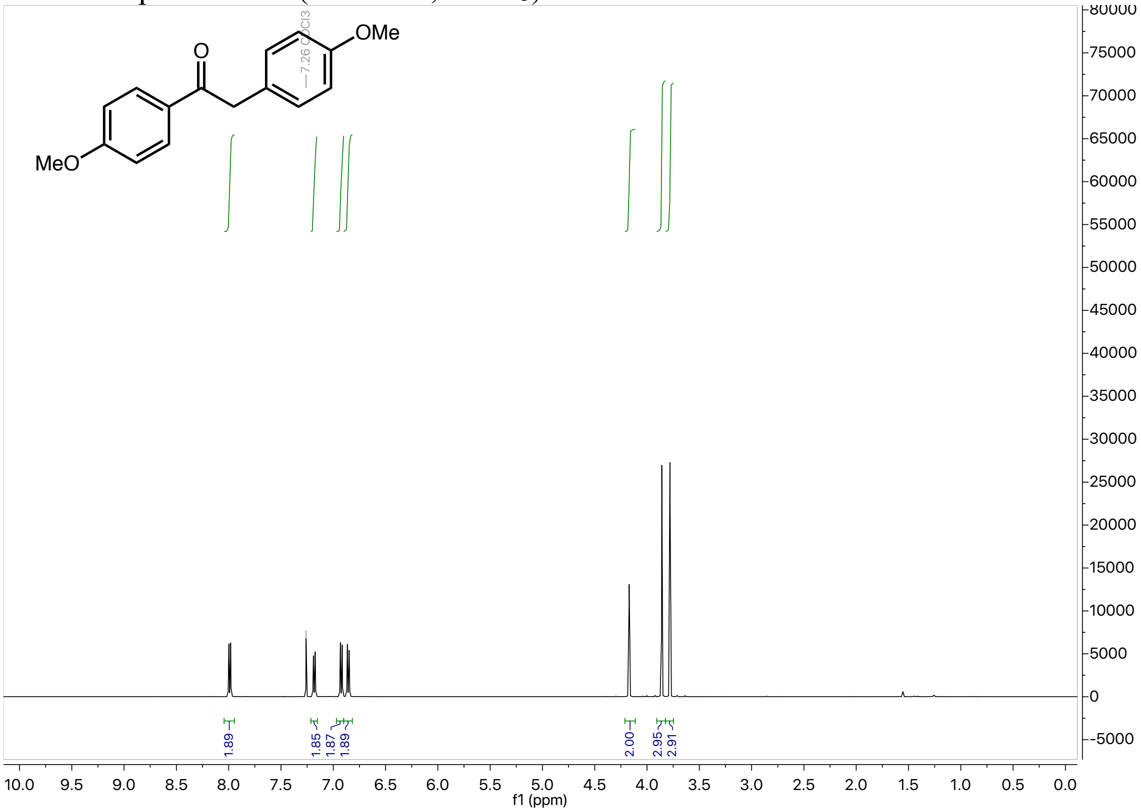
^{1}H NMR spectra of **3q** (500 MHz, $CDCl_3$)



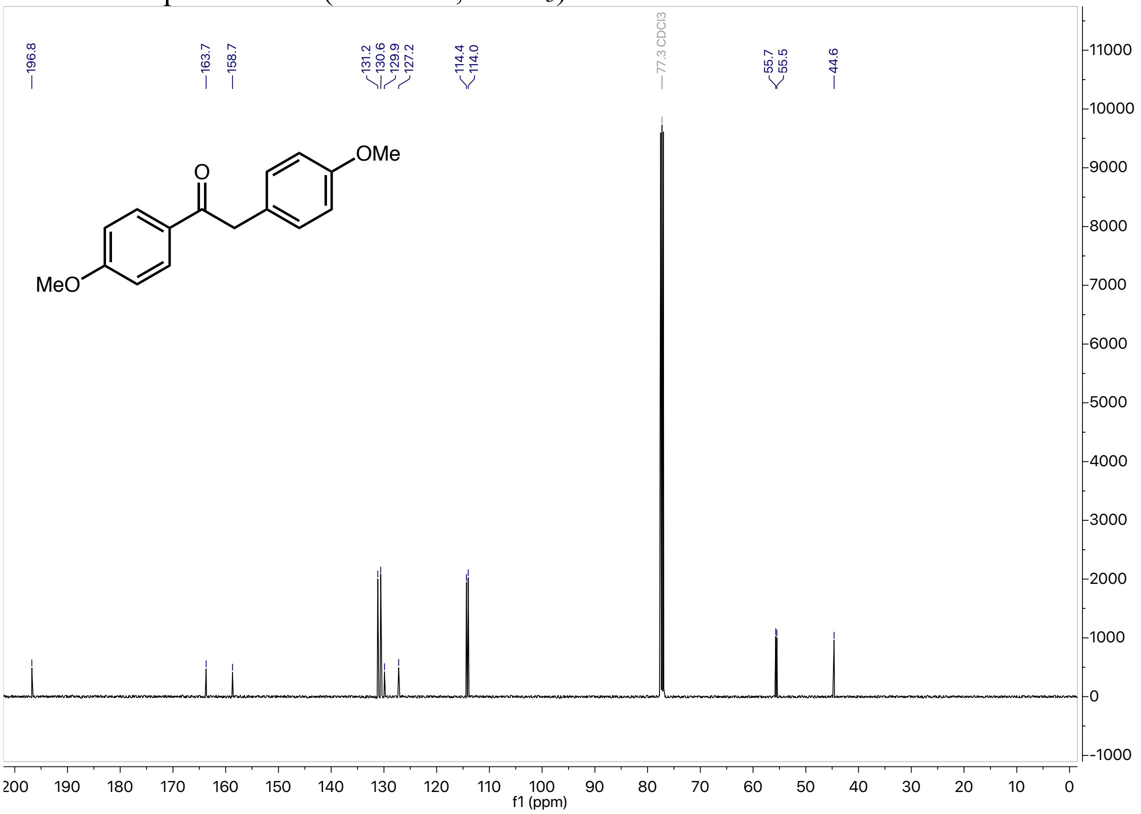
^{13}C NMR spectra of **3q** (126 MHz, $CDCl_3$)



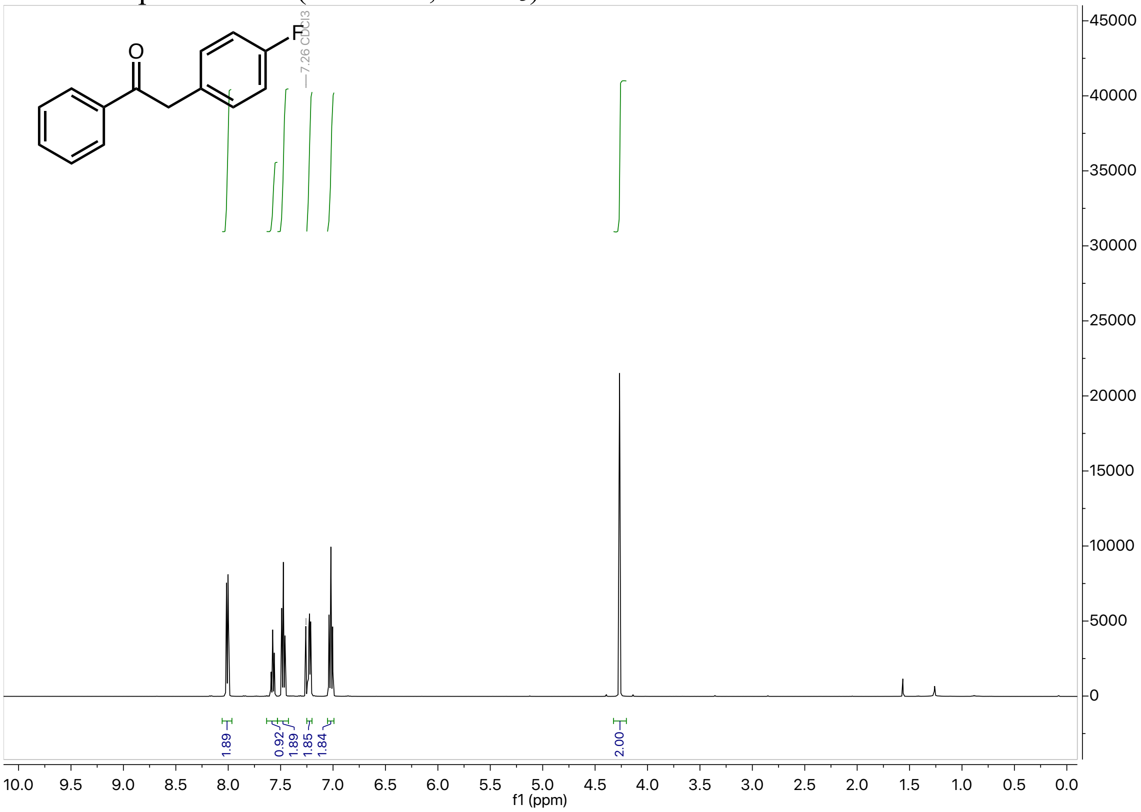
^{1}H NMR spectra of **3r** (500 MHz, $CDCl_3$)



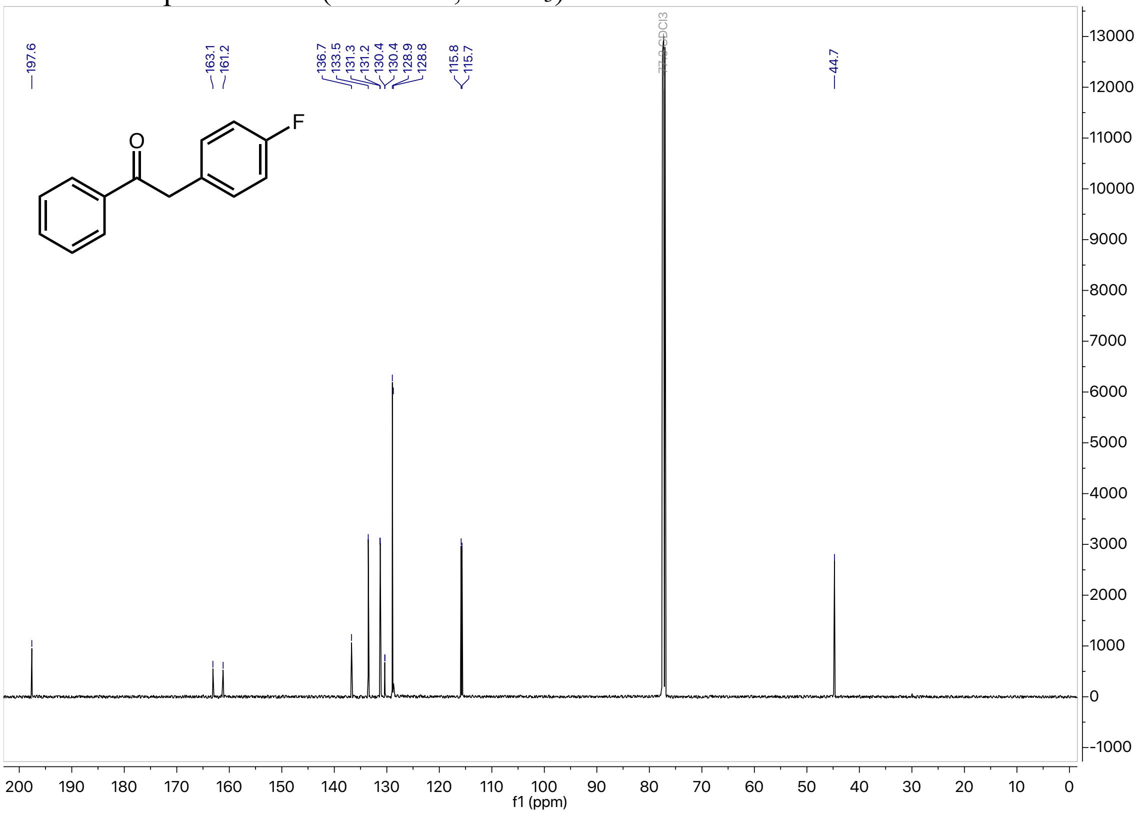
^{13}C NMR spectra of **3r** (126 MHz, $CDCl_3$)



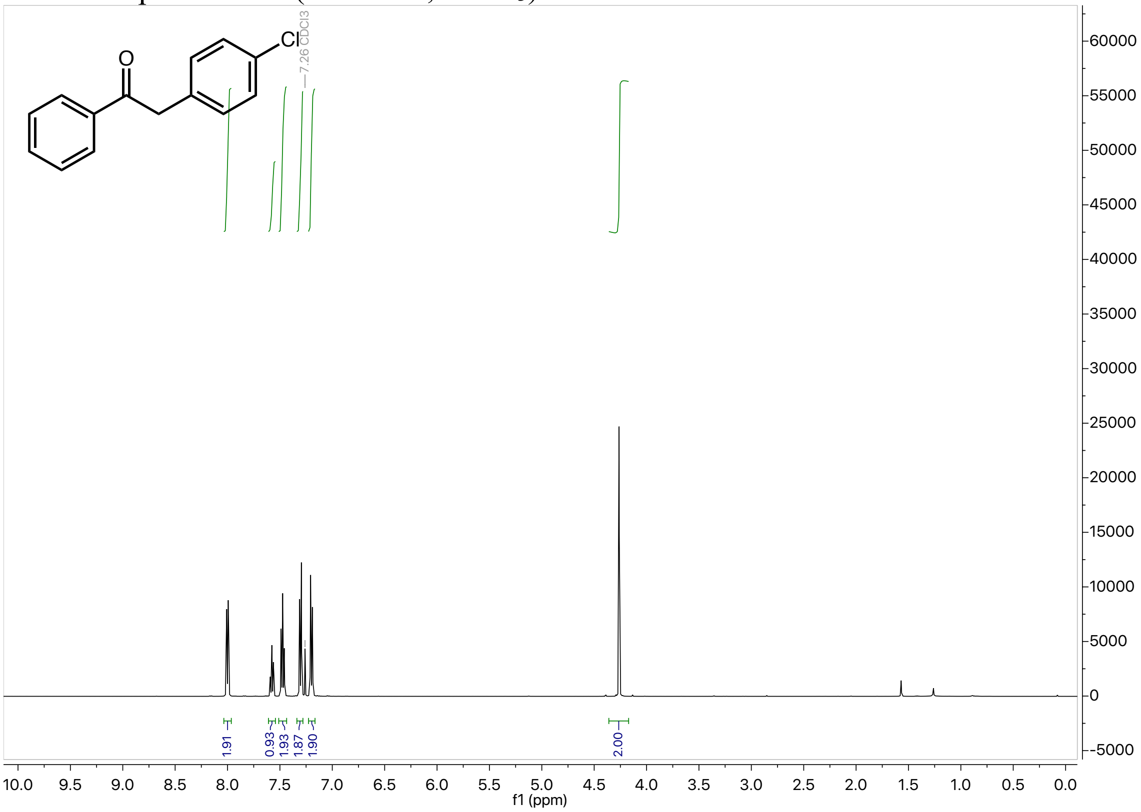
^{1}H NMR spectra of **3s** (500 MHz, CDCl$_3$)



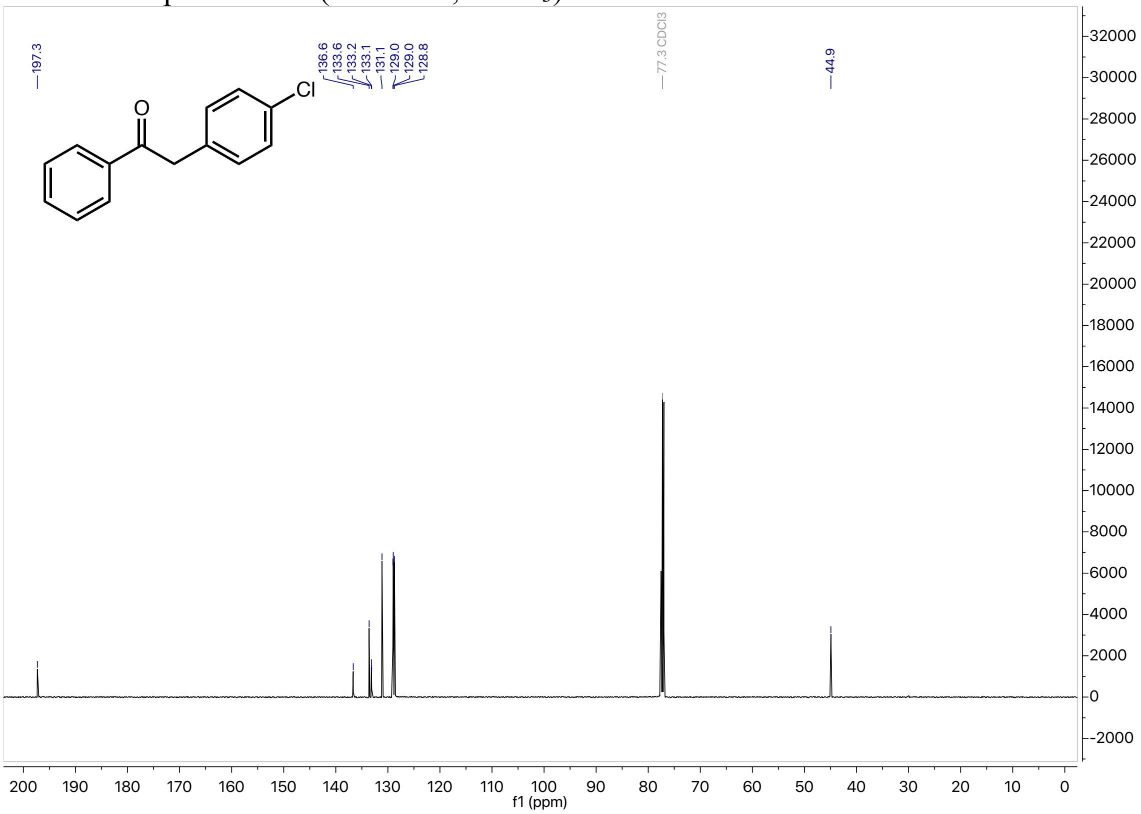
^{13}C NMR spectra of **3s** (126 MHz, CDCl$_3$)



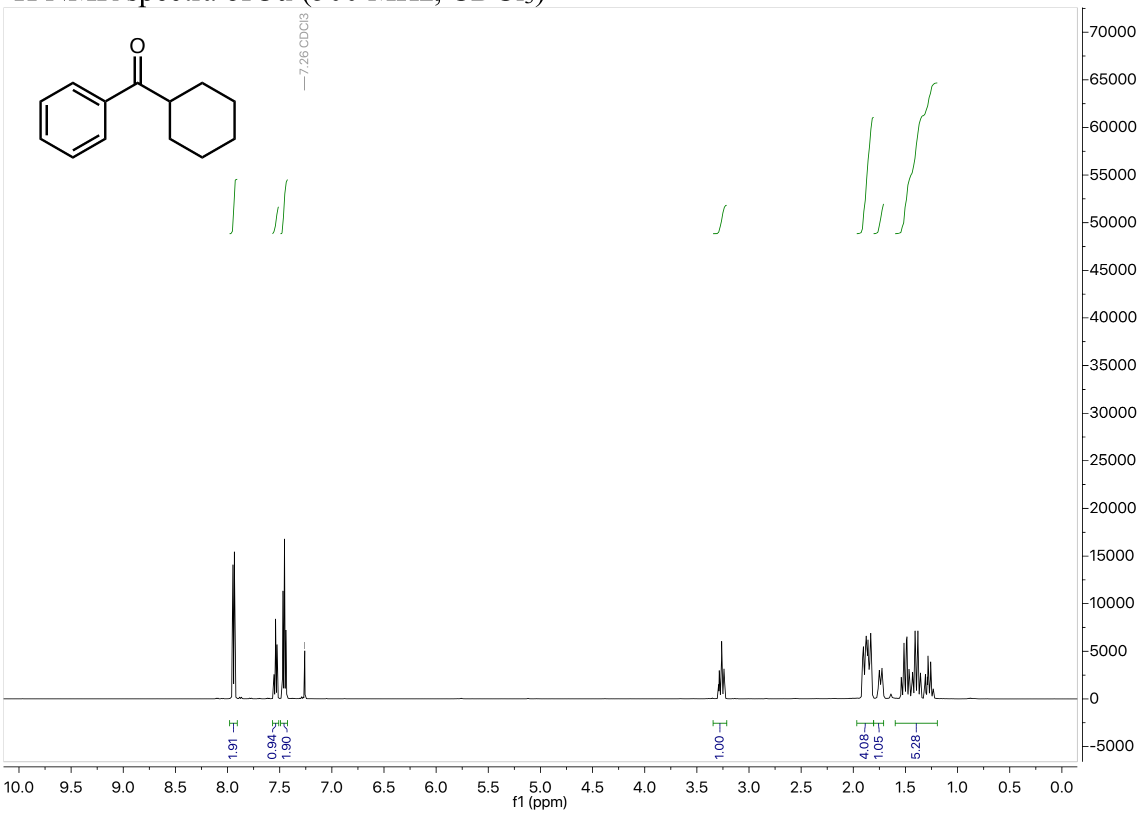
^{1}H NMR spectra of **3t** (500 MHz, $CDCl_3$)



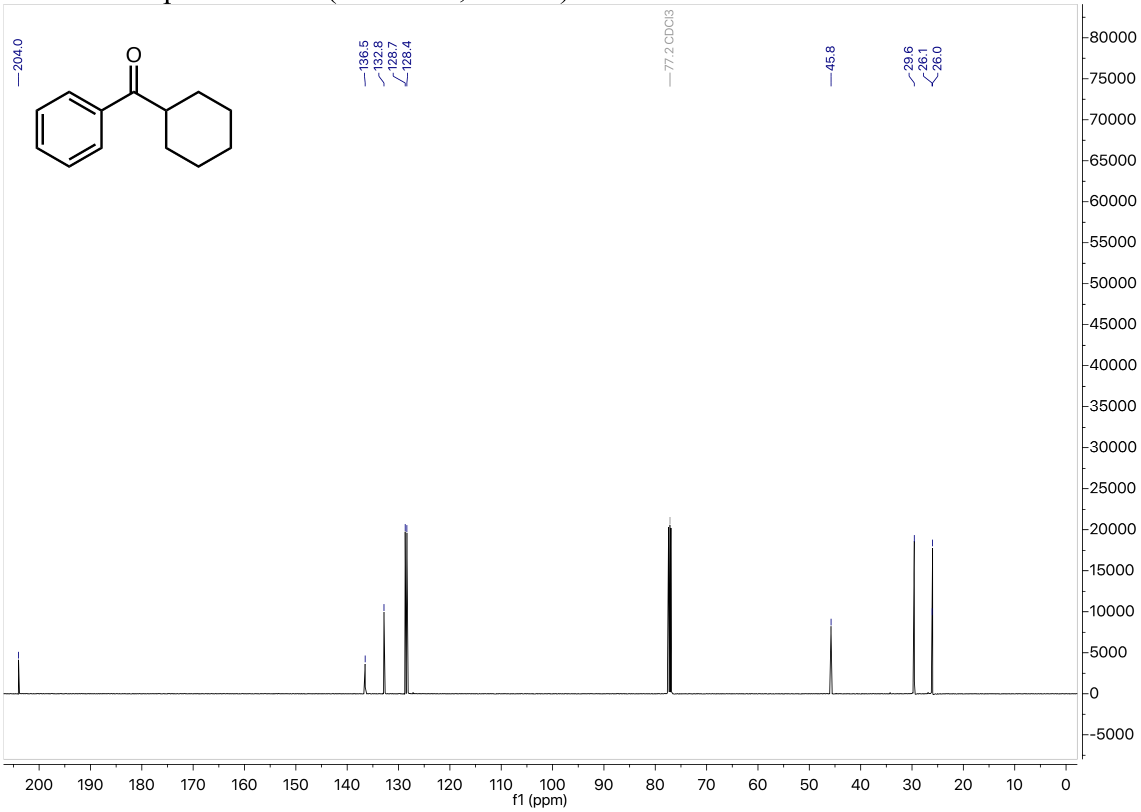
^{13}C NMR spectra of **3t** (126 MHz, $CDCl_3$)



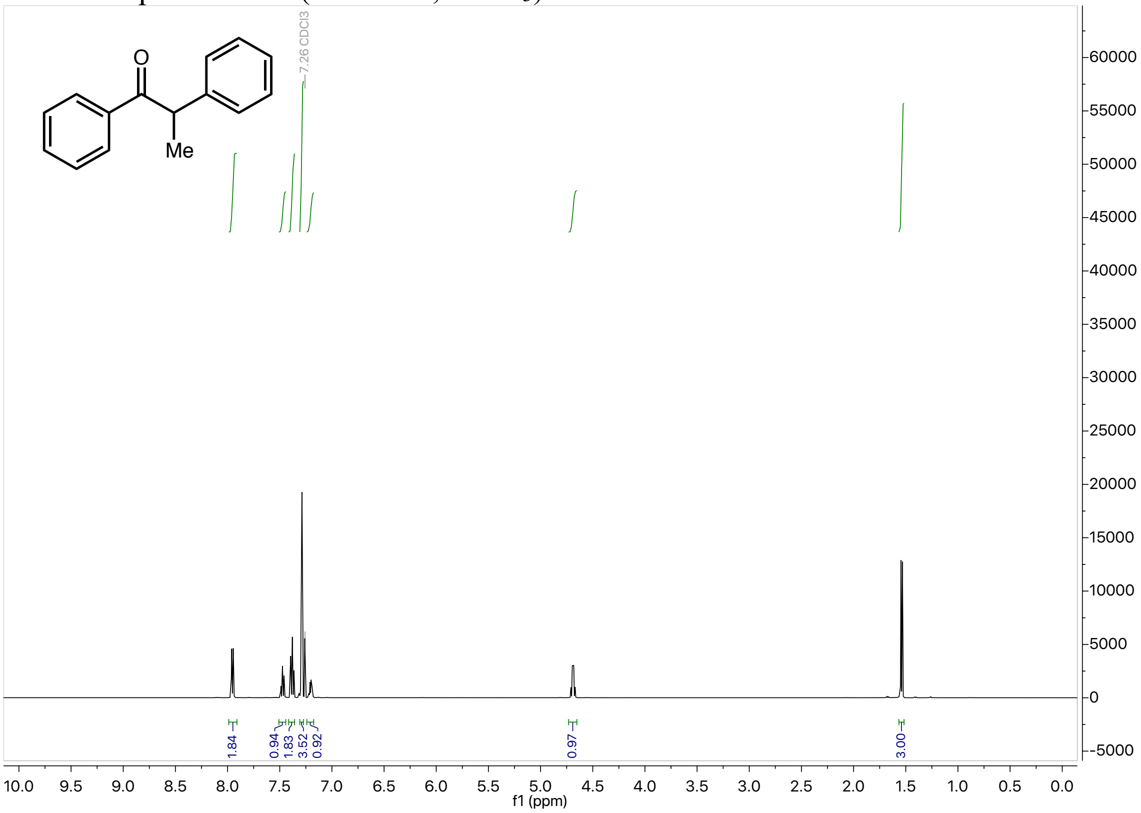
^{1}H NMR spectra of **3u** (500 MHz, $CDCl_3$)



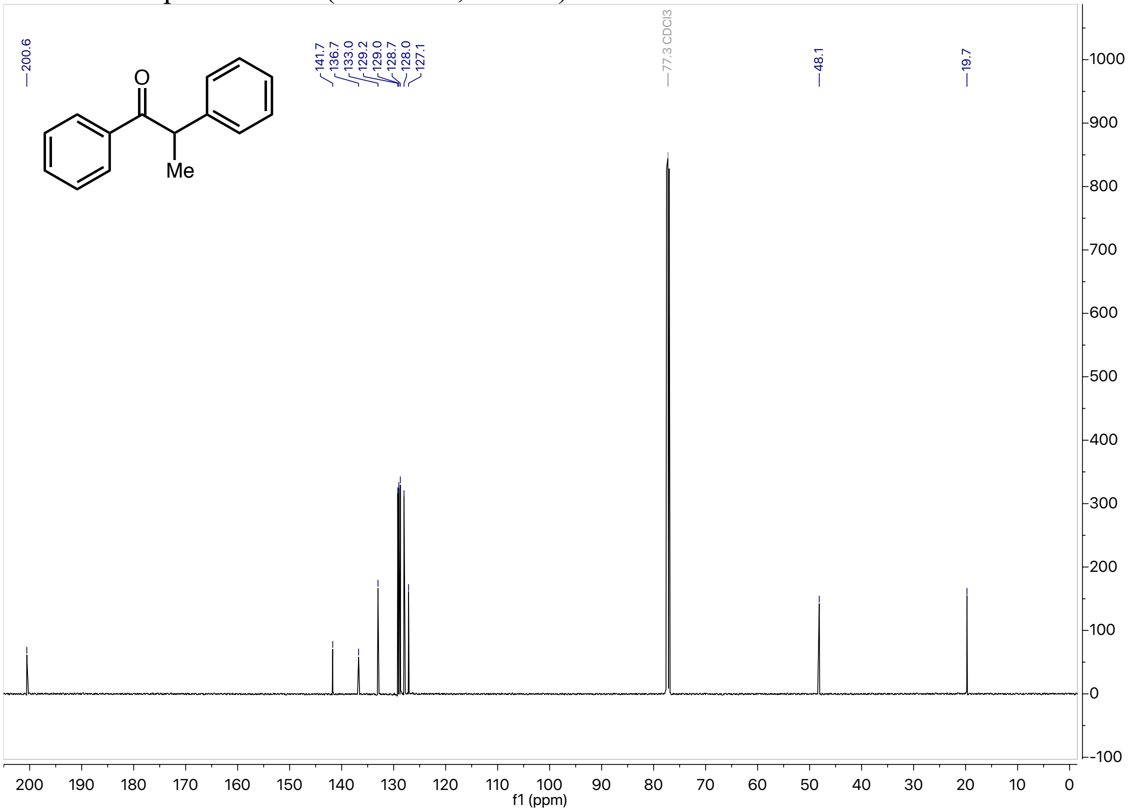
^{13}C NMR spectra of **3u** (126 MHz, $CDCl_3$)



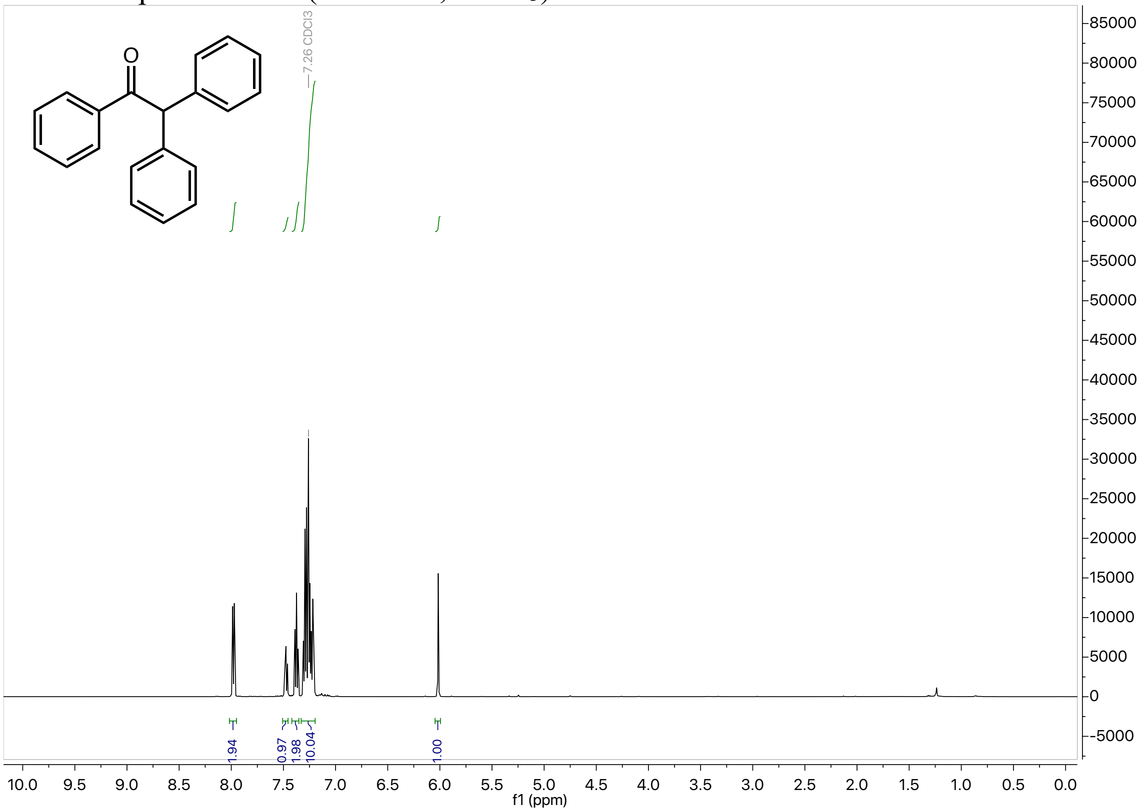
^{1}H NMR spectra of **3v** (500 MHz, CDCl$_3$)



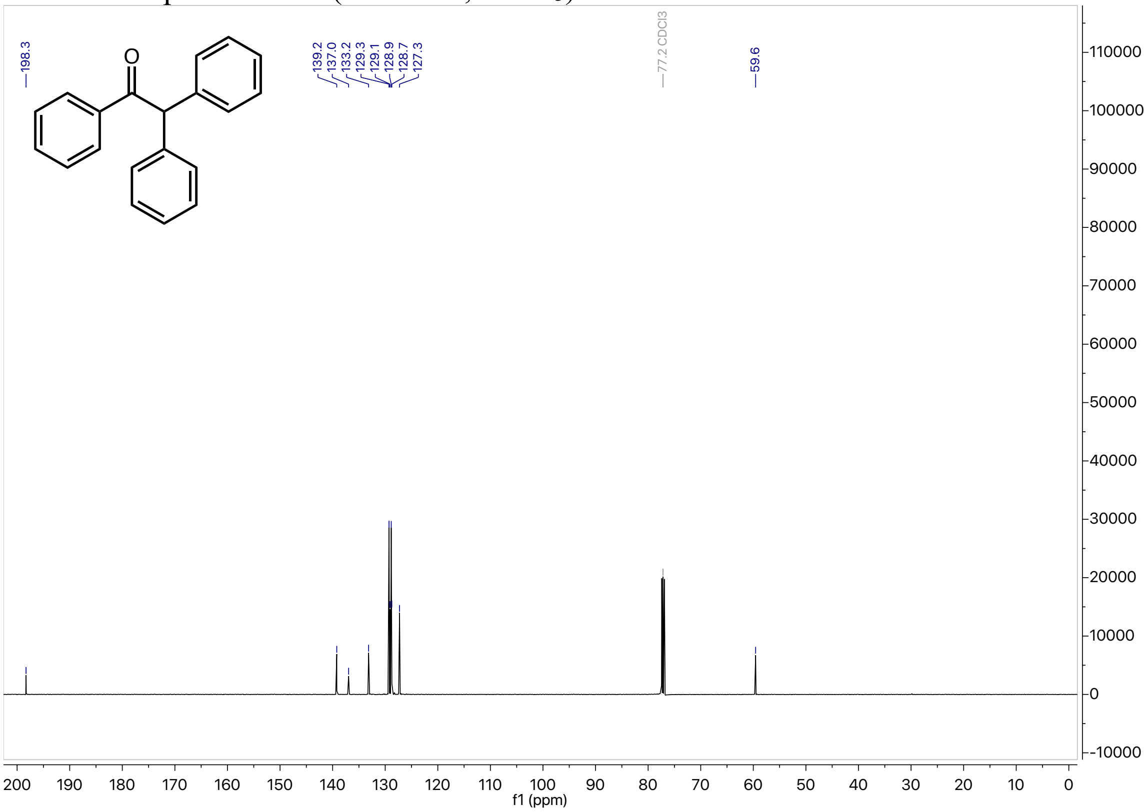
^{13}C NMR spectra of **3v** (126 MHz, CDCl$_3$)



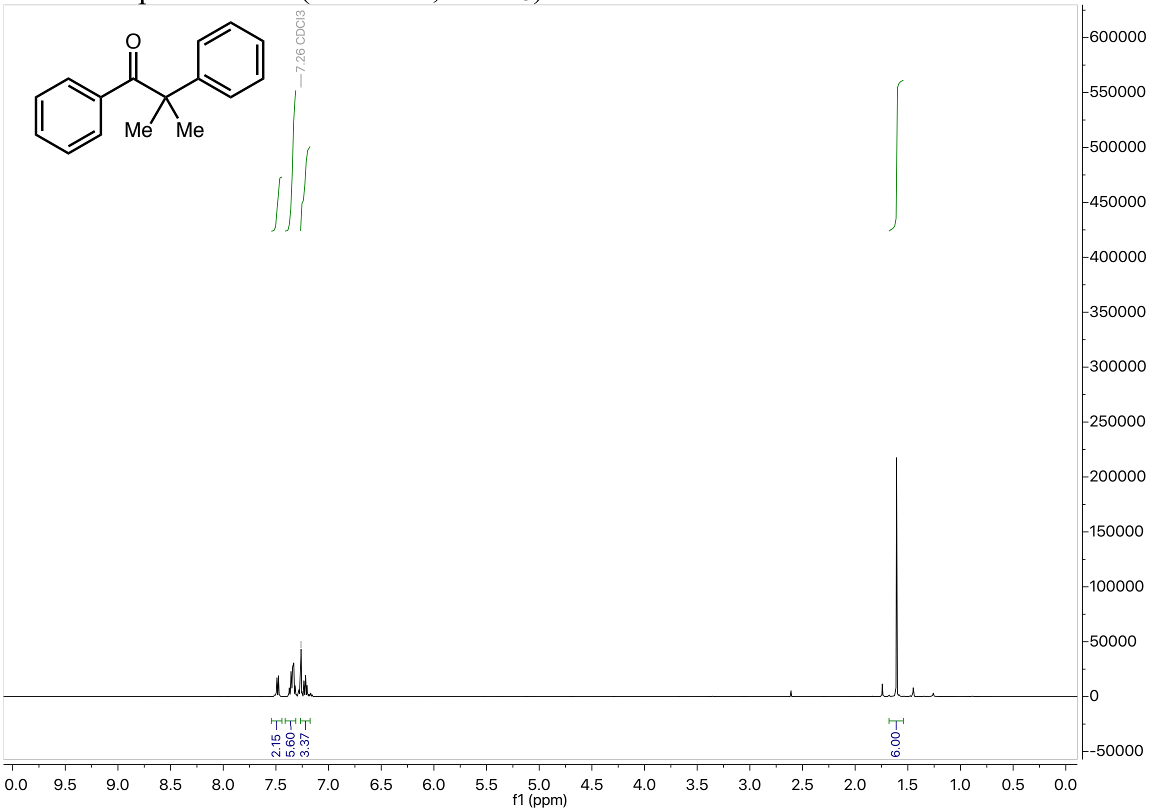
^{1}H NMR spectra of **3w** (500 MHz, CDCl$_3$)



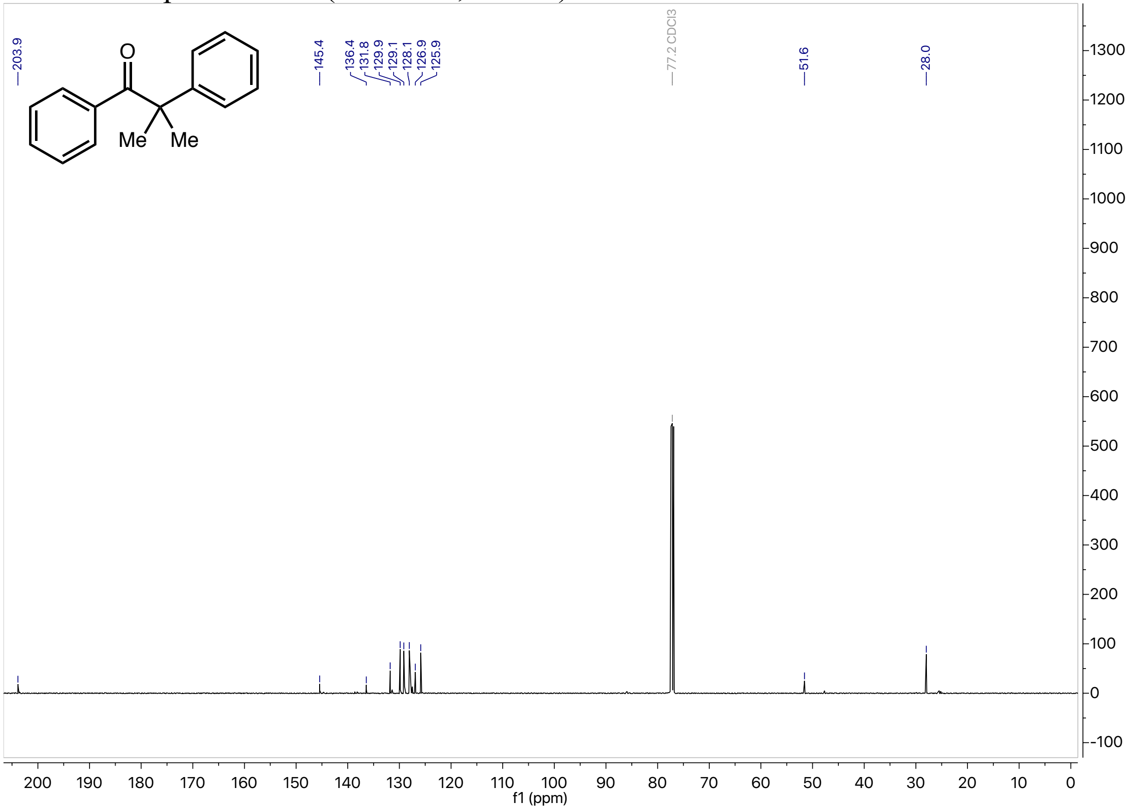
^{13}C NMR spectra of **3w** (126 MHz, CDCl$_3$)



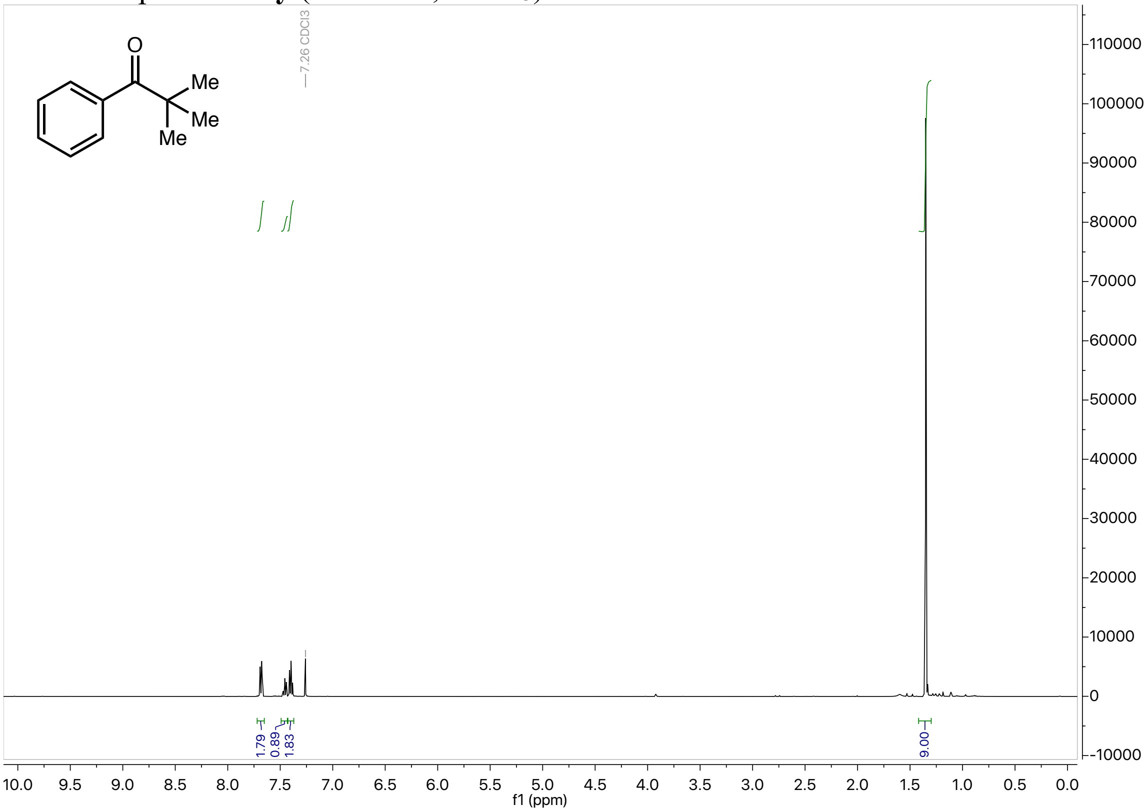
^{1}H NMR spectra of **3x** (500 MHz, CDCl$_3$)



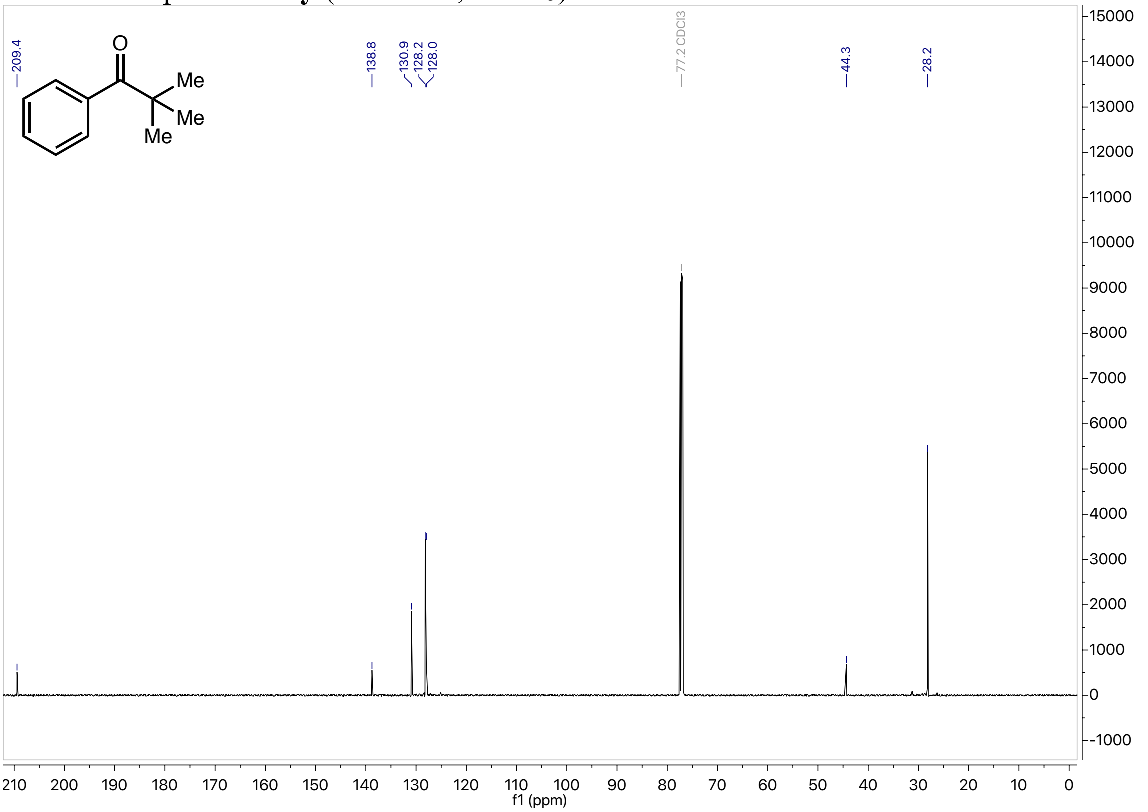
^{13}C NMR spectra of **3x** (126 MHz, CDCl$_3$)



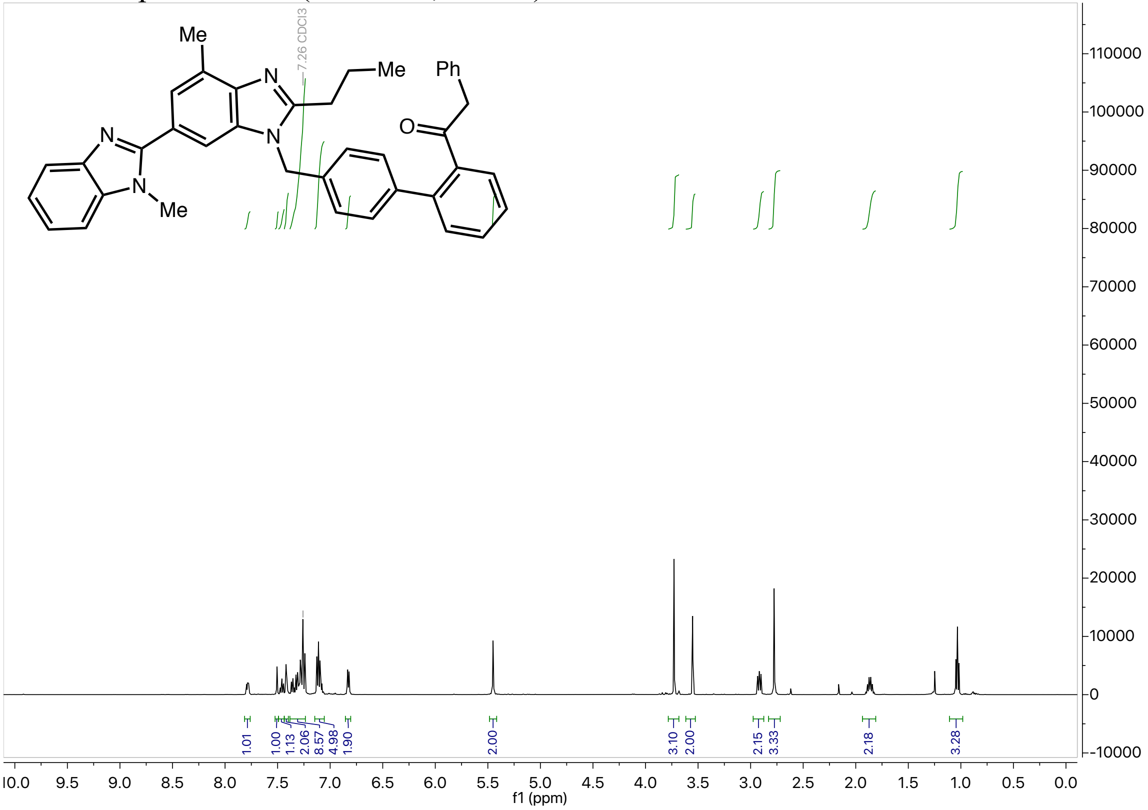
^{1}H NMR spectra of **3y** (500 MHz, $CDCl_3$)



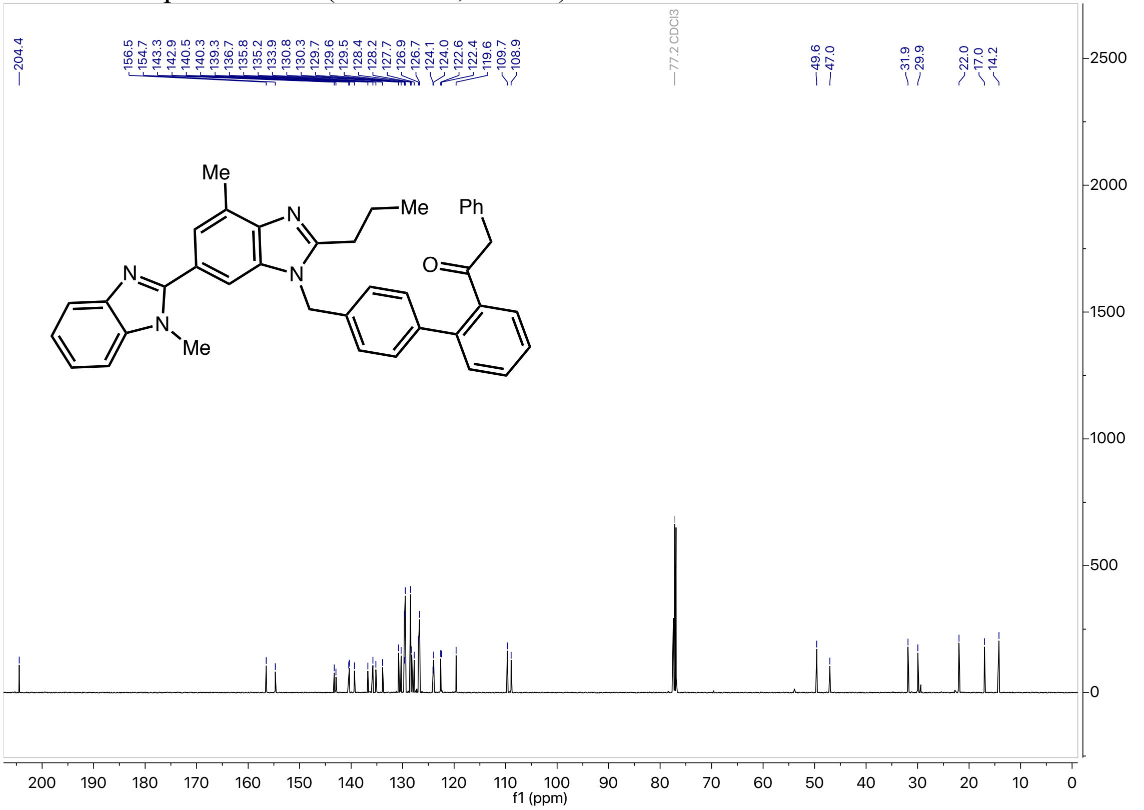
^{13}C NMR spectra of **3y** (126 MHz, $CDCl_3$)



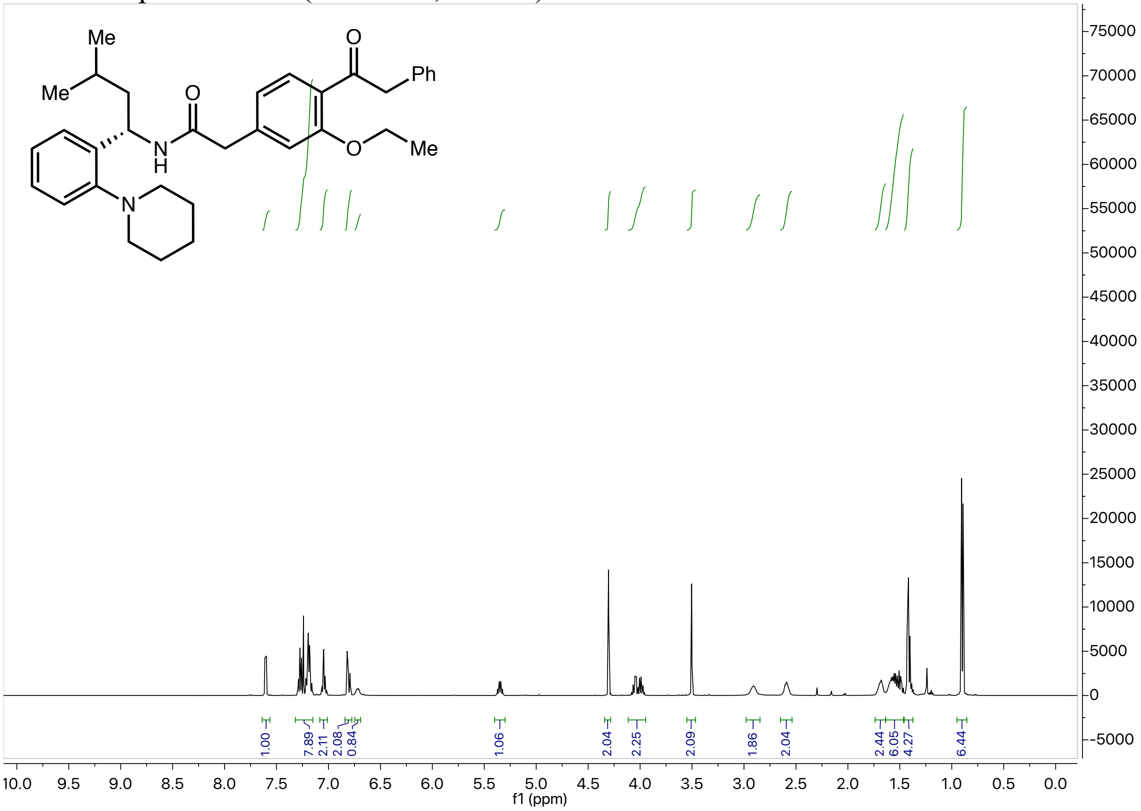
^{1}H NMR spectra of **4a** (500 MHz, CDCl$_3$)



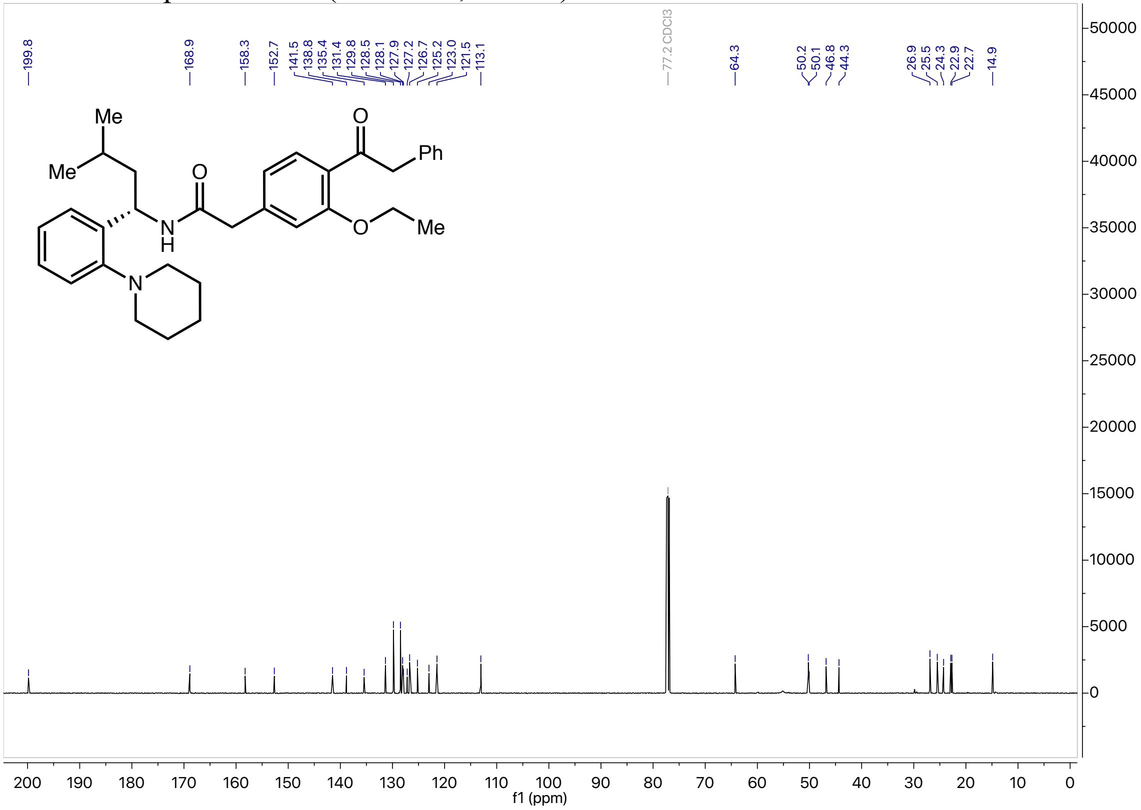
^{13}C NMR spectra of **4a** (126 MHz, CDCl$_3$)



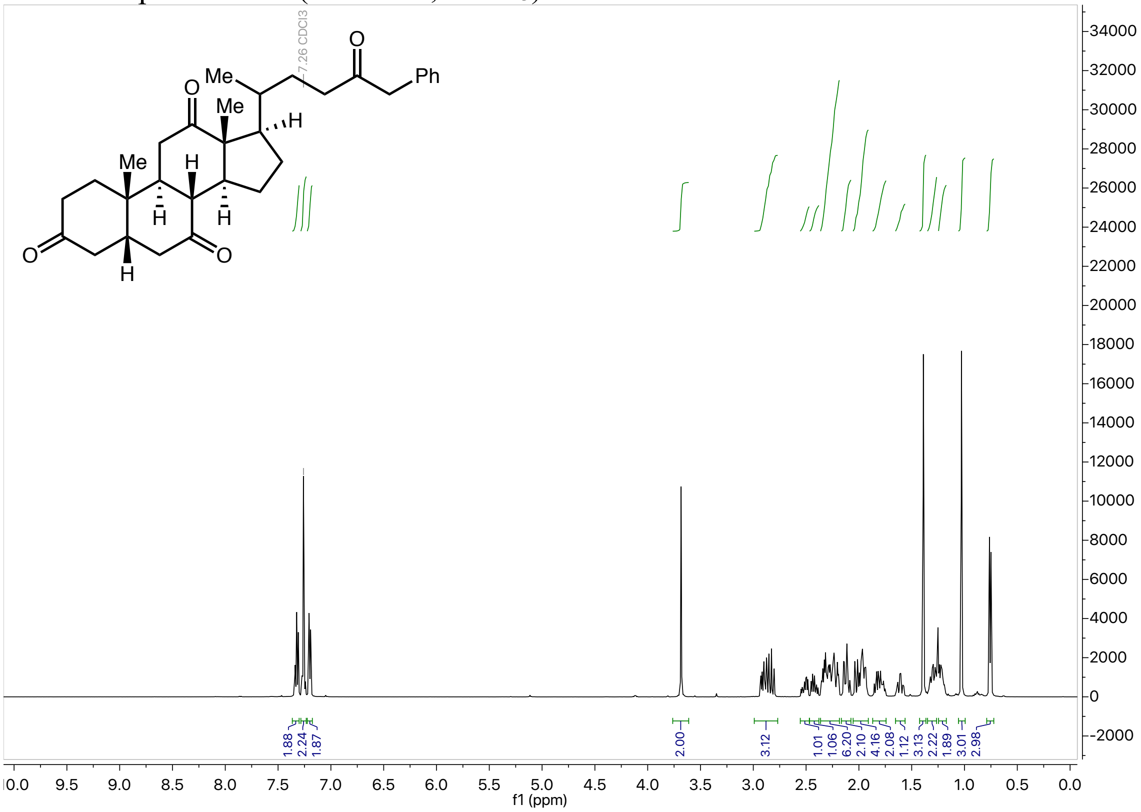
^{1}H NMR spectra of **4b** (500 MHz, CDCl$_3$)



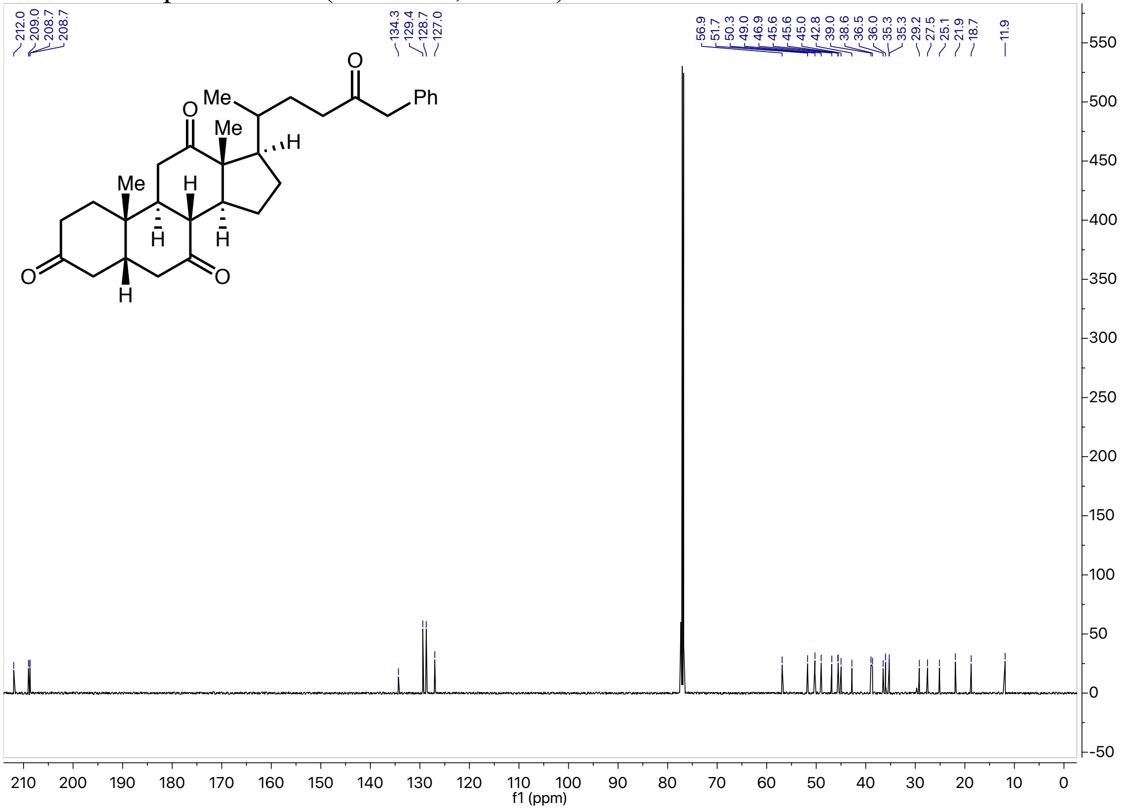
^{13}C NMR spectra of **4b** (126 MHz, CDCl$_3$)



^{1}H NMR spectra of **4c** (500 MHz, $CDCl_3$)



^{13}C NMR spectra of **4c** (126 MHz, $CDCl_3$)



References

1. Monos, T. M.; Sun, A. C.; McAtee, R. C.; Devery, J. J.; Stephenson, C. R. J., Microwave-Assisted Synthesis of Heteroleptic Ir(III)+ Polypyridyl Complexes. *J. Org. Chem.* **2016,** *81*, 6988-6994.
2. Lee, A.; Scheidt, K. A., N-Heterocyclic carbene-catalyzed enantioselective annulations: a dual activation strategy for a formal [4+2] addition for dihydrocoumarins. *Chem. Commun.* **2015,** *51*, 3407-3410.
3. Nakajima, K.; Nojima, S.; Sakata, K.; Nishibayashi, Y., Visible-Light-Mediated Aromatic Substitution Reactions of Cyanoarenes with 4-Alkyl-1,4-dihydropyridines through Double Carbon–Carbon Bond Cleavage. *ChemCatChem* **2016,** *8*, 1028-1032.
4. Gandolfo, E.; Tang, X.; Raha Roy, S.; Melchiorre, P., Photochemical Asymmetric Nickel-Catalyzed Acyl Cross-Coupling. *Angew. Chem. Int. Ed.* **2019,** *58*, 16854-16858.
5. Chen, W.; Liu, Z.; Tian, J.; Li, J.; Ma, J.; Cheng, X.; Li, G., Building Congested Ketone: Substituted Hantzsch Ester and Nitrile as Alkylation Reagents in Photoredox Catalysis. *J. Am. Chem. Soc.* **2016,** *138*, 12312-12315.
6. Zhao, B.; Lu, X., Cationic Palladium(II)-Catalyzed Addition of Arylboronic Acids to Nitriles. One-Step Synthesis of Benzofurans from Phenoxyacetonitriles. *Org. Lett.* **2006,** *8*, 5987-5990.
7. Miao, T.; Wang, G.-W., Synthesis of ketones by palladium-catalysed desulfitative reaction of arylsulfinic acids with nitriles. *Chem. Commun.* **2011,** *47*, 9501-9503.
8. Bechara, W. S.; Pelletier, G.; Charette, A. B., Chemoselective synthesis of ketones and ketimines by addition of organometallic reagents to secondary amides. *Nat. Chem.* **2012,** *4*, 228-234.
9. Huang, K.; Li, G.; Huang, W.-P.; Yu, D.-G.; Shi, Z.-J., Arylation of α-pivaloxyl ketones with arylboronic reagents viaNi-catalyzed sp3 C–O activation. *Chem. Commun.* **2011,** *47*, 7224-7226.
10. Wong, Y.-C.; Parthasarathy, K.; Cheng, C.-H., Direct Synthesis of Arylketones by Nickel-Catalyzed Addition of Arylboronic Acids to Nitriles. *Org. Lett.* **2010,** *12*, 1736-1739.
11. Abdel-Motaleb, R. M.; Makhloof, A.-M. A.-S.; Ibrahim, H. M.; Elnagdi, M. H., Studies with azoles and benzoazoles: A novel simple approach for synthesis of 3-functionally substituted 3-acylindoles. *J. Heterocycl. Chem.* **2007,** *44*, 109-114.
12. Astarloa, I.; SanMartin, R.; Herrero, M. T.; Domínguez, E., Aqueous α-Arylation of Mono- and Diarylethanone Enolates at Low Catalyst Loading. *Adv. Synth. Catal.* **2018,** *360*, 1711-1718.
13. Gao, K.; Yorimitsu, H.; Osuka, A., α-Arylation of Ketimines with Aryl Sulfides at a Low Palladium Catalyst Loading. *Angew. Chem. Int. Ed.* **2016,** *55*, 4573-4576.
14. Zhao, C.; Jia, X.; Wang, X.; Gong, H., Ni-Catalyzed Reductive Coupling of Alkyl Acids with Unactivated Tertiary Alkyl and Glycosyl Halides. *J. Am. Chem. Soc.* **2014,** *136*, 17645-17651.
15. Chen, X.; Chen, Z.; So, C. M., Exploration of Aryl Phosphates in Palladium-Catalyzed Mono-α-arylation of Aryl and Heteroaryl Ketones. *J. Org. Chem.* **2019,** *84*, 6337-6346.
16. Doherty, S.; Knight, J. G.; Smyth, C. H.; Harrington, R. W.; Clegg, W., Biaryl-Like CATPHOS Diphosphines via Double Diels–Alder Cycloaddition between 1,4-Bis(diphenylphosphinoyl)buta-1,3-diyne and Anthracenes: Efficient Ligands for the Palladium-Catalyzed Amination of Aromatic Bromides and α-Arylation of Ketones. *Organometallics* **2008,** *27*, 1679-1682.
17. Wu, X.-F.; Schranck, J.; Neumann, H.; Beller, M., Palladium-Catalyzed Carbonylative Negishi-type Coupling of Aryl Iodides with Benzyl Chlorides. *Chem. –Asian J.* **2012,** *7*, 40-44.

18. Takemiya, A.; Hartwig, J. F., Palladium-Catalyzed Synthesis of Aryl Ketones by Coupling of Aryl Bromides with an Acyl Anion Equivalent. *J. Am. Chem. Soc.* **2006,** *128*, 14800-14801.
19. Li, Z.; Gevorgyan, V., Double Duty for Cyanogen Bromide in a Cascade Synthesis of Cyanoepoxides. *Angew. Chem. Int. Ed.* **2011,** *50*, 2808-2810.
20. Ishii, T.; Kakeno, Y.; Nagao, K.; Ohmiya, H., N-Heterocyclic Carbene-Catalyzed Decarboxylative Alkylation of Aldehydes. *J. Am. Chem. Soc.* **2019,** *141*, 3854-3858.