Supporting information

Transition-metal-free chemoselective reduction of α, β-unsaturated ketones using H_2O as hydrogen sources

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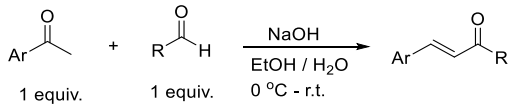
1. General information

All reactions were carried out under air atmosphere unless otherwise noted. Column chromatography was performed using silica gel (200-300 mesh). ^{1}H NMR and ^{13}C NMR spectra were recorded on Bruker-AV (400 and 100 MHz, respectively) instrument using $CDCl_3$ as solvent and TMS as an internal standard. Mass spectra were measured on Agilent 5977 GC-MS instrument (EI). The structures of known compounds were further corroborated by comparing their ^{1}H NMR, ^{13}C NMR data and MS data with those of literature.

2. General procedure for preparation of substrates

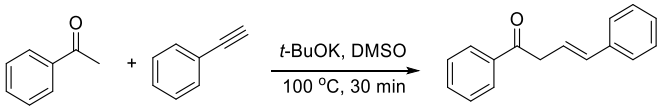
Substrates **1a**, **1ac** - **1aj** were purchased from commercial sources; **1b** – **1ab** were prepared from the corresponding aldehydes and ketones according to the literature; while **1ak** were prepared as reported in respective literature.

Preparation of the α, β-unsaturated ketones[1]:



To a solution of ketone (10 mmol, 1.0 equiv.) in 6 mL ethanol was added a solution of NaOH (520 mg, 13 mmol, 1.3 equiv.) in water (10 mL), then the corresponding aldehyde (10 mmol, 1.0 equiv.) was added gradually at 0 °C. The mixture was then allowed to warm to room temperature and stirred overnight. The solid product was collected by suction filtration on a Buchner funnel and washed repeatedly with cold water. Recrystallization from ethanol or purification by silica gel chromatography for liquid products.

Preparation of 1ak[2]:

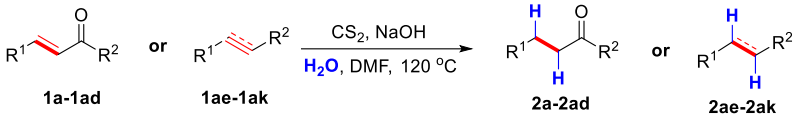


To a solution of acetophenone (2 g, 16.64 mmol, 1 equiv.) and phenyl acetylene (1.83 mL, 16.64 mmol) in DMSO (42 mL) was added *t*-BuOK (1.87 g, 16.64 mmol). The resulting solution was stirred at 100 °C for 0.5 h. The reaction mixture was cooled to room temperature, and the reaction was quenched with the addition of a saturated aqueous NH_4Cl solution (50 mL). The reaction mixture was extracted with EtOAc (50 mL×2). The combined organic solution was washed with brine (25 mL), dried over $MgSO_4$ and concentrated in vacuo to give crude residue. The resulting

residue was purified by flash chromatography to yield **1am** as a white solid (3 g, 82% yield).

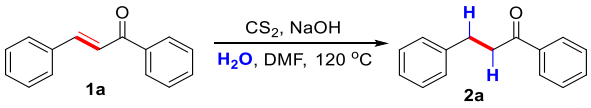
3. General experimental procedure

General Procedure for Chemoselective Reduction Unsaturated Compounds.



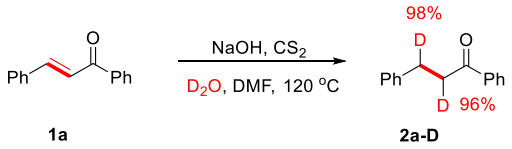
unsaturated compound **1** (0.2 mmol), NaOH (8.0 mg, 0.2 mmol) and CS_2 (42 μL, 0.7 mmol) were added to a reaction vessel (10 mL). *N*, *N*-dimethylacetamide (1.0 mL) and H_2O (20 μL) was added by syringe. The reaction was stirred in the oil bath at 120 °C under air for 12 h. After cooling to room temperature, the reaction mixture was diluted with ethyl acetate (15.0 mL) and washed by saturated sodium chloride solution. The organic layer was separated and the aqueous layer was extracted with ethyl acetate for three times. The combined organic layer was dried over $MgSO_4$ and the volatiles were removed under reduced pressure. The resulting mixture was purified by column chromatography on silica gel (eluted with EtOAc/PE) to afford the desired product.

Gram scale synthesis of 2a



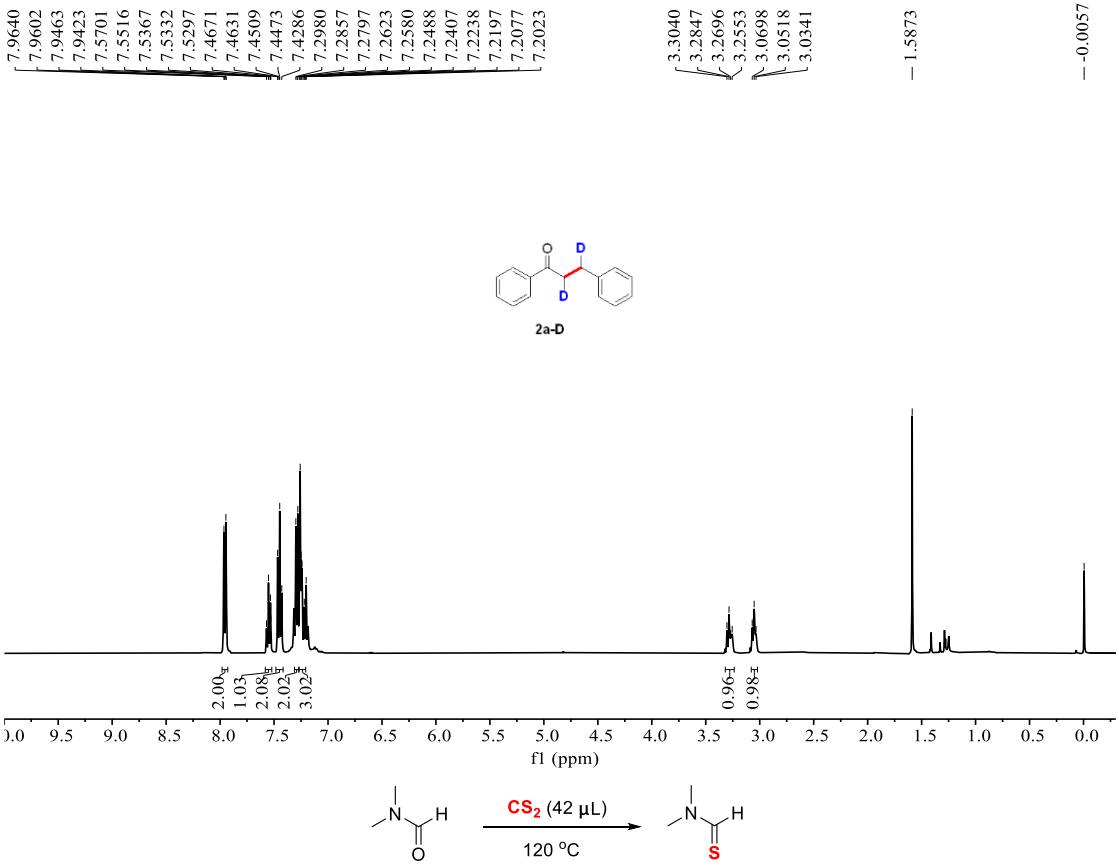
(*E*)-chalcone **1a** (1.04 g, 5 mmol), NaOH (200 mg, 5 mmol) and CS_2 (1.05 mL, 17.5 mmol) were added to a round-bottom flask (100 mL). *N*, *N*-dimethylacetamide (25 mL) and H_2O (500 μL) was added by syringe. The reaction was stirred in the oil bath at 120 °C under air for 12 h. After cooling to room temperature, the reaction mixture was diluted with ethyl acetate (15.0 mL) and washed by saturated sodium chloride solution. The organic layer was separated and the aqueous layer was extracted with ethyl acetate for three times. The combined organic layer was dried over $MgSO_4$ and the volatiles were removed under reduced pressure. The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate=30:1) to yield the desired product 1,3-diphenylpropan-1-one **2a** as white solid (892.5 mg, 85% yield).

4. The reaction procedure of Control Experiments

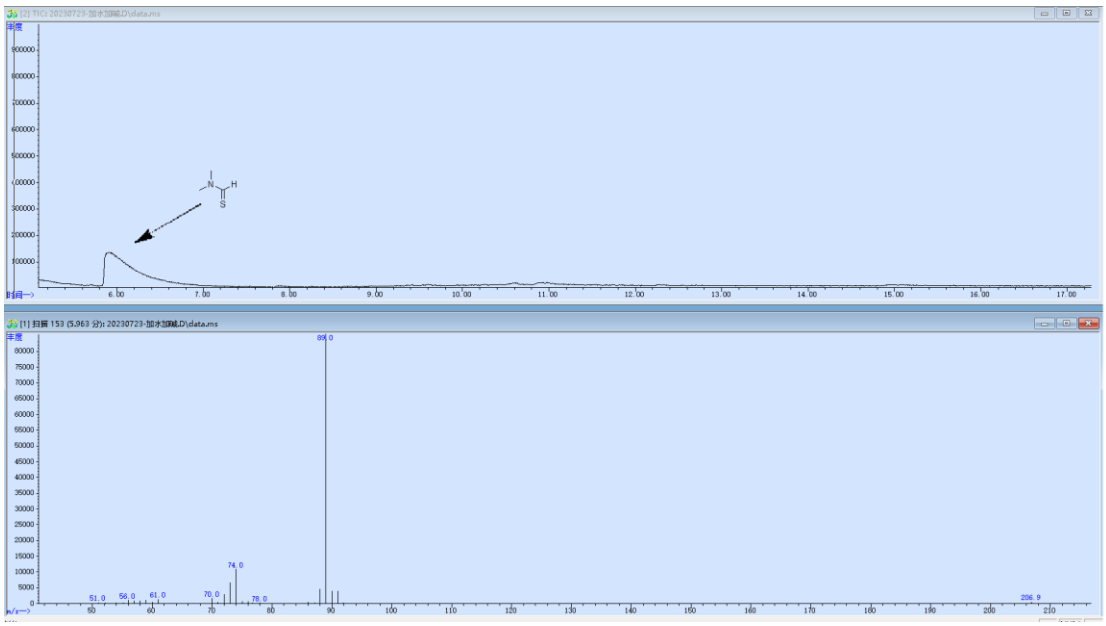


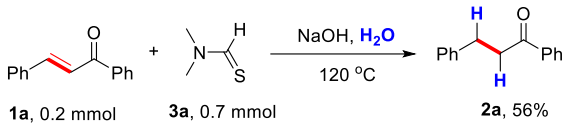
(*E*)-chalcone **1a** (0.2 mmol), NaOH (8.0 mg, 0.2 mmol) and CS_2 (42 μL, 0.7 mmol) were added to

a reaction vessel (10 mL). *N*, *N*-dimethylacetamide (1.0 mL) and D_2O (20 μL) was added by syringe. The reaction was stirred in the oil bath at 120 °C under air for 12 h. After cooling to room temperature, the reaction mixture was diluted with ethyl acetate (15.0 mL) and washed by saturated sodium chloride solution. The organic layer was separated and the aqueous layer was extracted with ethyl acetate for three times. The combined organic layer was dried over $MgSO_4$ and the volatiles were removed under reduced pressure. The resulting mixture was purified by column chromatography on silica gel (eluted with EtOAc/PE) to afford the desired product **2a-D** in 89% isolated yield, and the ^1H NMR spectrum showed 98 % d-incorporation at the β position and 96 % d-incorporation at α position:



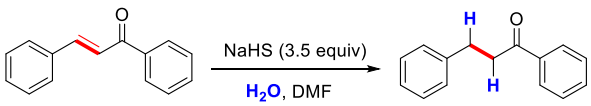
N,*N*-Dimethylformamide (1 mL), and CS_2 (42 μL, 0.7 mmol) were added to a reaction vessel (10 mL). The reaction was stirred in the oil bath at 120 °C under air for 12 h. After cooling to room temperature, the reaction mixture was diluted with ethyl acetate (15.0 mL) and washed by saturated sodium chloride solution. The organic layer was separated and the aqueous layer was extracted with ethyl acetate for three times. The combined organic layer was dried over $MgSO_4$ and the volatiles were removed under reduced pressure. The consequence was detected by GC-MS.





1a, 0.2 mmol **3a**, 0.7 mmol **2a**, 56%

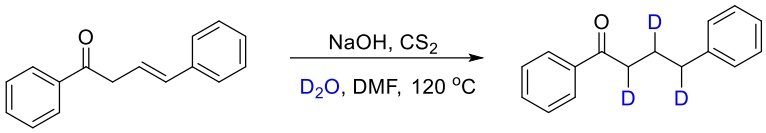
(*E*)-chalcone **1a** (0.2 mmol), NaOH (8.0 mg, 0.2 mmol) and **3a** (59,5 μL, 0.7 mmol) were added to a reaction vessel (10 mL). H_2O (20 μL) was added by syringe. The reaction was stirred in the oil bath at 120 °C under air for 12 h. After cooling to room temperature, the reaction mixture was diluted with ethyl acetate (15.0 mL) and washed by saturated sodium chloride solution. The organic layer was separated and the aqueous layer was extracted with ethyl acetate for three times. The combined organic layer was dried over $MgSO_4$ and the volatiles were removed under reduced pressure. The resulting mixture was purified by column chromatography on silica gel (eluted with EtOAc/PE) to afford the desired product **2a** in 56% yield.



1a, 0.2 mmol **2a**, 68%

(*E*)-chalcone **1a** (0.2 mmol), NaHS (39.2 mg, 3.5 equiv.) were added to a reaction vessel (10 mL). *N*, *N*-dimethylacetamide (1.0 mL) and H_2O (20 μL) was added by syringe. The reaction was stirred in the oil bath at 120 °C under air for 12 h. After cooling to room temperature, the reaction mixture was diluted with ethyl acetate (15.0 mL) and washed by saturated sodium chloride solution. The organic layer was separated and the aqueous layer was extracted with ethyl acetate for three times. The combined organic layer was dried over $MgSO_4$ and the volatiles were removed under reduced

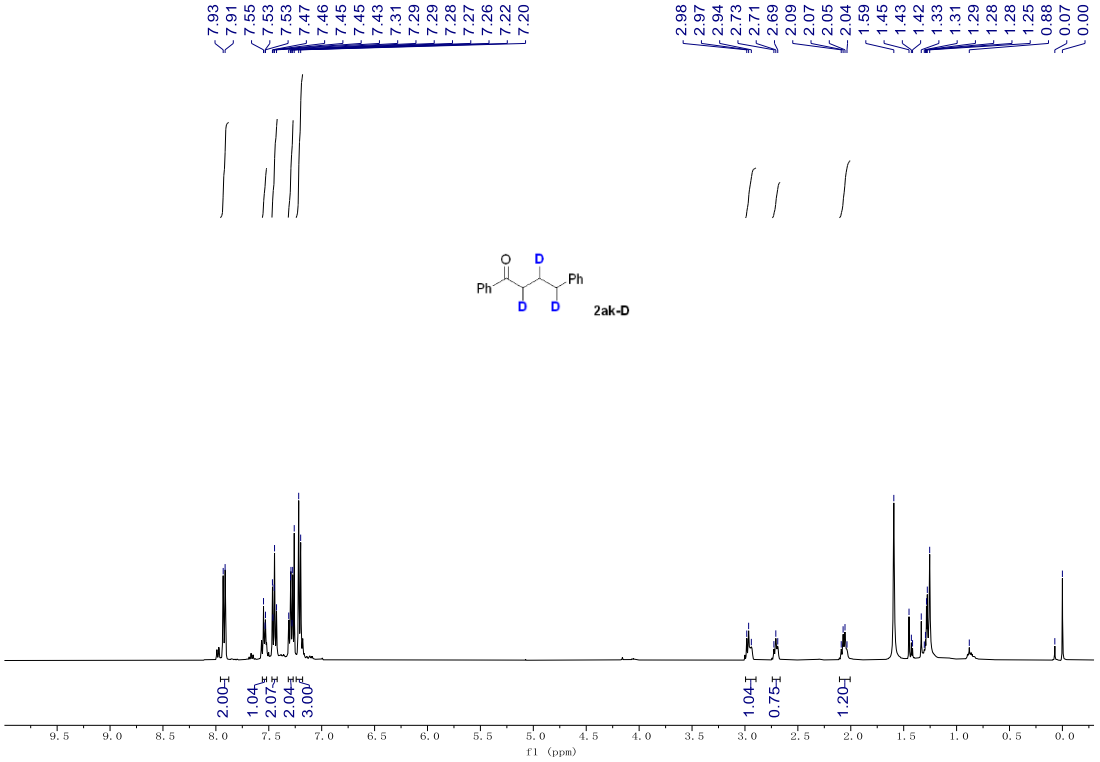
pressure. The resulting mixture was purified by column chromatography on silica gel (eluted with EtOAc/PE) to afford the desired product **2a** in 68% yield.



1ak **2ak-D**

(*E*)-1,4-diphenylbut-3-en-1-one **1ak** (0.2 mmol), NaOH (8.0 mg, 0.2 mmol) and CS_2 (42 μL, 0.7 mmol) were added to a reaction vessel (10 mL). *N*, *N*-dimethylacetamide (1.0 mL) and D_2O (20 μL) was added by syringe. The reaction was stirred in the oil bath at 120 °C under air for 12 h. After cooling to room temperature, the reaction mixture was diluted with ethyl acetate (15.0 mL) and washed by saturated sodium chloride solution. The organic layer was separated and the aqueous layer was extracted with ethyl acetate for three times. The combined organic layer was dried over $MgSO_4$ and the volatiles were removed under reduced pressure. The resulting mixture was purified by column chromatography on silica gel (eluted with EtOAc/PE) to afford the desired product **2ak-D** in 54% isolated yield,

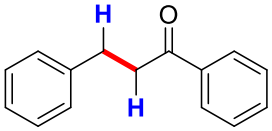
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 (d, *J* = 7.3 Hz, 2H), 7.54 (d, *J* = 7.4 Hz, 1H), 7.45 (t, *J* = 7.7 Hz, 2H), 7.32 – 7.27 (m, 2H), 7.24 – 7.18 (m, 3H), 2.96 (t, *J* = 8.7 Hz, 1H), 2.71 (t, *J* = 7.3 Hz, 1H), 2.06 (q, *J* = 7.3 Hz, 1H).



Detection of H_2S: The color change of lead acetate test paper after reaction.

5. Characterization data of products

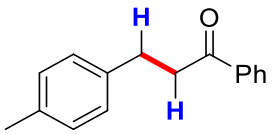
1,3-diphenylpropan-1-one (2a, CAS: 1083–30-3**)**[1]



38.6 mg, 92% yield; white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96 (d, *J* = 7.1 Hz, 2H), 7.56 (t, *J* = 7.4 Hz, 1H), 7.45 (t, *J* = 7.7 Hz, 2H), 7.32 – 7.24 (m, 4H), 7.22 (t, *J* = 7.0 Hz, 1H), 3.31 (t, *J* = 7.7 Hz, 2H), 3.07 (t, *J* = 7.7 Hz, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 199.2, 141.2, 136.8, 133.1, 128.6, 128.5, 128.4, 128.0, 126.1, 40.4, 30.1.

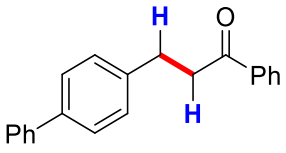
1-phenyl-3-(p-tolyl)propan-1-one (2b)[3]



40.3 mg, 90% yield; white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95 (d, *J* = 6.8 Hz, 2H), 7.54 (t, *J* = 7.4 Hz, 1H), 7.44 (t, *J* = 7.7 Hz, 2H), 7.13 (q, *J* = 8.0 Hz, 4H), 3.27 (t, *J* = 7.7 Hz, 2H), 3.02 (t, *J* = 7.7 Hz, 2H), 2.32 (s, 3H).

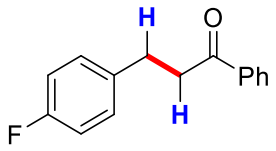
^{13}C NMR (101 MHz, $CDCl_3$) δ 199.3, 138.1, 136.8, 135.6, 133.0, 129.1, 128.5, 128.2, 128.0, 40.6, 29.6, 21.0.

3-([1,1'-biphenyl]-4-yl)-1-phenylpropan-1-one (2c)[3]



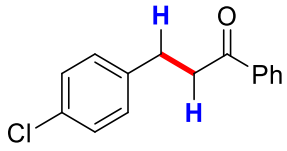
45.8 mg, 80% yield; yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.98 (d, *J* = 7.1 Hz, 2H), 7.60 – 7.51 (m, 5H), 7.49 – 7.40 (m, 4H), 7.36 – 7.30 (m, 3H), 3.34 (t, *J* = 7.6 Hz, 2H), 3.11 (t, *J* = 7.7 Hz, 2H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 199.1, 140.9, 140.4, 139.1, 136.8, 133.1, 128.8, 128.7, 128.6, 128.0, 127.2, 127.1, 127.0, 40.3, 29.7.

3-(4-fluorophenyl)-1-phenylpropan-1-one (2d)[3]



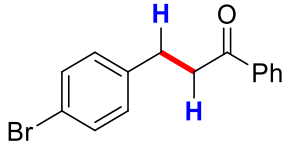
39.7 mg, 87% yield; white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95 (d, *J* = 7.0 Hz, 2H), 7.55 (t, *J* = 7.3 Hz, 1H), 7.45 (t, *J* = 7.7 Hz, 2H), 7.23 – 7.17 (m, 2H), 6.97 (t, *J* = 8.7 Hz, 2H), 3.28 (t, *J* = 7.6 Hz, 2H), 3.04 (t, *J* = 7.5 Hz, 2H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 199.0, 161.3 (d, *J* = 242 Hz), 136.8 (d, *J* = 3 Hz), 136.7, 133.1, 129.8 (d, *J* = 7 Hz), 128.6, 128.0, 115.2 (d, *J* = 21 Hz), 40.3, 29.2.
^{19}F NMR (376 MHz, $CDCl_3$) δ -117.21.

3-(4-chlorophenyl)-1-phenylpropan-1-one (2e)[4]



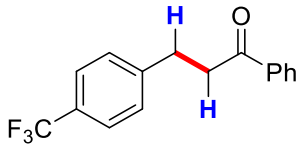
40.5 mg, 83% yield; white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95 (d, *J* = 8.1 Hz, 2H), 7.56 (d, *J* = 7.7 Hz, 1H), 7.46 (t, *J* = 7.7 Hz, 2H), 7.27 (d, *J* = 4.7 Hz, 2H), 7.19 (d, *J* = 8.5 Hz, 2H), 3.29 (t, *J* = 7.6 Hz, 2H), 3.05 (t, *J* = 7.5 Hz, 2H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 198.8, 139.7, 136.7, 133.2, 131.8, 129.8, 128.6, 128.6, 128.0, 40.1, 29.3.

3-(4-bromophenyl)-1-phenylpropan-1-one (2f)[4]



49.0 mg, 85% yield; white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95 (d, *J* = 7.0 Hz, 2H), 7.56 (t, *J* = 7.4 Hz, 1H), 7.49 – 7.38 (m, 4H), 7.13 (d, *J* = 8.3 Hz, 2H), 3.28 (t, *J* = 7.5 Hz, 2H), 3.02 (t, *J* = 7.5 Hz, 2H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 198.8, 140.2, 136.6, 133.2, 131.5, 130.2, 128.6, 128.0, 119.8, 40.0, 29.4.

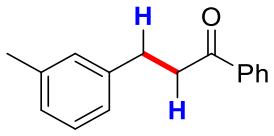
1-phenyl-3-(4-(trifluoromethyl)phenyl)propan-1-one (2g)[1]



40.0 mg,72% yield; white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96 (d, *J* = 7.0 Hz, 2H), 7.60 – 7.52 (m, 3H), 7.46 (t, *J* = 7.7 Hz, 2H), 7.37 (d, *J* = 8.0 Hz, 2H), 3.33 (t, *J* = 7.5 Hz, 2H), 3.14 (t, *J* = 7.5 Hz, 2H).

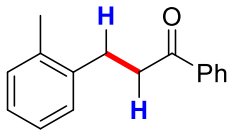
^{13}C NMR (101 MHz, $CDCl_3$) δ 198.6, 145.4, 136.7, 133.2, 129.3, 128.8, 128.7, 128.0, 125.6(t, *J* = 272 Hz), 125.4 (q, *J* = 3.8 Hz), 39.8, 29.8.
^{19}F NMR (376 MHz, $CDCl_3$) δ -62.35.

1-phenyl-3-(m-tolyl)propan-1-one (2h)[1]



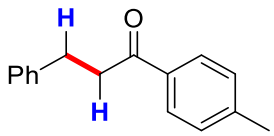
40.8 mg, 91% yield; white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96 (d, *J* = 7.0 Hz, 2H), 7.59 – 7.52 (m, 1H), 7.45 (t, *J* = 7.7 Hz, 2H), 7.20 (t, *J* = 7.5 Hz, 1H), 7.09 – 7.00 (m, 3H), 3.29 (t, *J* = 7.8 Hz, 2H), 3.03 (t, *J* = 7.8 Hz, 2H), 2.34 (s, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 199.3, 141.2, 138.1, 136.8, 133.0, 129.2, 128.6, 128.4, 128.0, 126.8, 125.4, 40.5, 30.0, 21.4.

1-phenyl-3-(o-tolyl)propan-1-one (2i)[4]



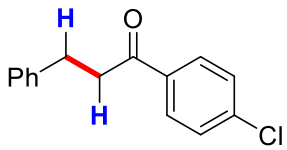
27.3 mg, 61% yield; white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.97 (d, *J* = 7.0 Hz, 2H), 7.57 (t, *J* = 7.4 Hz, 1H), 7.46 (t, *J* = 7.7 Hz, 2H), 7.22 – 7.13 (m, 4H), 3.26 (t, *J* = 7.7 Hz, 2H), 3.06 (t, *J* = 7.9 Hz, 2H), 2.35 (s, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 199.4, 139.4, 136.8, 136.0, 133.1, 130.3, 128.7, 128.6, 128.0, 126.3, 126.2, 39.1, 27.5, 19.4.

3-phenyl-1-(p-tolyl)propan-1-one (2j)[1]



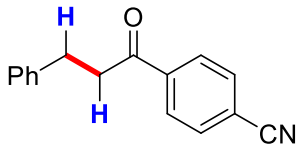
37.6 mg, 84% yield; white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.85 (d, *J* = 8.2 Hz, 2H), 7.30 – 7.19 (m, 7H), 3.27(t, *J* = 7.7 Hz, 2H), 3.05 (t, *J* = 7.7 Hz, 2H), 2.39 (s, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 203.2, 141.1, 138.0, 137.8, 131.9, 131.2, 128.4, 128.3, 128.3, 126.0, 125.6, 43.1, 30.2, 21.2.

1-(4-chlorophenyl)-3-phenylpropan-1-one (2k)[1]



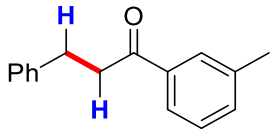
15.1 mg, 31% yield; white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89 (d, *J* = 8.6 Hz, 2H), 7.42 (d, *J* = 8.6 Hz, 2H), 7.30 (t, *J* = 7.4 Hz, 2H), 7.26 – 7.18 (m, 3H), 3.27 (t, *J* = 7.7 Hz, 2H), 3.06 (t, *J* = 7.6 Hz, 2H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 198.0, 141.1, 139.5, 135.2, 129.5, 128.9, 128.6, 128.4, 126.2, 40.4, 30.1.

4-(3-phenylpropanoyl)benzonitrile (2l)[5]



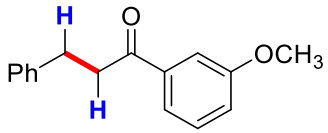
21.6 mg, 46% yield; yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.99 – 7.87 (m, 4H), 7.73 (s, 1H), 7.31 (t, *J* = 7.4 Hz, 2H), 7.23 (d, *J* = 8.9 Hz, 2H), 3.31 (t, *J* = 7.6 Hz, 2H), 3.07 (t, *J* = 7.6 Hz, 2H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 201.7, 198.5, 142.8, 140.9, 139.0, 128.6, 128.4, 128.2, 127.2, 126.3, 40.8, 30.0.

3-phenyl-1-(m-tolyl)propan-1-one (2m)[6]



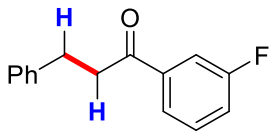
38.5 mg, 86% yield; white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.75 (d, *J* = 8.9 Hz, 2H), 7.38 – 7.26 (m, 5H), 7.25 – 7.19 (m, 2H), 3.28 (t, *J* = 7.7 Hz, 2H), 3.06 (t, *J* = 7.7 Hz, 2H), 2.39 (s, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 198.9, 143.8, 141.3, 134.3, 129.2, 128.5, 128.4, 128.1, 126.0, 40.3, 30.1, 21.6.

1-(3-methoxyphenyl)-3-phenylpropan-1-one (2n)[5]



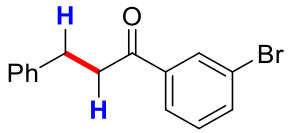
43.2 mg, 90% yield; white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.53 (d, *J* = 7.7 Hz, 1H), 7.49 (t, *J* = 2.1 Hz 1H), 7.38 – 7.27 (m, 4H), 7.25 – 7.20 (m, 2H), 7.12 – 7.08 (m, 1H), 3.84 (s, 3H), 3.29 (t, *J* = 7.7 Hz 2H), 3.06 (t, *J* = 7.7 Hz 2H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 199.0, 159.8, 141.2, 138.2, 129.6, 128.5, 128.4, 126.1, 120.6, 119.6, 112.2, 55.4, 40.5, 30.1.

1-(3-fluorophenyl)-3-phenylpropan-1-one (2o)[7]



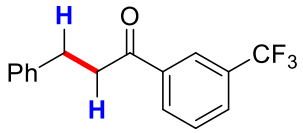
33.3 mg, 73% yield; white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 (d, *J* = 7.7 Hz, 1H), 7.63 (d, *J* = 9.6 Hz, 1H), 7.45 – 7.40 (m, 1H), 7.33 – 7.26 (m, 3H), 7.25 – 7.21 (m, 3H), 3.28 (t, *J* = 7.7 Hz 2H), 3.07 (t, *J* = 7.6 Hz 2H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 197.9, 162.8(d, *J* = 246 Hz), 141.0, 138.9(d, *J* = 5 Hz), 130.2(d, *J* = 8 Hz), 128.4(q, *J* = 17.7 Hz), 126.2, 123.7(d, *J* = 3 Hz), 120.2, 120.0, 114.8(d, *J* = 22 Hz), 40.6, 29.9.
^{19}F NMR (376 MHz, $CDCl_3$) δ -111.78.

1-(3-bromophenyl)-3-phenylpropan-1-one (2p)[6]



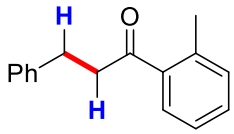
46.1 mg, 90% yield; white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 (s, 1H), 7.83 (d, *J* = 9.2 Hz, 1H), 7.53 (d, *J* = 8.0 Hz, 1H), 7.40 (t, *J* = 7.9 Hz, 1H), 7.33 – 7.28 (m, 2H), 7.26 – 7.18 (m, 3H), 3.28 (t, *J* = 7.6 Hz, 2H), 3.07 (t, *J* = 7.6 Hz, 2H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 197.9, 141.0, 138.3, 134.9, 133.0, 129.9, 128.6, 128.4, 128.2, 126.2, 126.1, 40.6, 29.9.

3-phenyl-1-(3-(trifluoromethyl)phenyl)propan-1-one (2q)[8]



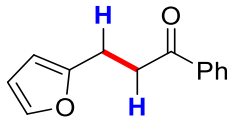
37.8 mg, 68% yield; white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.20 (s, 1H), 8.13 (d, *J* = 7.9 Hz, 1H), 7.81 (d, *J* = 7.8 Hz, 1H), 7.60 (t, *J* = 7.8 Hz, 1H), 7.31 (t, *J* = 7.4 Hz, 2H), 7.26 – 7.20 (m, 3H), 3.33 (t, *J* = 7.6 Hz, 2H), 3.09 (t, *J* = 7.6 Hz, 2H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 197.8, 140.9, 137.3, 131.4, 131.1, 129.5 (q, *J* = 3.7 Hz), 129.3, 128.5 (t, *J* = 19 Hz), 126.3, 125.0, 124.9 (q, *J* = 3.8 Hz), 122.3, 40.6, 29.9.
^{19}F NMR (376 MHz, $CDCl_3$) δ -62.78.

3-phenyl-1-(o-tolyl)propan-1-one (2r)[8]



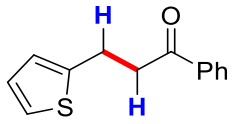
38.5 mg, 86% yield; white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57 (d, *J* = 6.6 Hz, 1H), 7.35 – 7.25 (m, 3H), 7.23 – 7.16 (m, 5H), 3.20 (t, *J* = 7.6 Hz, 2H), 3.03 (t, *J* = 7.6 Hz, 2H), 2.46 (s, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 199.4, 141.3, 138.3, 136.8, 133.8, 128.5, 128.5, 128.4, 128.4, 126.1, 125.2, 40.5, 30.1, 21.3.

3-(furan-2-yl)-1-phenylpropan-1-one (2s)[8]



32.0 mg, 80% yield; yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.98 (d, *J* = 7.2 Hz, 2H), 7.57 (t, *J* = 7.4 Hz, 1H), 7.46 (t, *J* = 7.6 Hz, 2H), 7.31 (s, 1H), 6.28 (s, 1H), 6.06 (s, 1H), 3.34 (t, *J* = 7.5 Hz, 2H), 3.09 (t, *J* = 7.5 Hz, 2H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 198.7, 154.7, 141.1, 136.7, 133.1, 128.6, 128.0, 110.2, 105.3, 36.9, 22.5.

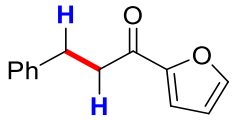
1-phenyl-3-(thiophen-2-yl)propan-1-one (2t)[8]



35.0 mg, 81% yield; white oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.97 (d, *J* = 7.0 Hz, 2H), 7.57 (t, *J* = 7.4 Hz, 1H), 7.47 (t, *J* = 7.7 Hz, 2H), 7.13 (d, *J* = 3.9 Hz, 1H), 6.92 (t, *J* = 4.3 Hz, 1H), 6.87 (d, *J* = 2.3 Hz, 1H), 3.37 (t, *J* = 7.0 Hz, 2H), 3.30 (t, *J* = 6.8 Hz, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 198.6, 143.9, 136.7, 133.2, 128.6, 128.0, 126.8, 124.7, 123.4, 40.5, 24.2.

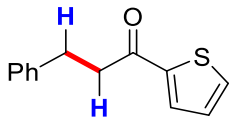
1-(furan-2-yl)-3-phenylpropan-1-one (2u)[8]



28.8 mg, 72% yield; white oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.55 (s, 1H), 7.29 (t, *J* = 7.4 Hz, 2H), 7.25 – 7.18 (m, 3H), 7.16 (d, *J* = 3.6 Hz, 1H), 6.51 (dd, *J* = 3.6, 1.7 Hz, 1H), 3.15 (t, *J* = 7.3 Hz, 2H), 3.04 (t, *J* = 7.7 Hz 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 188.4, 152.5, 146.3, 140.9, 128.4, 128.3, 126.1, 117.0, 112.1, 40.1, 29.8.

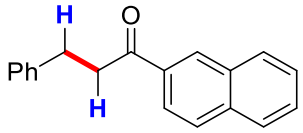
3-phenyl-1-(thiophen-2-yl)propan-1-one (2v)[8]



30.2 mg, 70% yield; yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.69 (d, *J* = 3.8 Hz, 1H), 7.63 (d, *J* = 5.0 Hz, 1H), 7.29 (t, *J* = 7.4 Hz, 2H), 7.26 – 7.18 (m, 3H), 7.11 (t, *J* = 7.3 Hz, 1H), 3.24 (t, *J* = 7.9 Hz, 2H), 3.07 (t, *J* = 7.7 Hz, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 192.2, 144.1, 141.0, 133.6, 131.8, 128.5, 128.4, 128.1, 126.2, 41.1, 30.3.

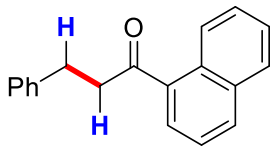
1-(naphthalen-2-yl)-3-phenylpropan-1-one (2w)[5]



40.6 mg, 78% yield; white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.45 (s, 1H), 8.03 (d, *J* = 8.6 Hz, 1H), 7.95 – 7.83 (m, 3H), 7.62 – 7.50 (m, 2H), 7.34 – 7.27 (m, 4H), 7.24 – 7.21 (m, 1H), 3.43 (t, *J* = 7.7 Hz, 2H), 3.13 (t, *J* = 7.7 Hz, 2H).

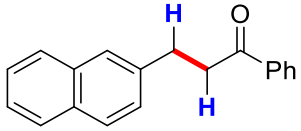
^{13}C NMR (101 MHz, $CDCl_3$) δ 199.1, 141.3, 135.5, 134.1, 132.5, 129.7, 129.5, 128.5, 128.4, 128.4, 127.7, 126.7, 126.1, 123.8, 40.5, 30.2.

1-(naphthalen-1-yl)-3-phenylpropan-1-one (2x)[8]



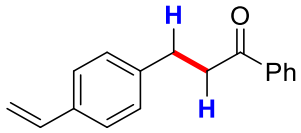
32.8 mg, 63% yield; white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.55 (d, *J* = 7.8 Hz, 1H), 7.96 (d, *J* = 8.2 Hz, 1H), 7.86 (d, *J* = 8.0 Hz, 1H), 7.80 (d, *J* = 7.2 Hz, 1H), 7.54 (m, 2H), 7.45 (t, *J* = 7.7 Hz, 1H), 7.31 – 7.26 (m, 3H), 7.25 – 7.17 (m, 2H), 3.37 (t, *J* = 7.6 Hz, 2H), 3.13 (t, *J* = 7.6 Hz, 2H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 203.5, 141.1, 135.9, 133.9, 132.6, 130.1, 128.5, 128.4, 128.4, 127.8, 127.4, 126.4, 126.1, 125.7, 124.3, 43.8, 30.5.

3-(naphthalen-2-yl)-1-phenylpropan-1-one (2y)[8]



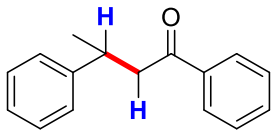
44.2 mg, 85% yield; white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.04 (d, *J* = 8.2 Hz, 1H), 7.94 (d, *J* = 7.0 Hz, 2H), 7.86 (d, *J* = 7.7 Hz, 1H), 7.73 (t, *J* = 4.8 Hz, 1H), 7.54 – 7.45 (m, 3H), 7.45 – 7.36 (m, 4H), 3.53 (t, *J* = 7.4 Hz, 2H), 3.41 (t, *J* = 7.3 Hz, 2H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 199.2, 137.3, 136.7, 133.9, 133.1, 131.6, 128.9, 128.6, 128.0, 127.0, 126.1, 126.0, 125.6, 125.6, 123.5, 39.7, 27.1.

1-phenyl-3-(4-vinylphenyl)propan-1-one (2z)[9]



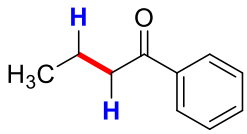
17.9 mg, 38% yield; yellow oil.^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95 (d, *J* = 7.7 Hz, 2H), 7.55 (t, *J* = 7.4 Hz, 1H), 7.45 (t, *J* = 7.6 Hz, 2H), 7.35 (d, *J* = 7.8 Hz, 2H), 7.21 (d, *J* = 7.8 Hz, 2H), 6.69 (dd, *J* = 17.6, 10.8 Hz, 1H), 5.71 (d, *J* = 17.6 Hz, 1H), 5.20 (d, *J* = 10.9 Hz, 1H), 3.29 (t, *J* = 7.7 Hz, 2H), 3.06 (t, *J* = 7.7 Hz, 2H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 199.1, 141.0, 136.8, 136.5, 135.6, 133.1, 128.6, 128.0, 126.3, 113.2, 40.3, 29.8.

(S)-1,3-diphenylbutan-1-one (2ab)[1]



26.0 mg, 58% yield; white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93 (d, *J* = 7.0 Hz, 2H), 7.55 (t, *J* = 7.4 Hz, 1H), 7.44 (t, *J* = 7.7 Hz, 2H), 7.33 – 7.26 (m, 4H), 7.20 (m, *J* = 1H), 3.51 (dq, *J* = 13.9, 6.9 Hz, 1H), 3.30 (dd, *J* = 16.5, 5.7 Hz, 1H), 3.19 (dd, *J* = 16.5, 8.3 Hz, 1H), 1.34 (d, *J* = 6.9 Hz, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 199.1, 146.6, 137.2, 133.0, 128.6, 128.5, 128.1, 126.8, 126.3, 47.0, 35.6, 21.9.

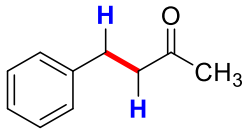
1-phenylbutan-1-one (2ac, CAS:495-40-9)[10]



17.8 mg, 60% yield; colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.97 (d, *J* = 7.0 Hz, 2H), 7.56 (t, *J* = 7.4 Hz, 1H), 7.46 (t, *J* = 7.5 Hz, 2H), 2.95 (t, *J* = 7.3 Hz, 2H), 1.83 – 1.72 (m, 2H), 1.01 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 200.5, 137.1, 132.9, 128.5, 128.0, 40.5, 17.7, 13.9.

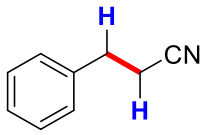
4-phenylbutan-2-one (2ad, CAS: 2550-26-7)[1]



18.4 mg, 62% yield; colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.26 (t, *J* = 7.5 Hz, 2H), 7.18 (t, *J* = 7.5 Hz, 3H), 2.89 (t, *J* = 7.6 Hz, 2H), 2.76 (t, *J* = 7.4 Hz, 2H), 2.14 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 208.0, 140.9, 128.4, 128.2, 126.1, 45.1, 30.0, 29.7.

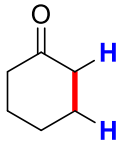
3-phenylpropanenitrile (2ae, CAS: 645-59-0)[11]



8.4 mg, 32% yield; colorless oil.^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38 – 7.30 (m, 2H), 7.28 (d, *J* = 7.3 Hz, 1H), 7.23 (d, *J* = 7.0 Hz, 3H), 2.96 (t, *J* = 7.4 Hz, 2H), 2.62 (t, *J* = 7.4 Hz, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 138.0, 128.8, 128.2, 127.2, 119.1, 31.5, 19.3.

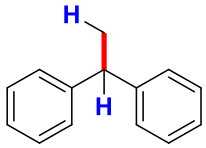
Cyclohexanone (2af, CAS: 108-94-1)[12]



2.9 mg, 15% yield; colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 2.34 (t, *J* = 6.6 Hz, 4H), 1.87 (t, *J* = 6.2 Hz, 4H), 1.75 – 1.70 (m, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 212.2, 41.9, 27.0, 25.0.

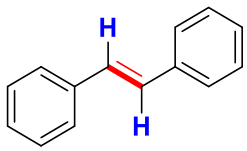
ethane-1,1-diyldibenzene (2ag, CAS: 612-00-0)[13]



26.2 mg, 72% yield; colorless solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32 – 7.25 (m, 4H), 7.25 – 7.14 (m, 6H), 4.15 (q, *J* = 7.2 Hz, 1H), 1.64 (d, *J* = 5.4 Hz, 3H).

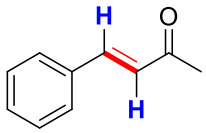
^{13}C NMR (101 MHz, $CDCl_3$) δ 146.3, 128.3, 127.6, 126.0, 44.7, 21.8.

(E)-1,2-diphenylethene (2ah, CAS: 103-30-0)[3]



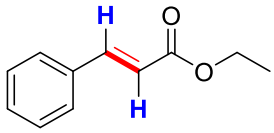
21.2 mg, 59% yield; white solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.52 (d, *J* = 7.0 Hz, 4H), 7.36 (t, *J* = 7.6 Hz, 4H), 7.25 (d, *J* = 7.5 Hz, 2H), 7.11 (s, 2H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 137.3, 128.7, 127.6, 126.5.

(E)-4-phenylbut-3-en-2-one (1ad, CAS: 1896-62-4)[14]



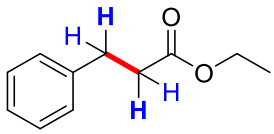
9.6 mg, 33% yield; colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.59 – 7.49 (m, 3H), 7.43 – 7.38 (m, 3H), 6.72 (d, *J* = 16.3 Hz, 1H), 2.39 (s, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 198.5, 143.5, 134.4, 130.5, 129.0, 128.2, 127.1, 27.5.

ethyl cinnamate (2aj, CAS: 4192-77-2)[15]



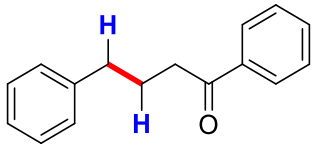
20.1 mg, 57% yield; colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.68 (d, *J* = 16.0 Hz, 1H), 7.51 (dd, *J* = 6.6, 3.0 Hz, 2H), 7.40 – 7.34 (m, 3H), 6.43 (d, *J* = 16.0 Hz, 1H), 4.26 (q, *J* = 7.1 Hz, 2H), 1.33 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 167.0, 144.6, 134.4, 130.2, 128.8, 128.0, 118.2, 60.5, 14.3.

ethyl 3-phenylpropanoate (2aj', CAS: 2021-28-5)[15]



4.6 mg, 13% yield; faint yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32 – 7.26 (m, 2H), 7.23 – 7.17 (m, 3H), 4.13 (q, *J* = 7.1 Hz, 2H), 2.95 (t, *J* = 7.9 Hz, 2H), 2.62 (t, *J* = 7.8 Hz, 2H), 1.23 (t, *J* = 7.2 Hz, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 172.9, 140.6, 128.5, 128.3, 126.2, 60.4, 35.9, 31.0, 14.2.

1,4-diphenylbutan-1-one (2ak, CAS: 5407-91-0)[16]



30.0 mg, 67% yield; faint yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 (d, *J* = 7.1 Hz, 2H), 7.55 (t, *J* = 7.4 Hz, 1H), 7.45 (t, *J* = 7.7 Hz, 2H), 7.33 – 7.27 (m, 2H), 7.24 – 7.16 (m, 3H), 2.98 (t, *J* = 7.3 Hz, 2H), 2.73 (t, *J* = 7.6 Hz, 2H), 2.09 (p, *J* = 7.4 Hz, 2H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 200.1, 141.7, 137.0, 132.9, 128.5, 128.5, 128.4, 128.0, 125.9, 37.7, 35.2, 25.7.

6. Reference

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1514.

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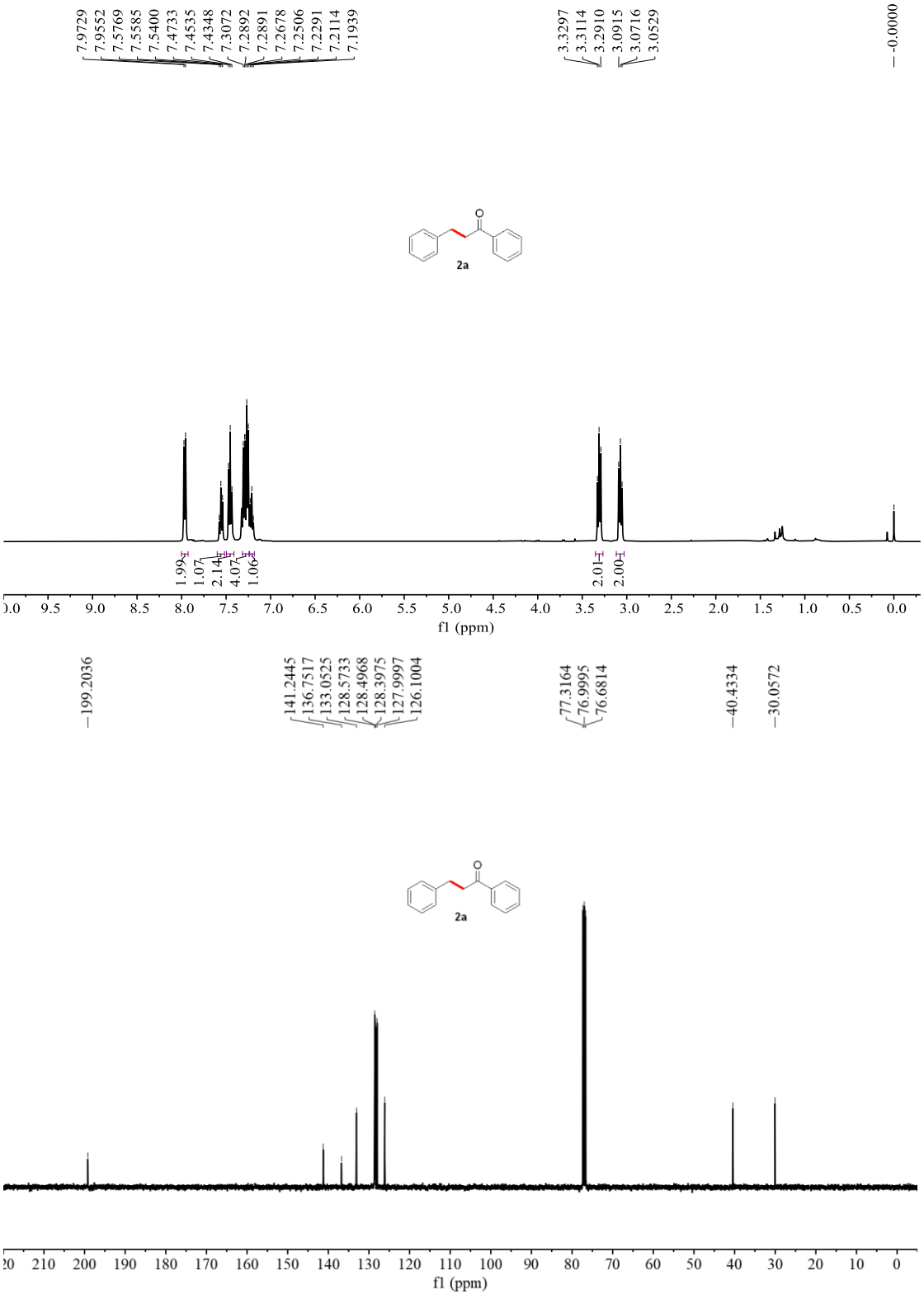
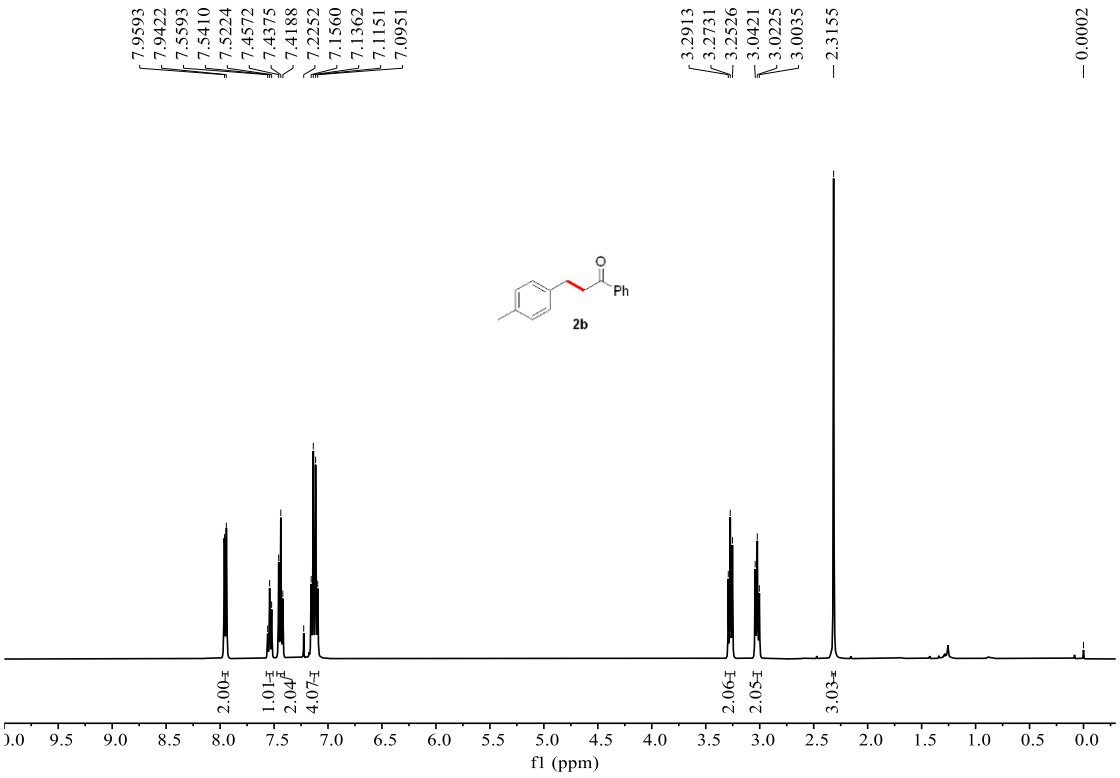
7. NMR Spectra for the compounds prepared

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3.0225
3.0035
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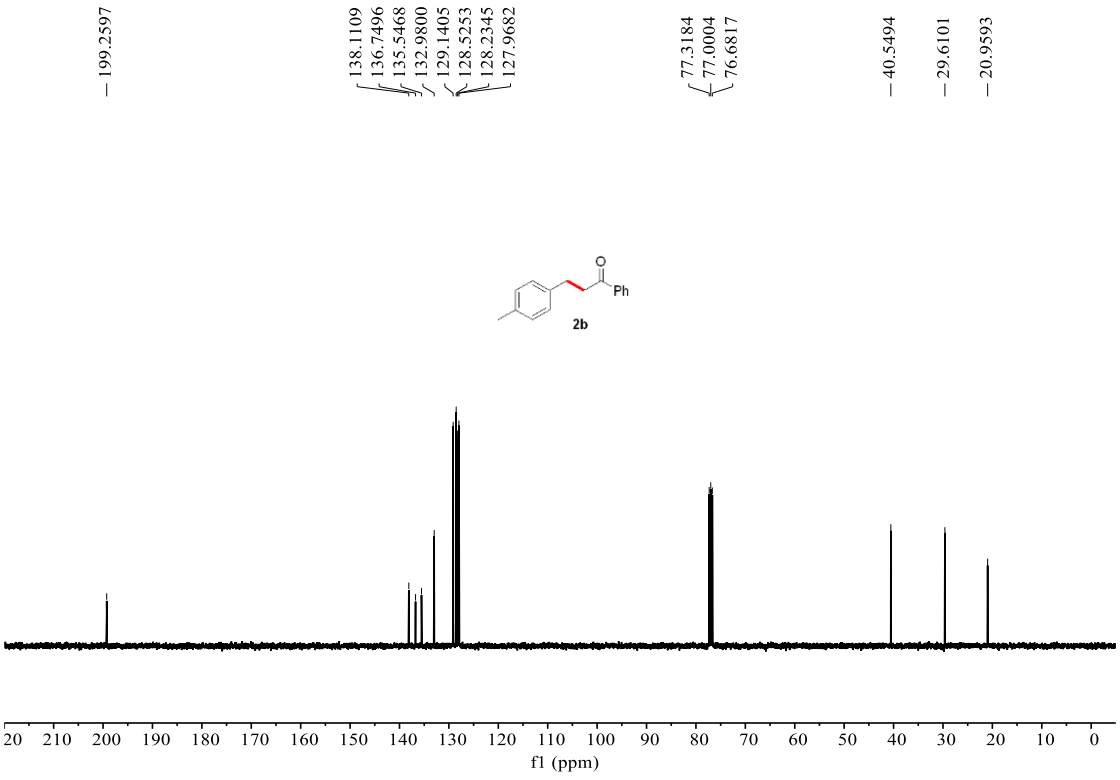
f1 (ppm)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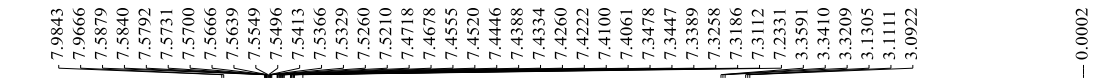
O
Ph
2b
f1 (ppm)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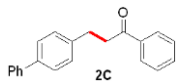
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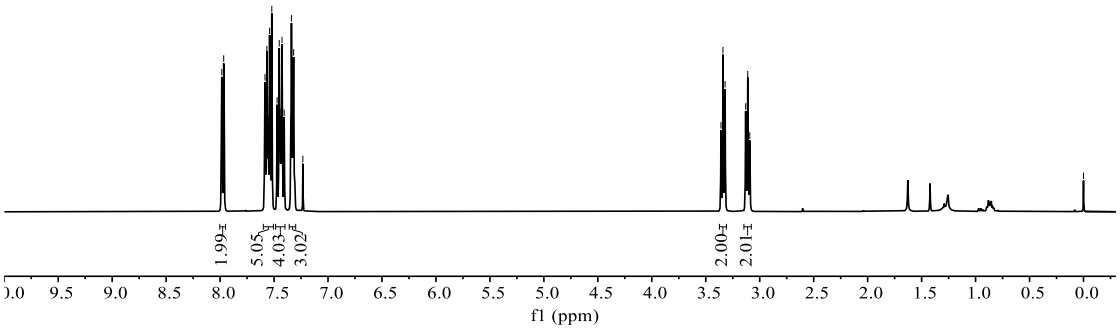
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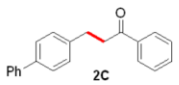
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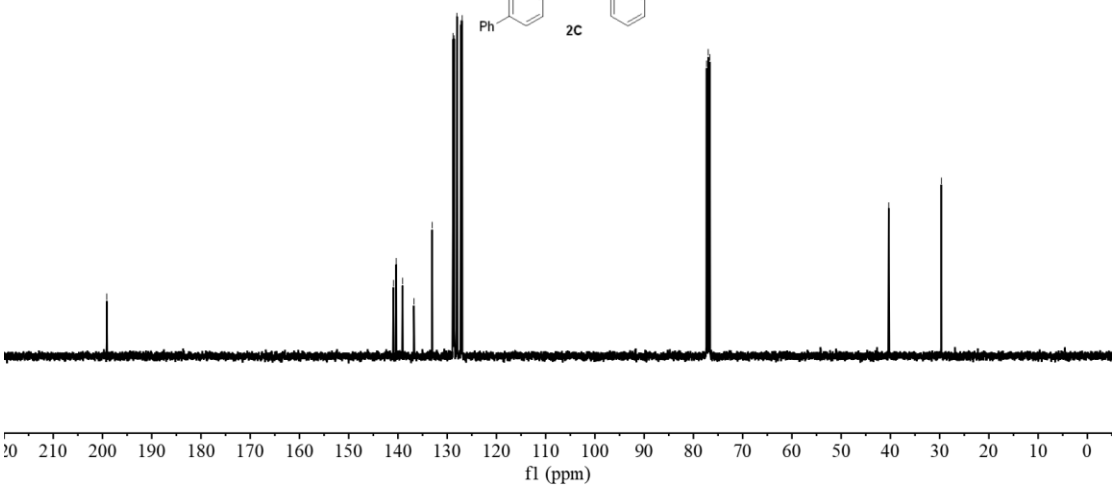
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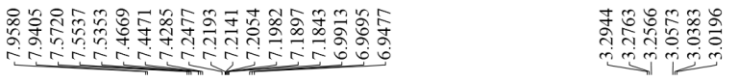
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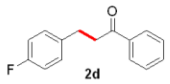
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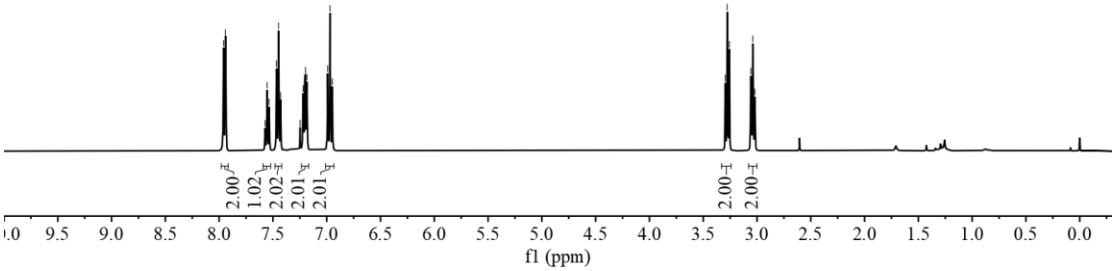
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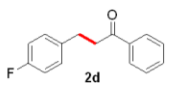
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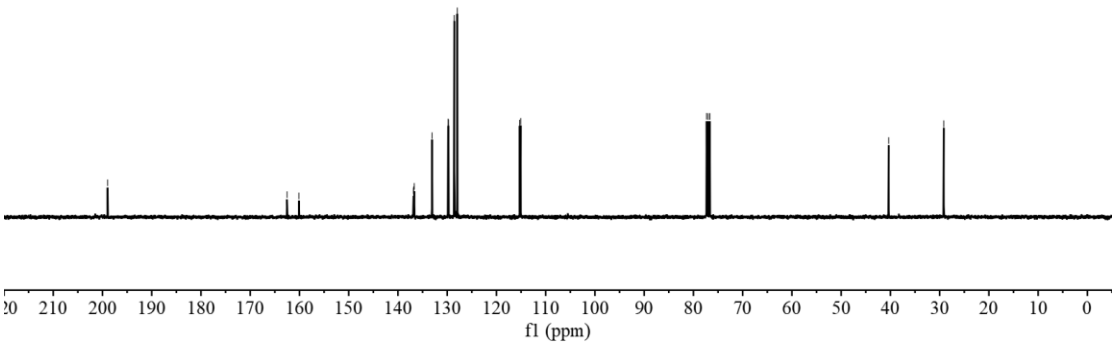
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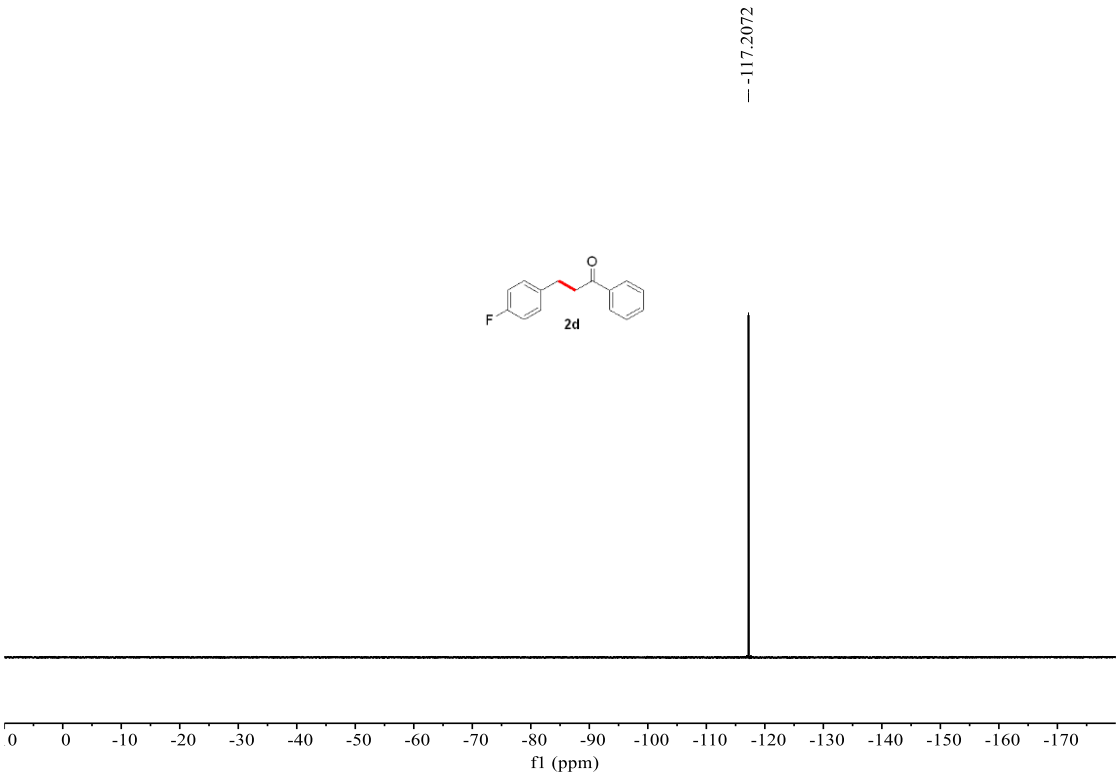
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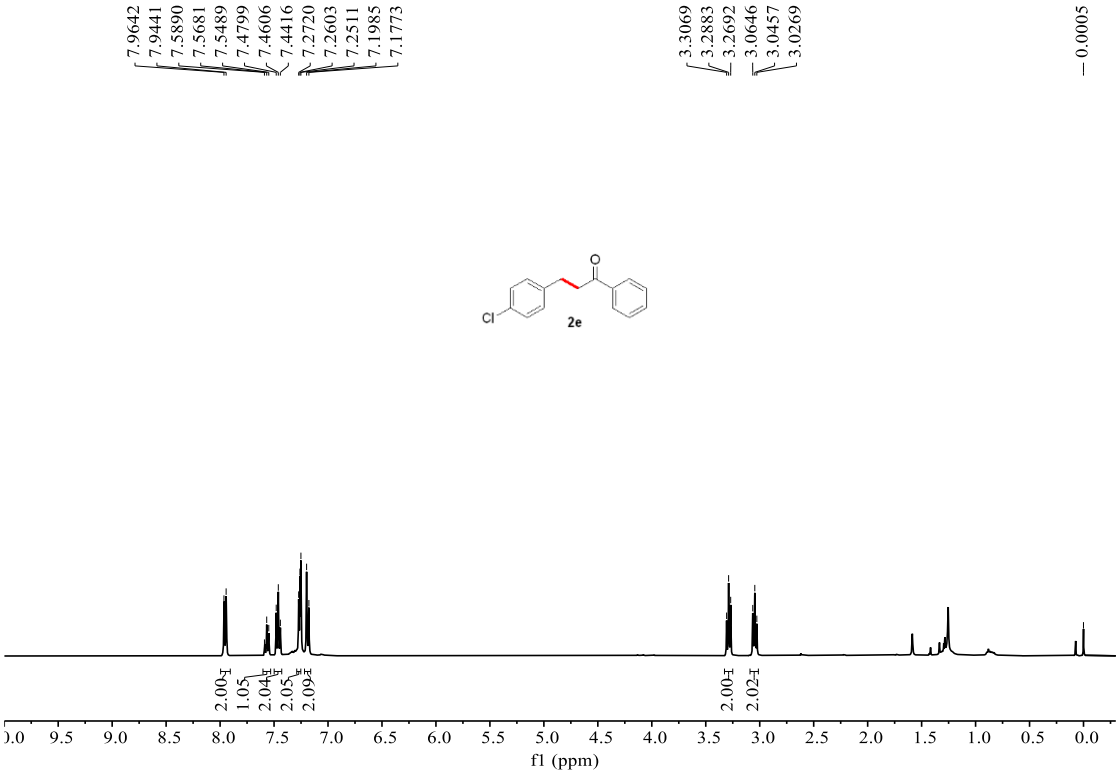
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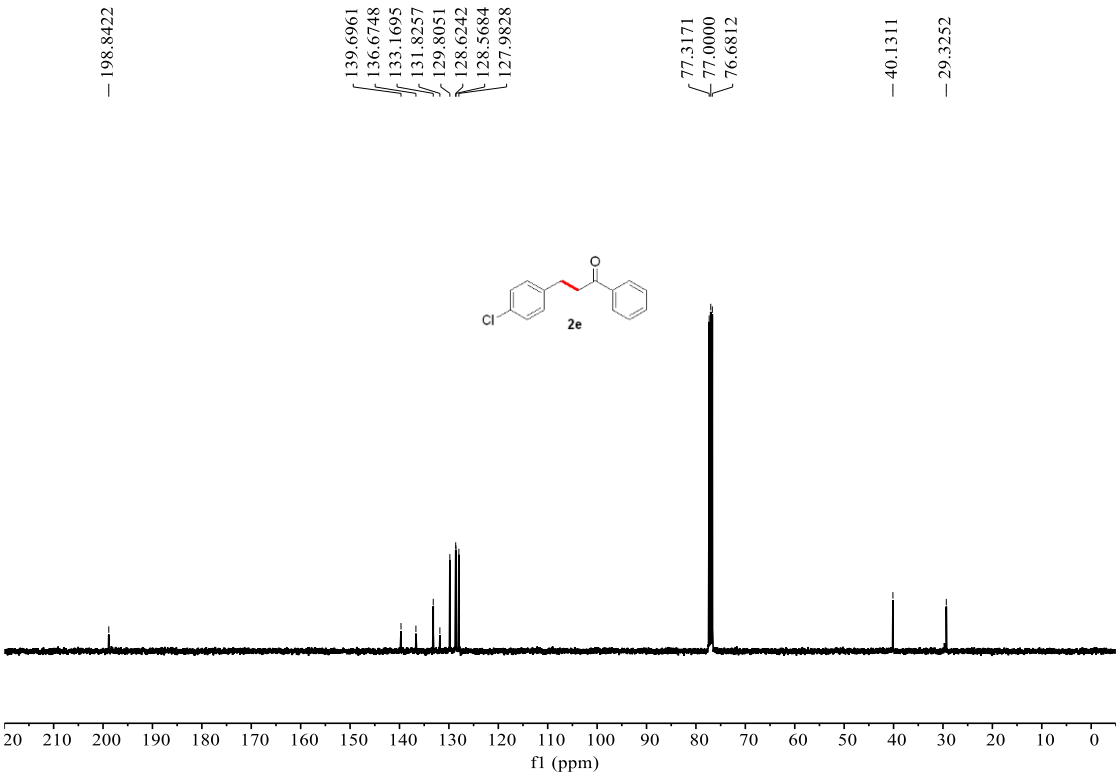
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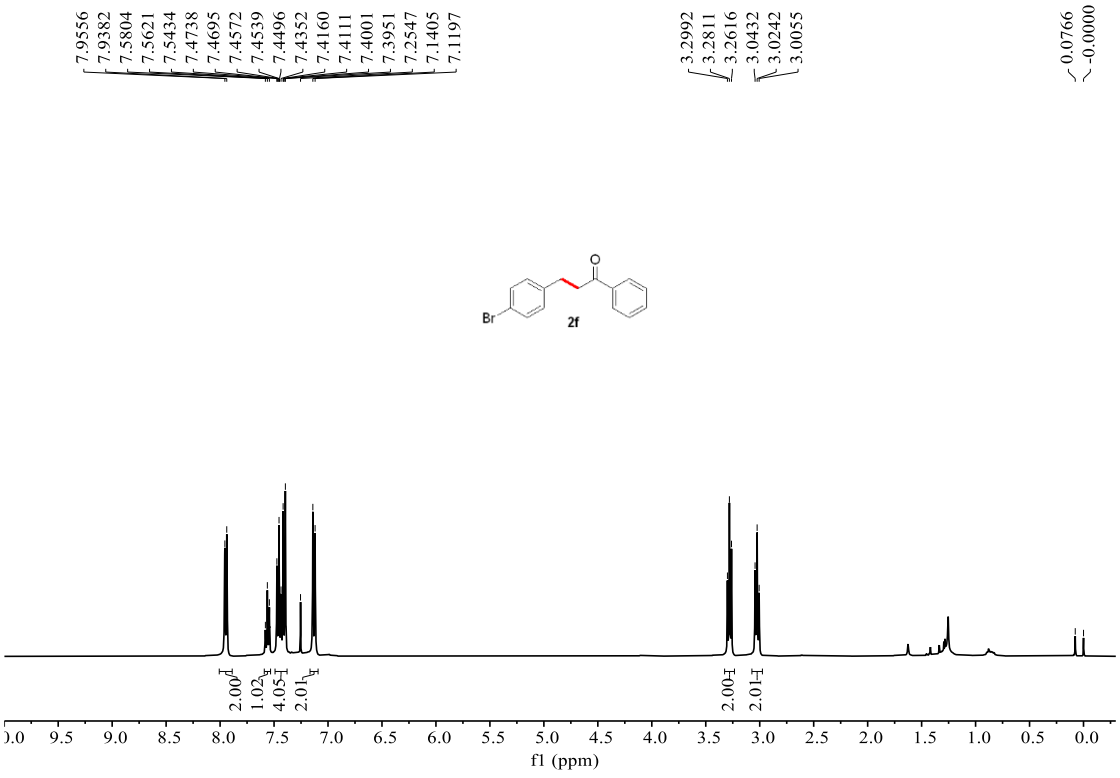
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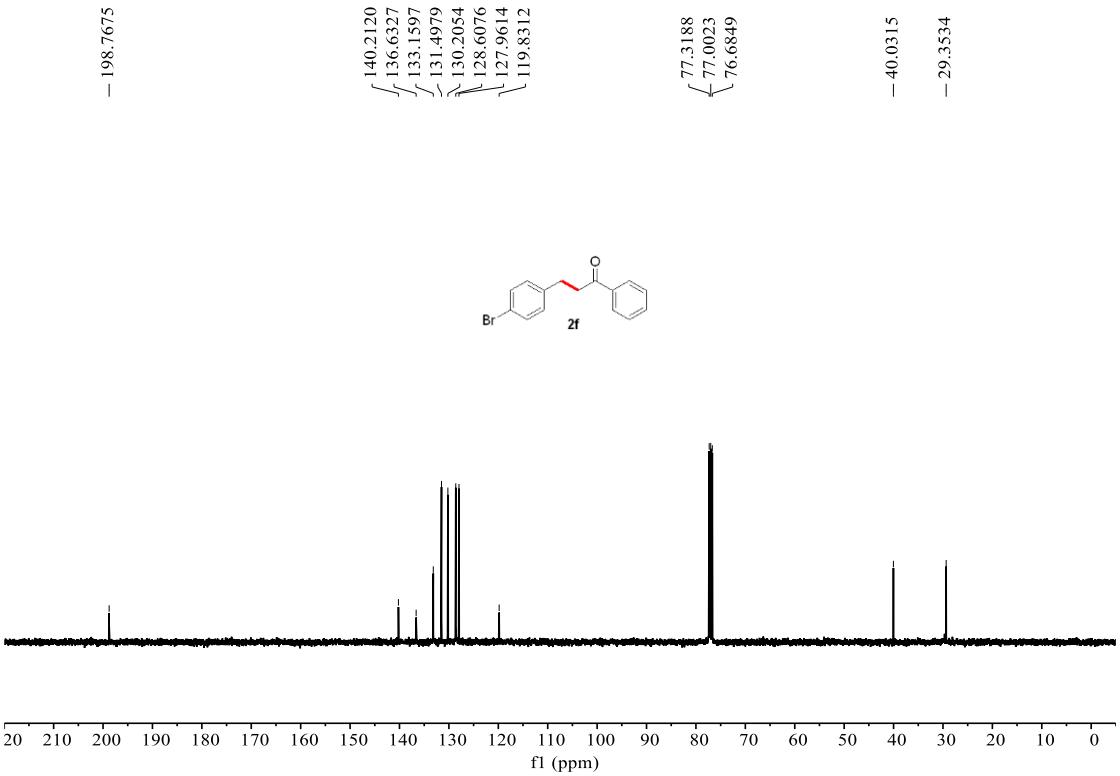
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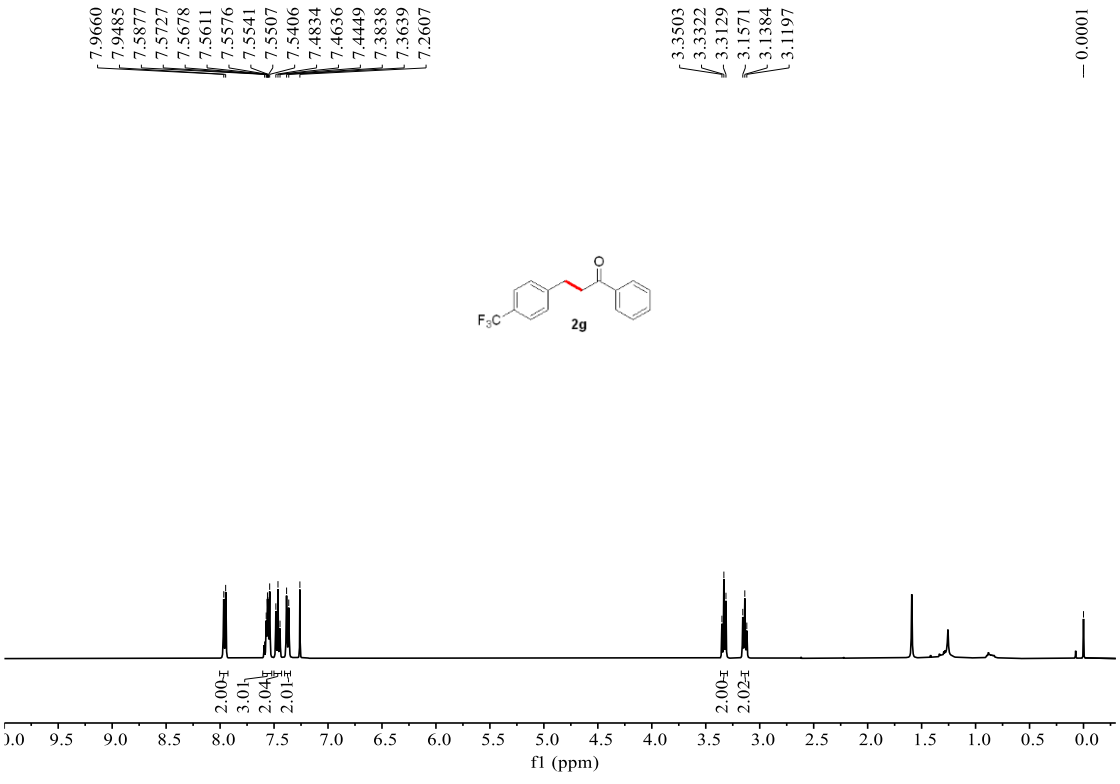
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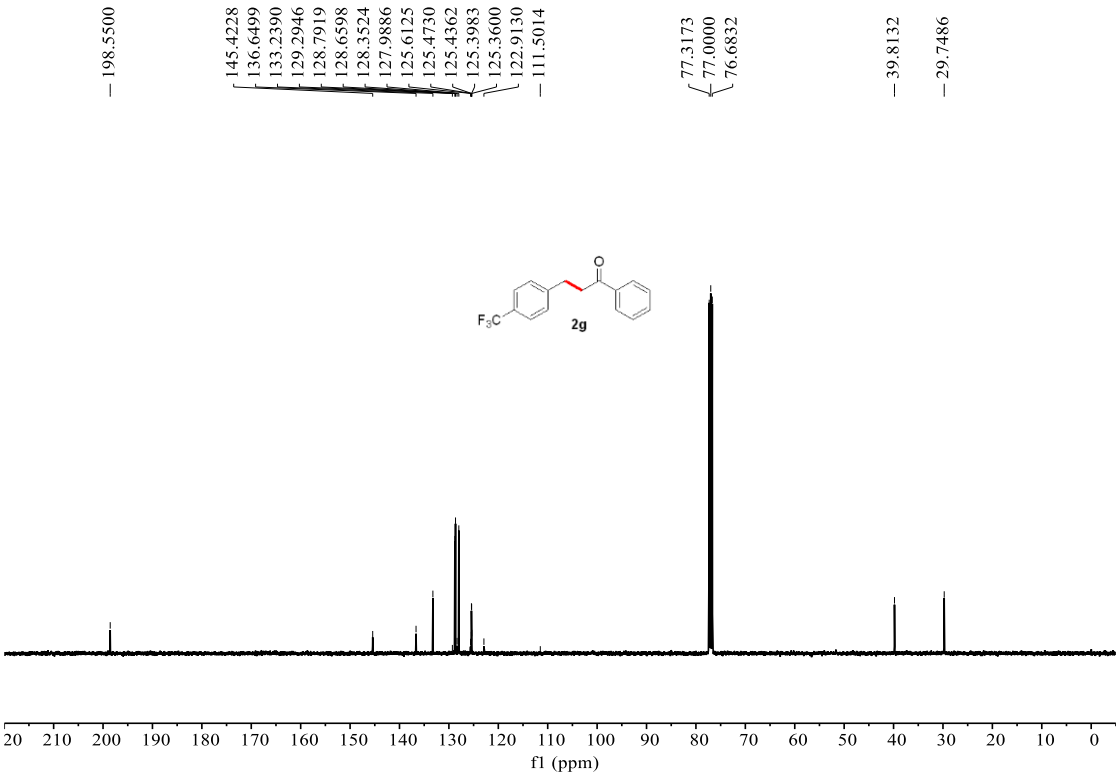
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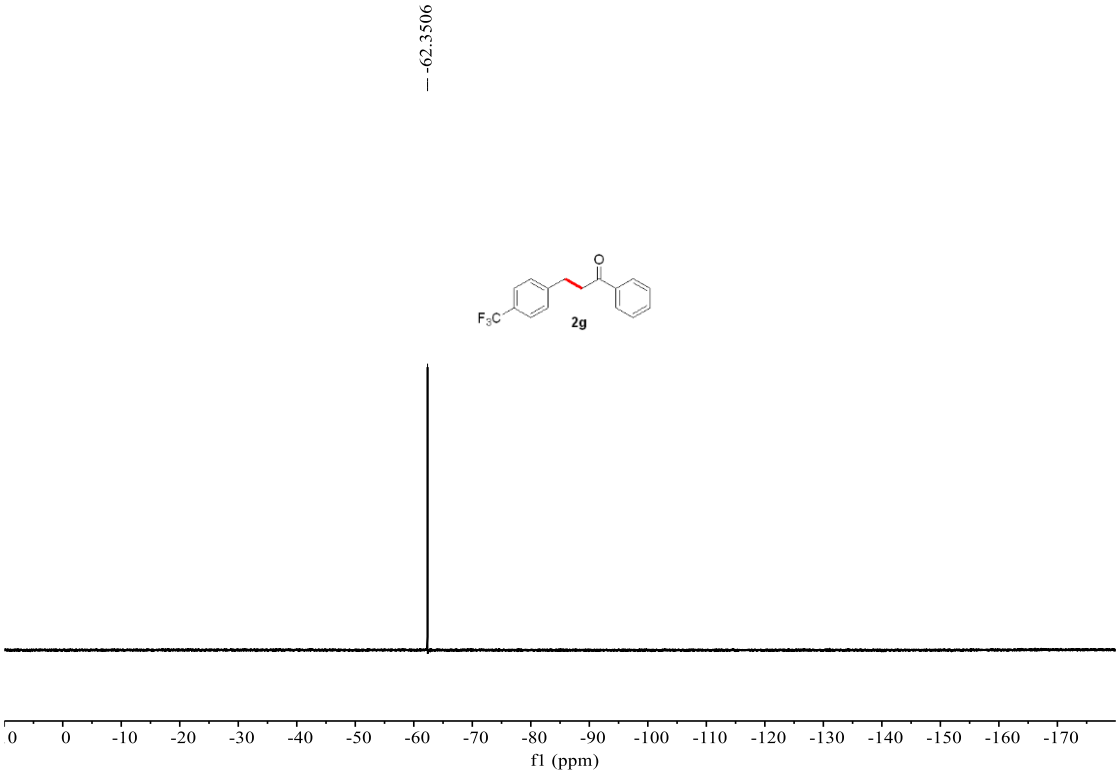
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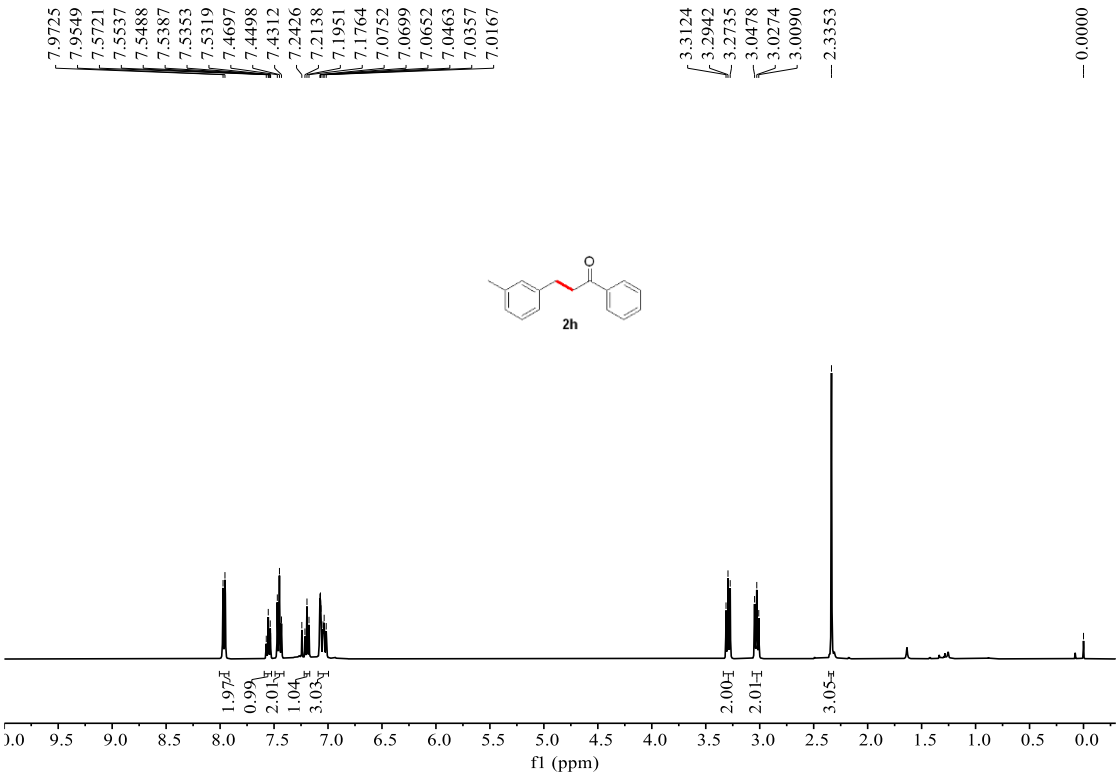
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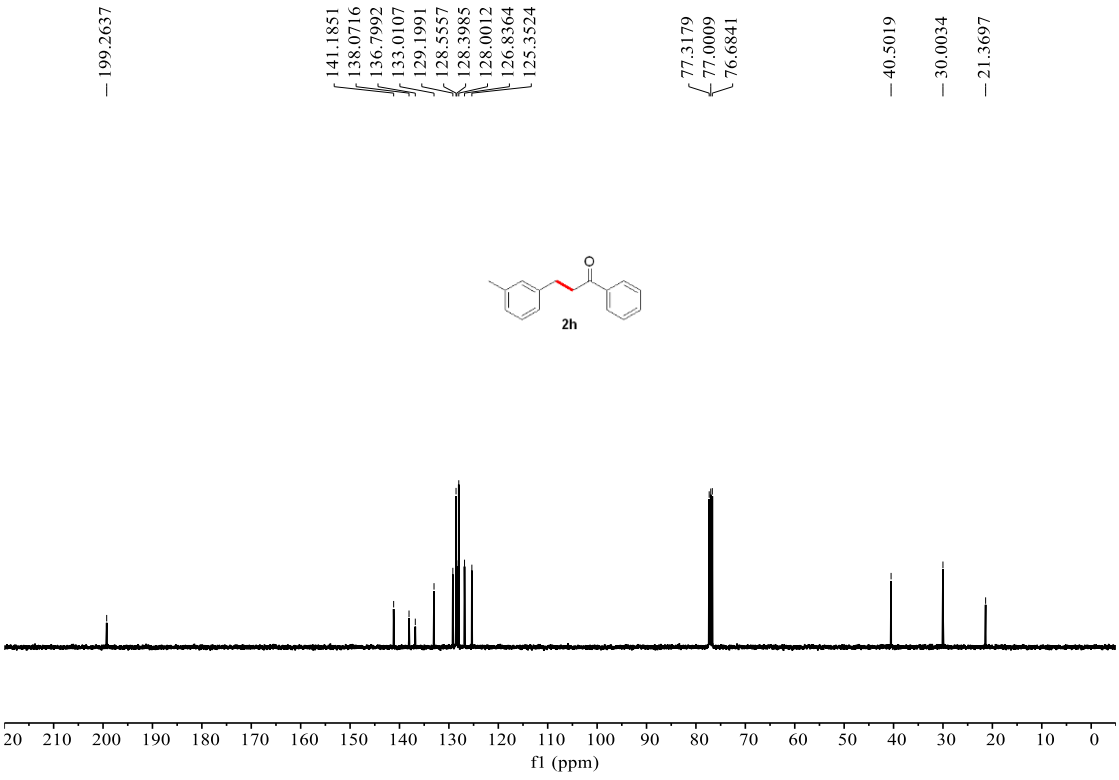
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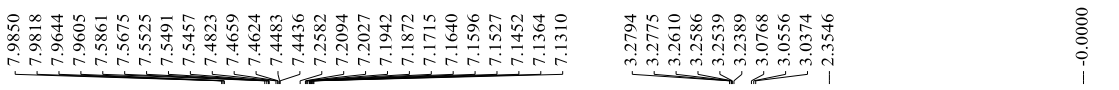
2h
f1 (ppm)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7.9644
7.9605
7.5861
7.5675
7.5525
7.5491
7.5457
7.4823
7.4659
7.4624
7.4483
7.4436
7.2582
7.2094
7.2027
7.1942
7.1872
7.1715
7.1640
7.1596
7.1527
7.1452
7.1364
7.1310
3.2794
3.2775
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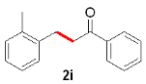
3.2586
3.2539
3.2389
3.0768
3.0556
3.0374
2.3546
-0.0000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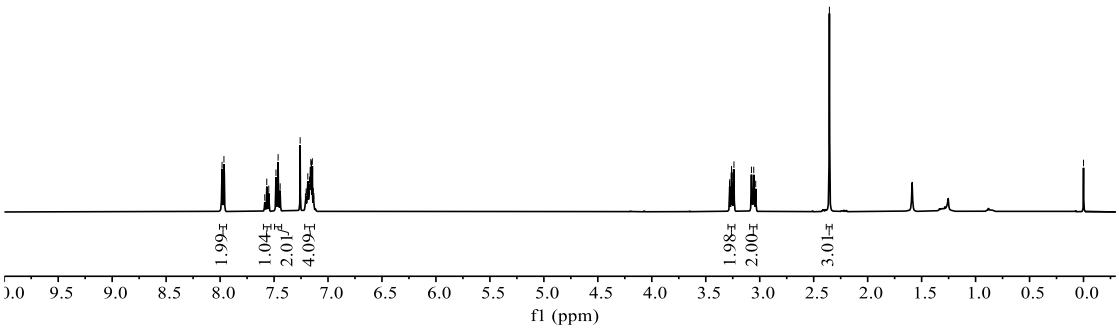
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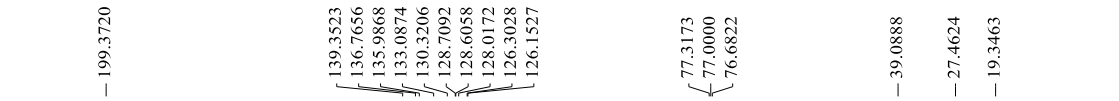
1.04
2.01
4.09
1.98
2.00
3.01
f1 (ppm)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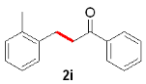
136.7656
135.9868
133.0874
130.3206
128.7092
128.6058
128.0172
126.3028
126.1527
77.3173
77.0000
76.6822
39.0888
27.4624
19.3463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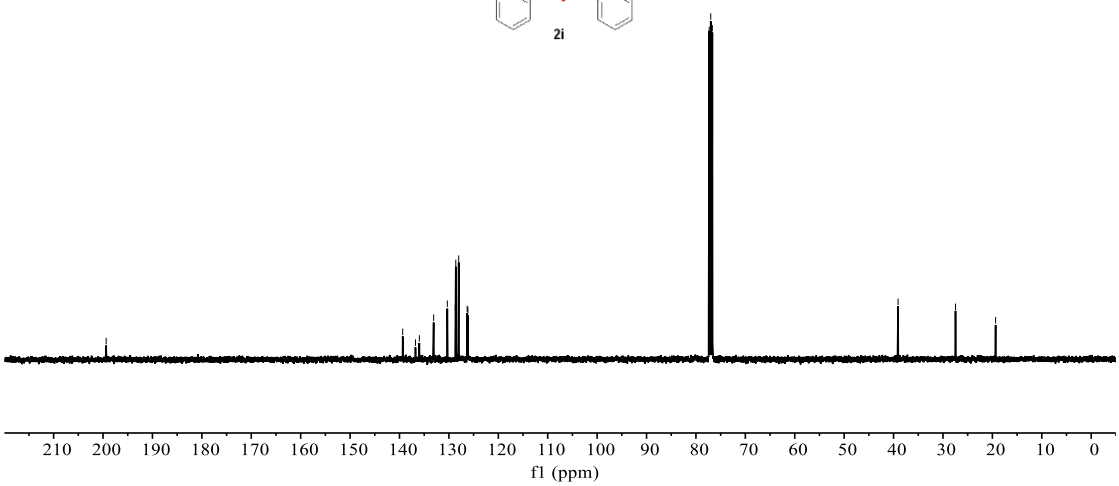
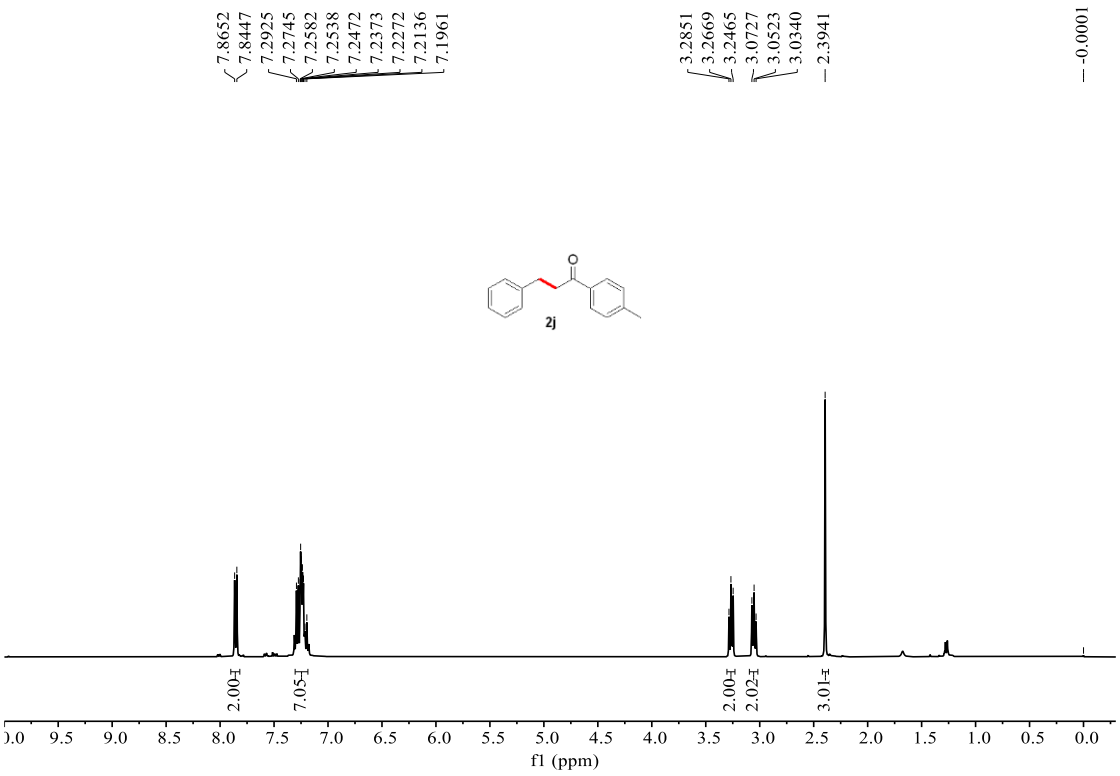
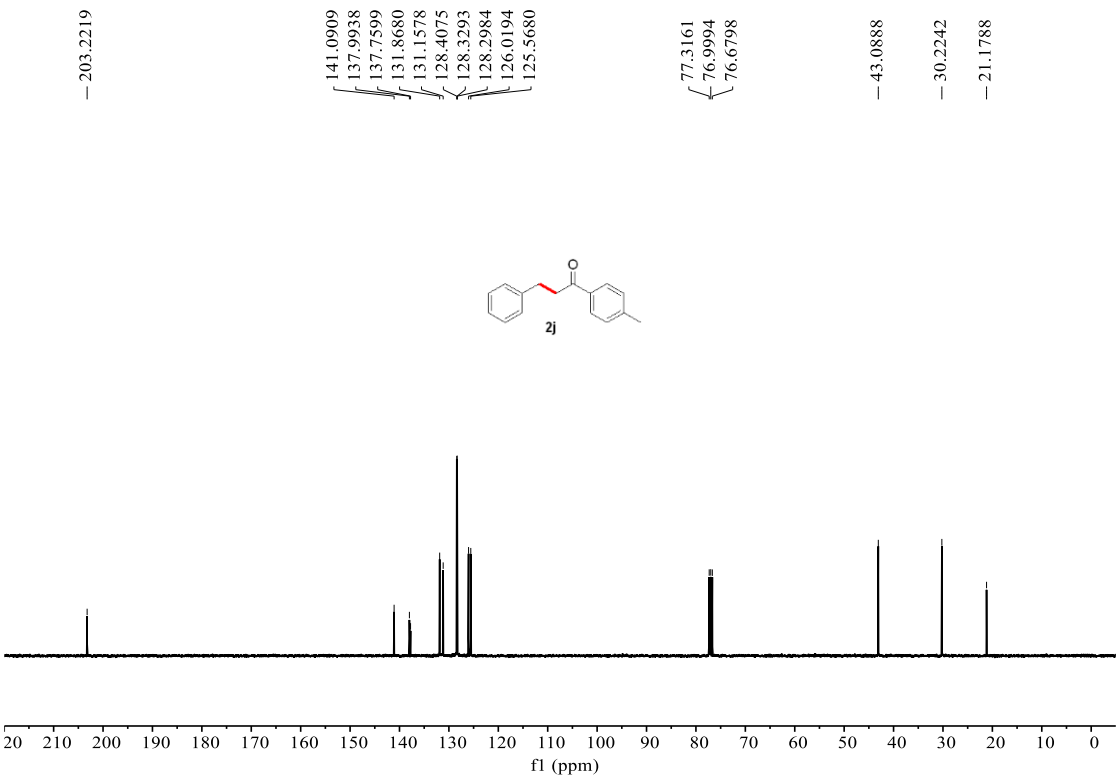

f1 (ppm)


7.8652
7.8447
7.2925
7.2745
7.2582
7.2538
7.2472
7.2373
7.2272
7.2136
7.1961
3.2851
3.2669
3.2465
3.0727
3.0523
3.0340
2.3941
-0.0001
2j
2.00
7.05
2.00
2.02
3.01
f1 (ppm)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141.0909
137.9938
137.7599
131.8680
131.1578
128.4075
128.3293
128.2984
126.0194
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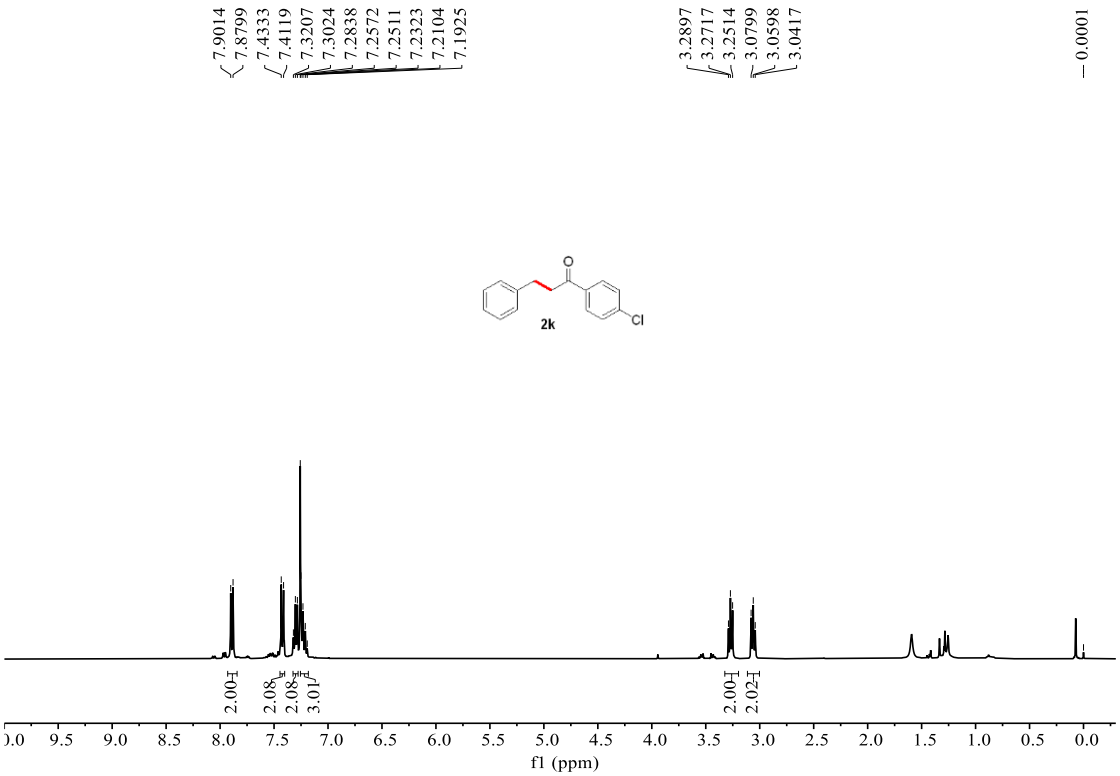
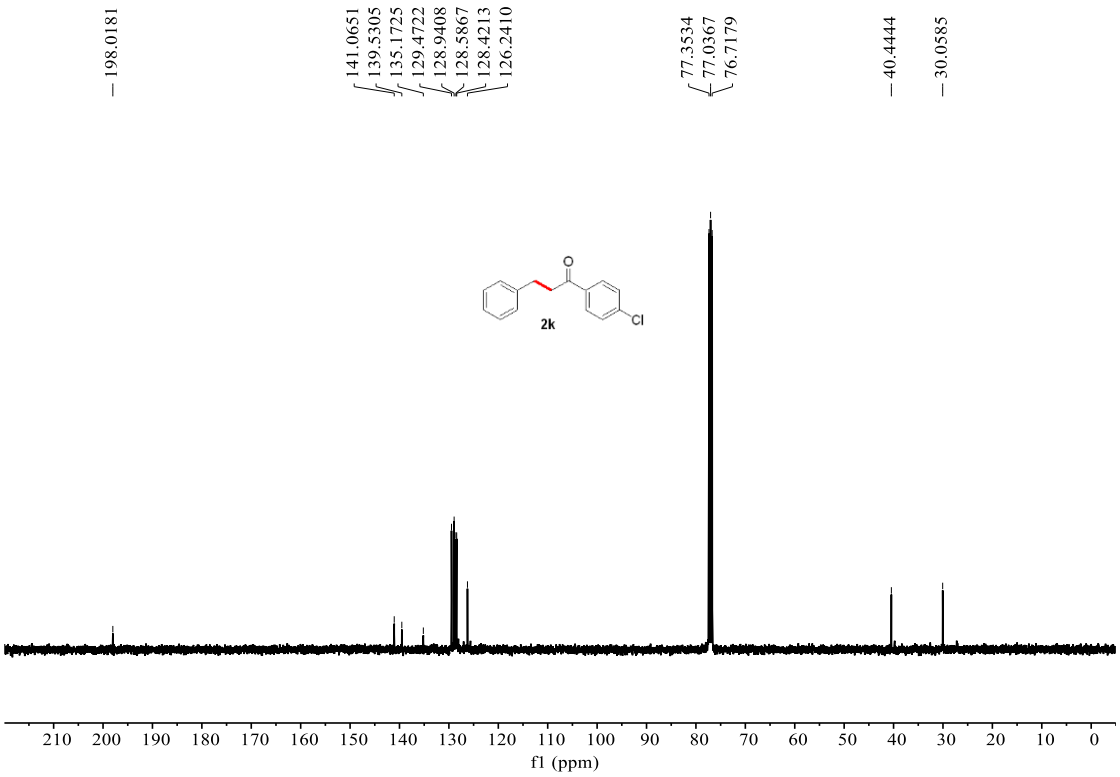
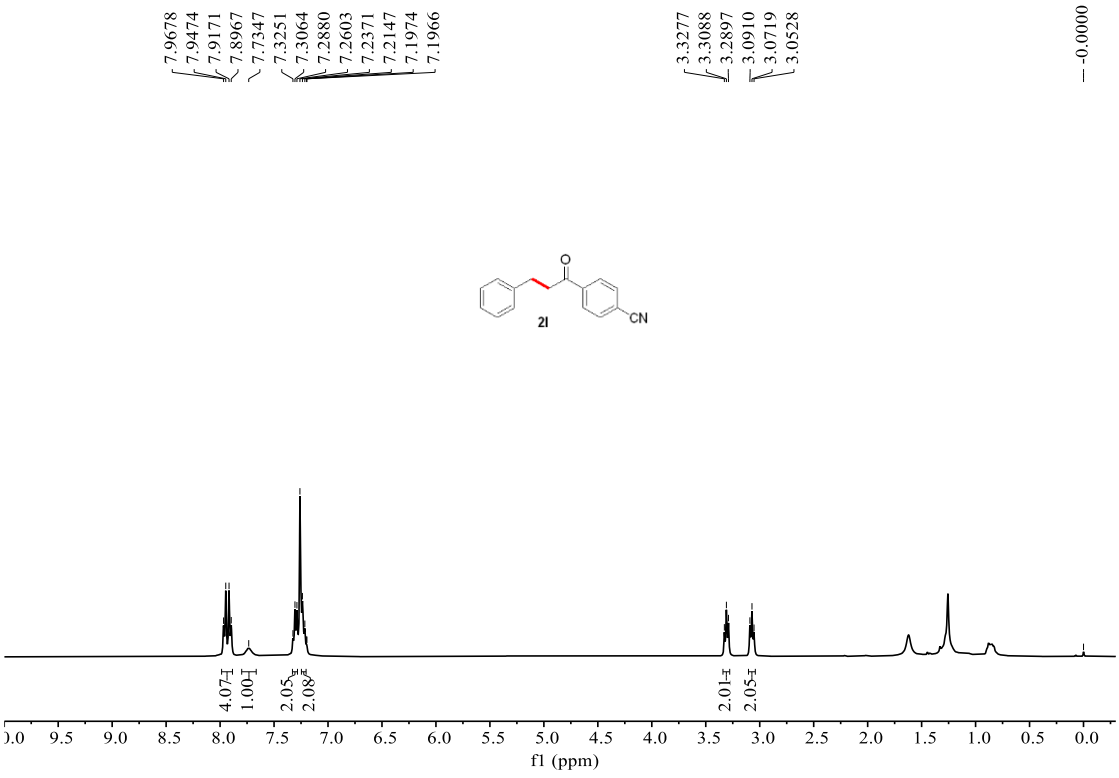
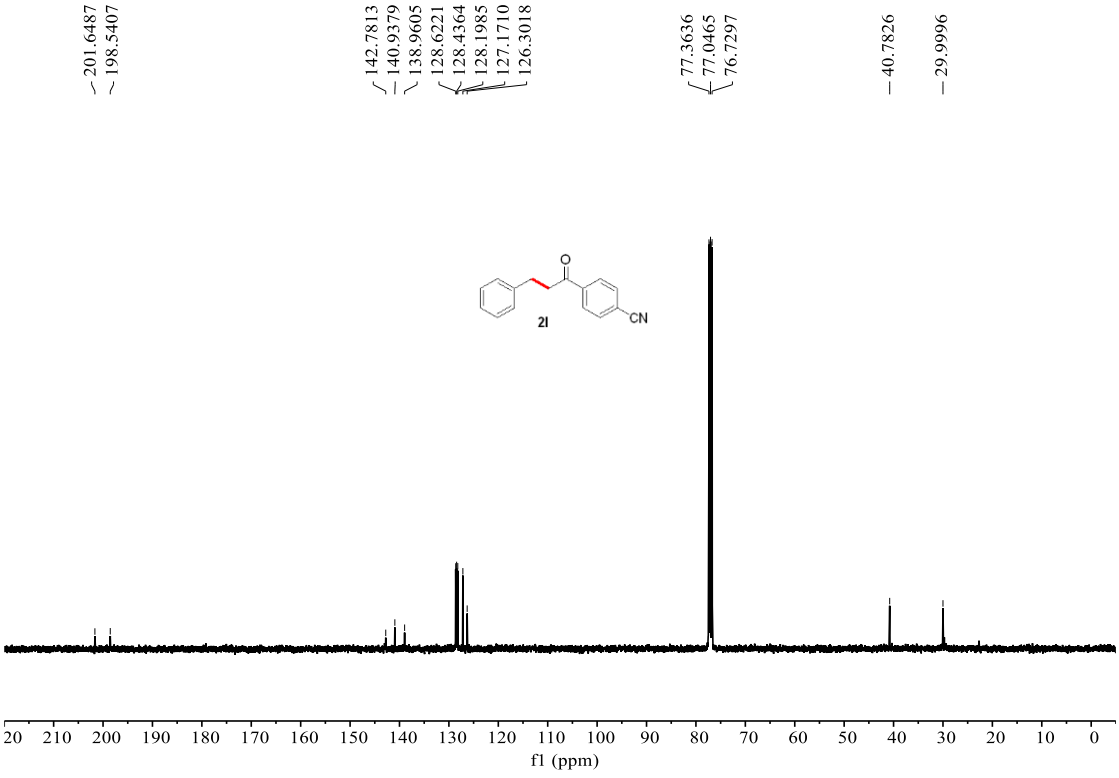
43.0888
30.2242
21.1788
2j
f1 (ppm)

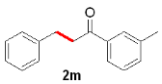

7.9014
7.8799
7.4333
7.4119
7.3207
7.3024
7.2838
7.2572
7.2511
7.2323
7.2104
7.1925
3.2897
3.2717
3.2514
3.0799
3.0598
3.0417
0.0001
2k
Cl
2.00
2.08
2.08
3.01
2.00
2.02
f1 (ppm)

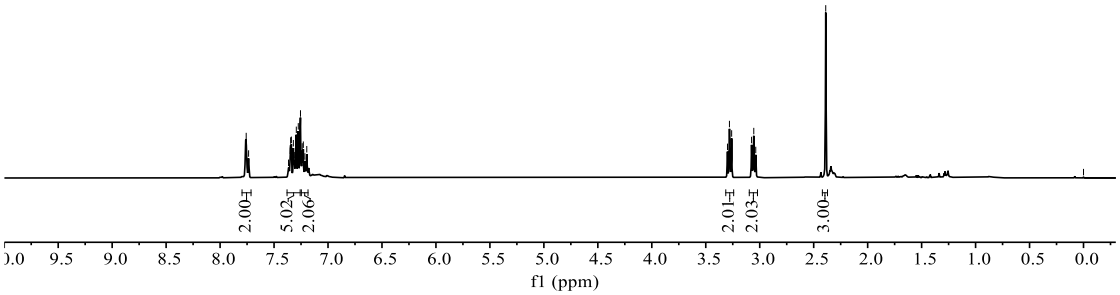

198.0181
141.0651
139.5305
135.1725
129.4722
128.9408
128.5867
128.4213
126.2410
77.3534
77.0367
76.7179
40.4444
30.0585
2k
Cl
f1 (ppm)


7.9678
7.9474
7.9171
7.8967
7.7347
7.3251
7.3064
7.2880
7.2603
7.2371
7.2147
7.1974
7.1966
3.3277
3.3088
3.2897
3.0910
3.0719
3.0528
-0.0000
O
CN
2l
4.07
1.00
2.05
2.08
2.01
2.05
f1 (ppm)

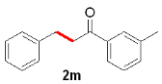

201.6487
198.5407
142.7813
140.9379
138.9605
128.6221
128.4364
128.1985
127.1710
126.3018
77.3636
77.0465
76.7297
40.7826
29.9996
O
CN
2l
f1 (ppm)

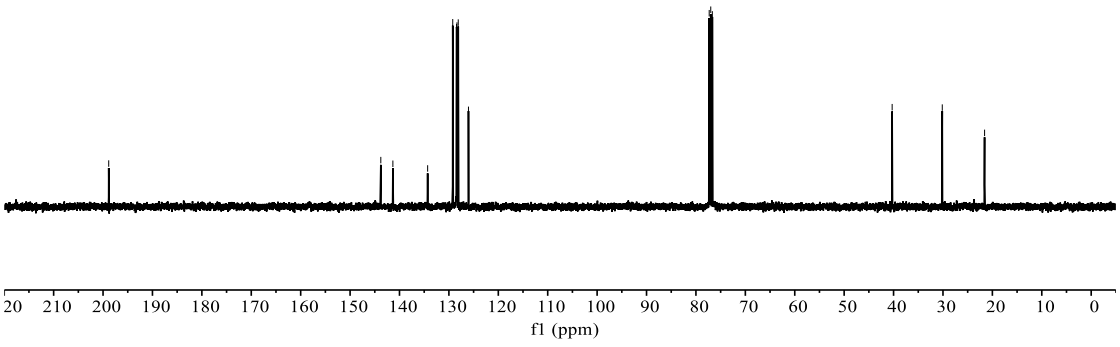

7.7581
7.7358
7.3658
7.3508
7.3464
7.3394
7.3211
7.3125
7.3022
7.2937
7.2811
7.2756
7.2596
7.2551
7.2392
7.2348
7.2287
7.2143
7.1968
3.2988
3.2806
3.2602
3.0755
3.0552
3.0369
2.3885
0.0000

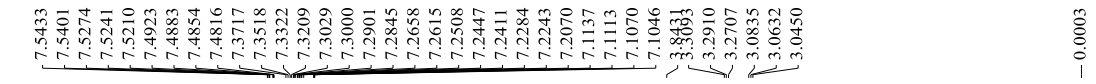

O
2m

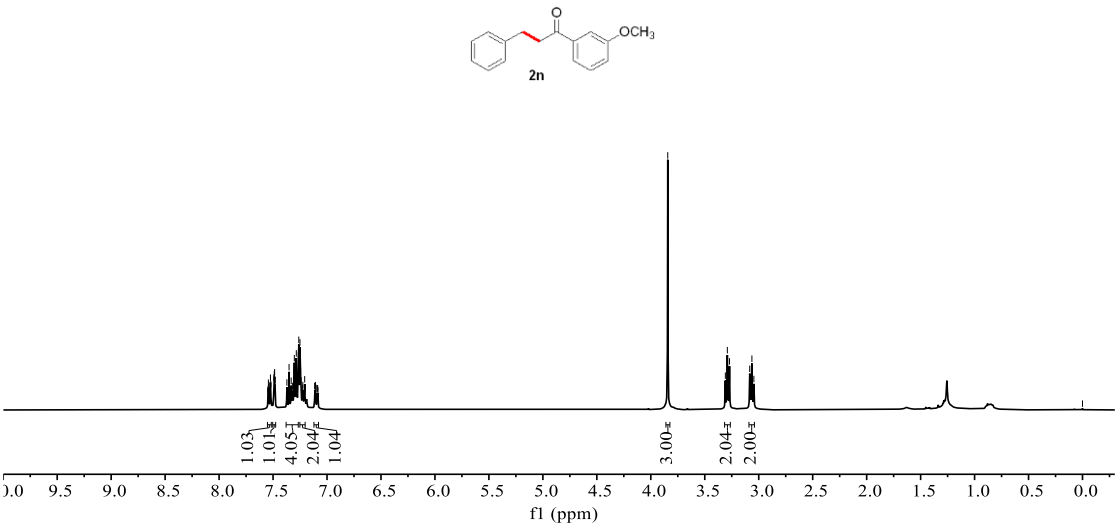

2.00
5.02
2.06
2.01
2.03
3.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

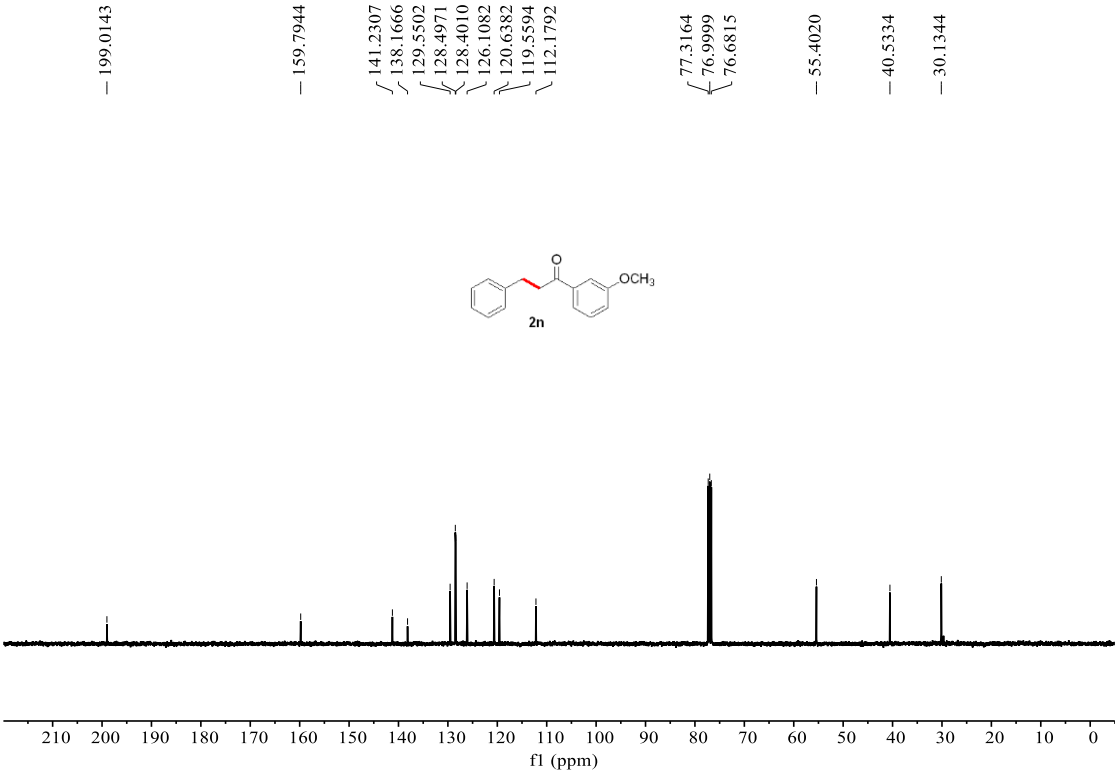

198.8519
143.7805
141.3381
134.3016
129.2231
128.4533
128.3702
128.1078
126.0380
77.3159
76.9997
76.6807
40.2856
30.1427
21.5792


O
2m


210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.5433
7.5401
7.5274
7.5241
7.5210
7.4923
7.4883
7.4854
7.4816
7.3717
7.3518
7.3322
7.3209
7.3029
7.3000
7.2901
7.2845
7.2658
7.2615
7.2508
7.2447
7.2411
7.2284
7.2243
7.2070
7.1137
7.1113
7.1070
7.1046
3.3093
3.2910
3.2707
3.0835
3.0632
3.0450
0.0003


O
OCH3
2n
1.03
1.01
4.05
2.04
1.04
3.00
2.04
2.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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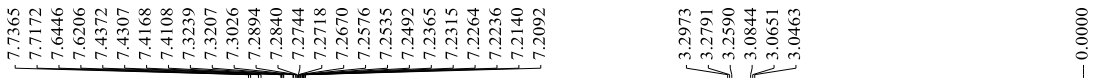
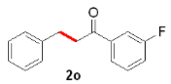
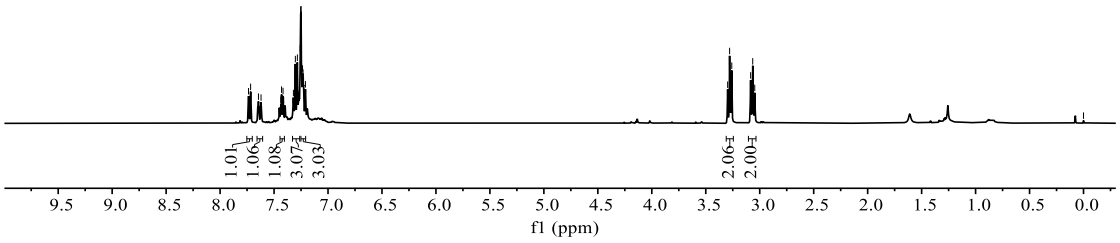
159.7944
141.2307
138.1666
129.5502
128.4971
128.4010
126.1082
120.6382
119.5594
112.1792
77.3164
76.9999
76.6815
55.4020
40.5334
30.1344
O
OCH3
2n
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.7365
7.7172
7.6446
7.6206
7.4372
7.4307
7.4168
7.4108
7.3239
7.3207
7.3026
7.2894
7.2840
7.2744
7.2718
7.2670
7.2576
7.2535
7.2492
7.2365
7.2315
7.2264
7.2236
7.2140
7.2092
3.2973
3.2791
3.2590
3.0844
3.0651
3.0463
0.0000


O
F

2o


1.01
1.06
1.08
3.07
3.03
2.06
2.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


197.8975
164.0606
161.5960
140.9590
138.9035
138.8455
130.2782
130.2019
128.6590
128.5380
128.3786
128.1288
126.1993
123.7513
123.7215
120.1603
119.9470
114.8600
114.6397
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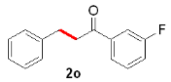
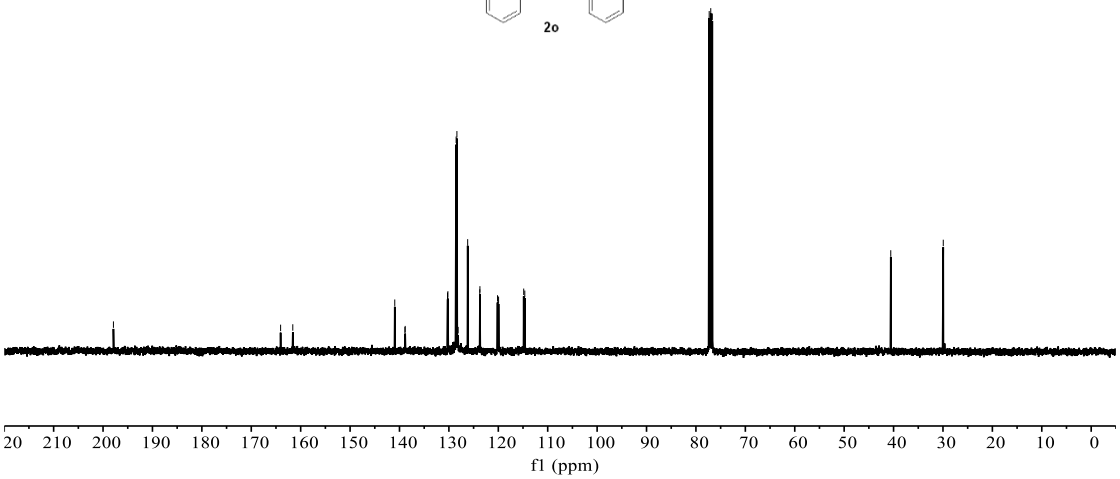
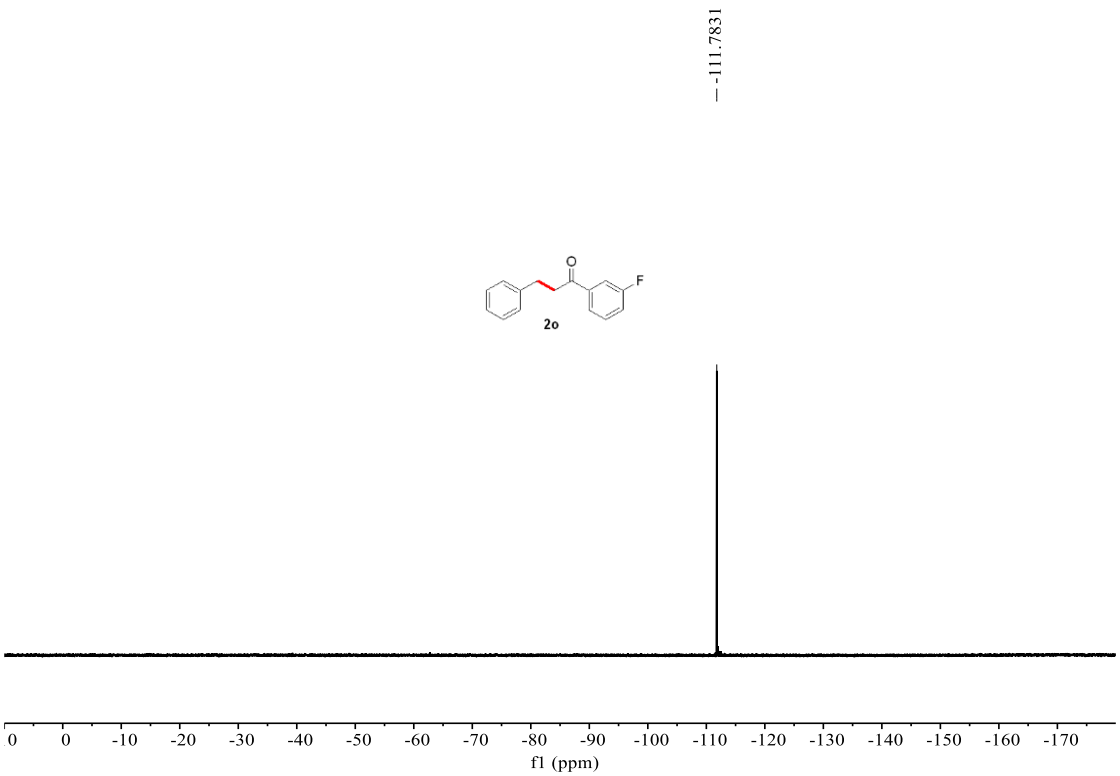
77.0012
76.6851
40.5678
29.9423

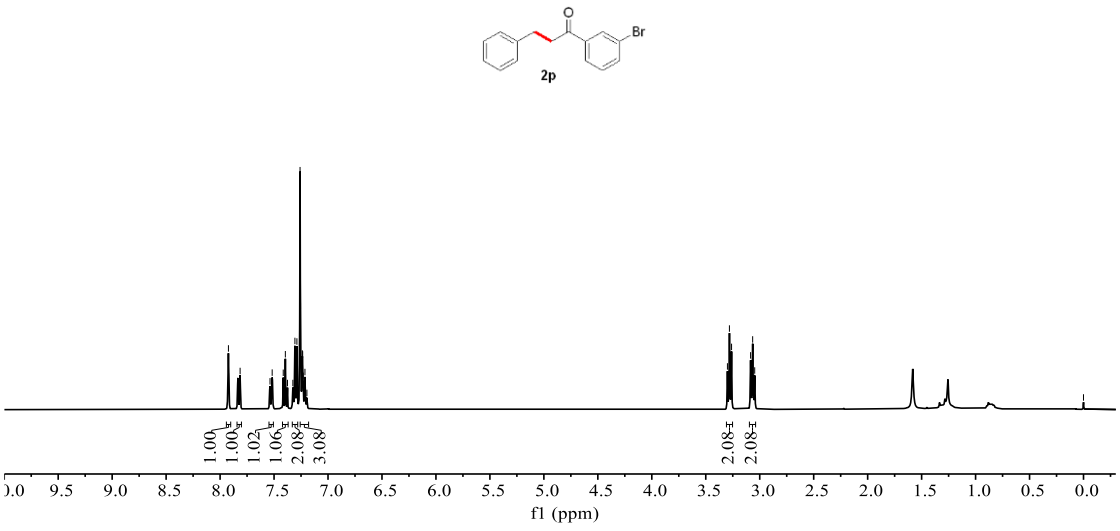

O
F

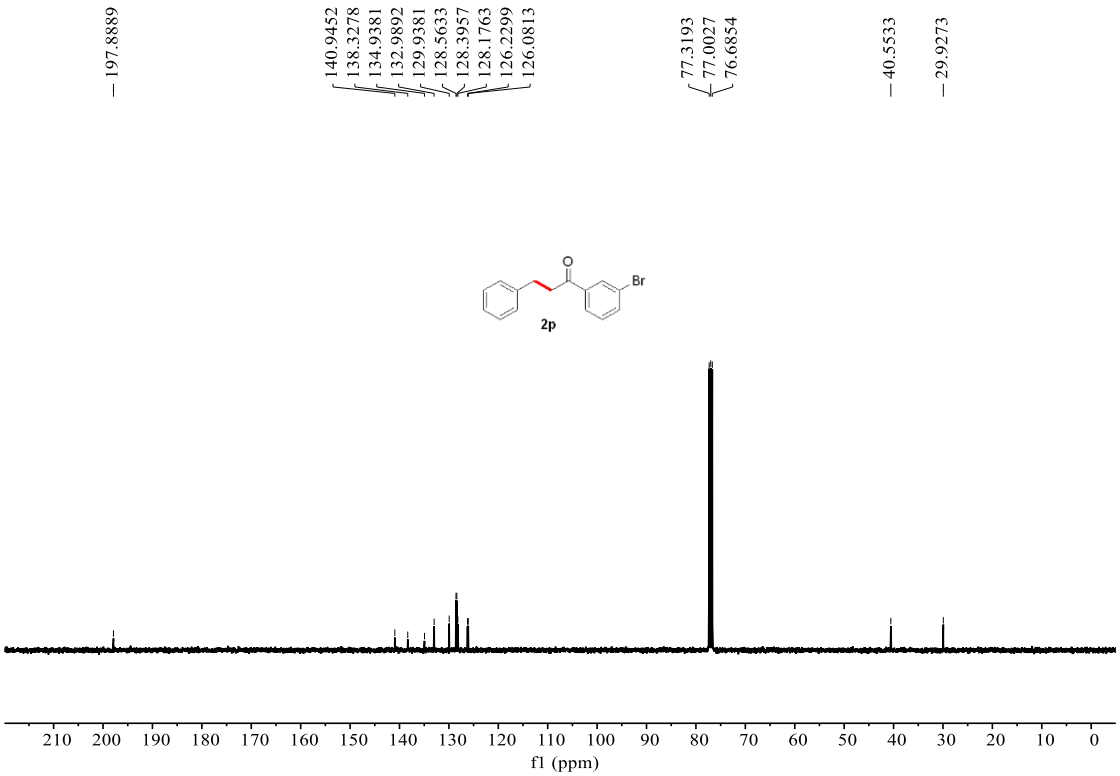
2o


20 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


-111.7831
O
F
2o
0 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170
f1 (ppm)


7.9227
7.8377
7.8146
7.5374
7.5175
7.4150
7.3953
7.3757
7.3257
7.3204
7.3068
7.2883
7.2591
7.2547
7.2384
7.2348
7.2306
7.2139
7.1957
3.2993
3.2809
3.2611
3.0848
3.0656
3.0467
0.0003


O
Br
2p
1.00
1.00
1.02
1.06
2.08
3.08
2.08
2.08
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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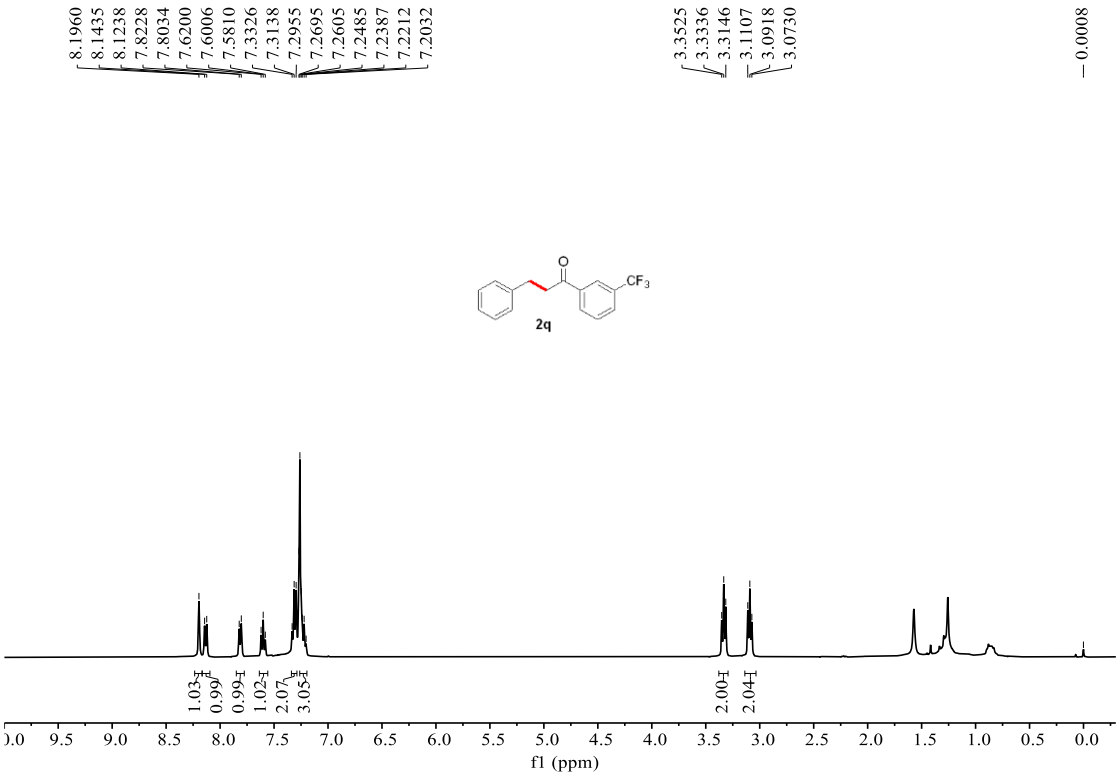
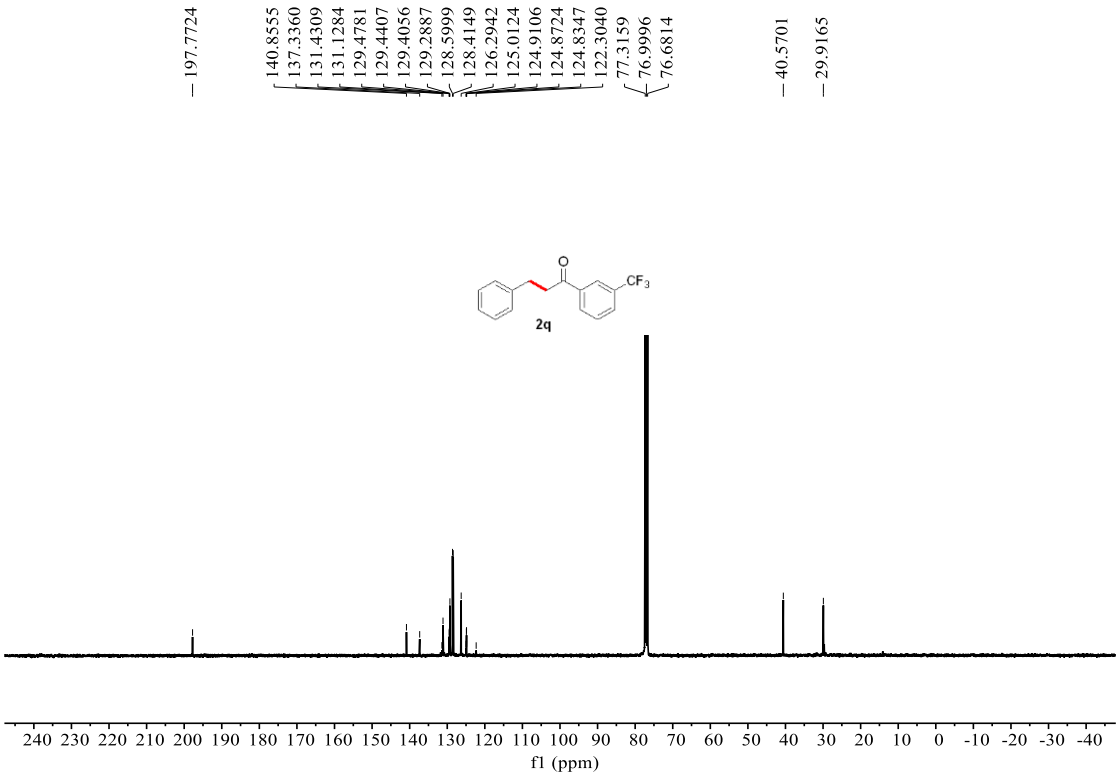
138.3278
134.9381
132.9892
129.9381
128.5633
128.3957
128.1763
126.2299
126.0813
77.3193
77.0027
76.6854
40.5533
29.9273
O
Br
2p
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


8.1960
8.1435
8.1238
7.8228
7.8034
7.6200
7.6006
7.5810
7.3326
7.3138
7.2955
7.2695
7.2605
7.2485
7.2387
7.2212
7.2032
3.3525
3.3336
3.3146
3.1107
3.0918
3.0730
0.0008
O
CF3
2q
1.03
0.99
0.99
1.02
2.07
3.05
2.00
2.04
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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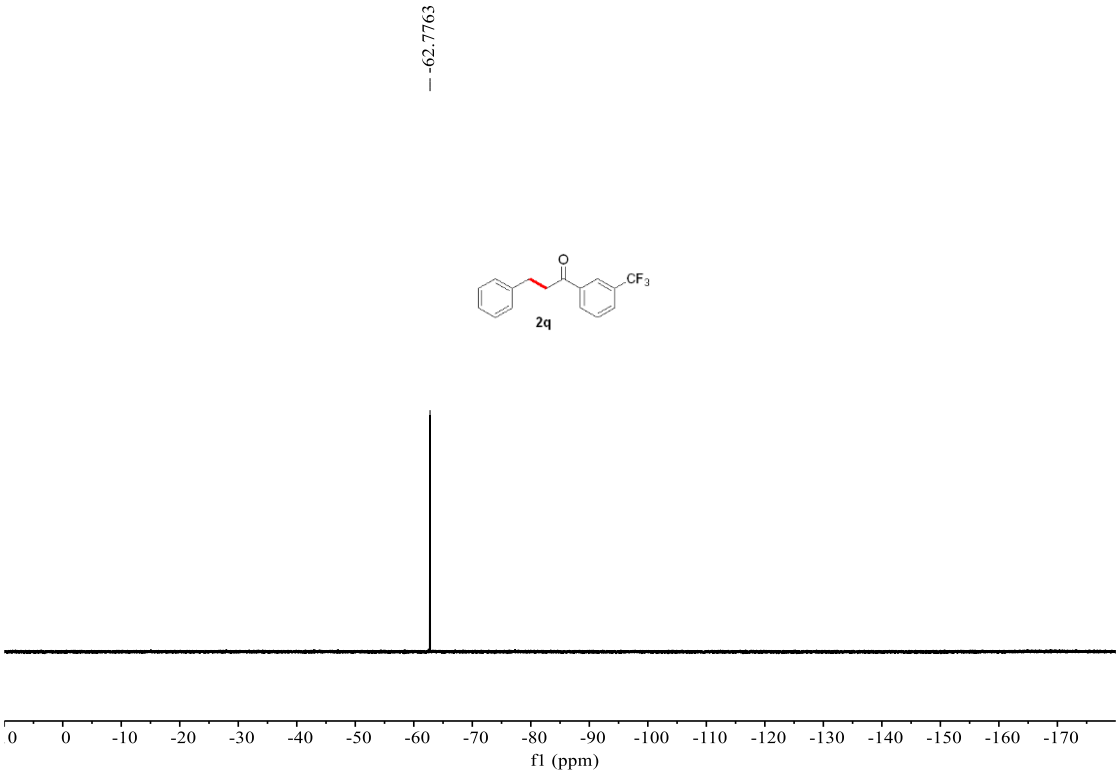
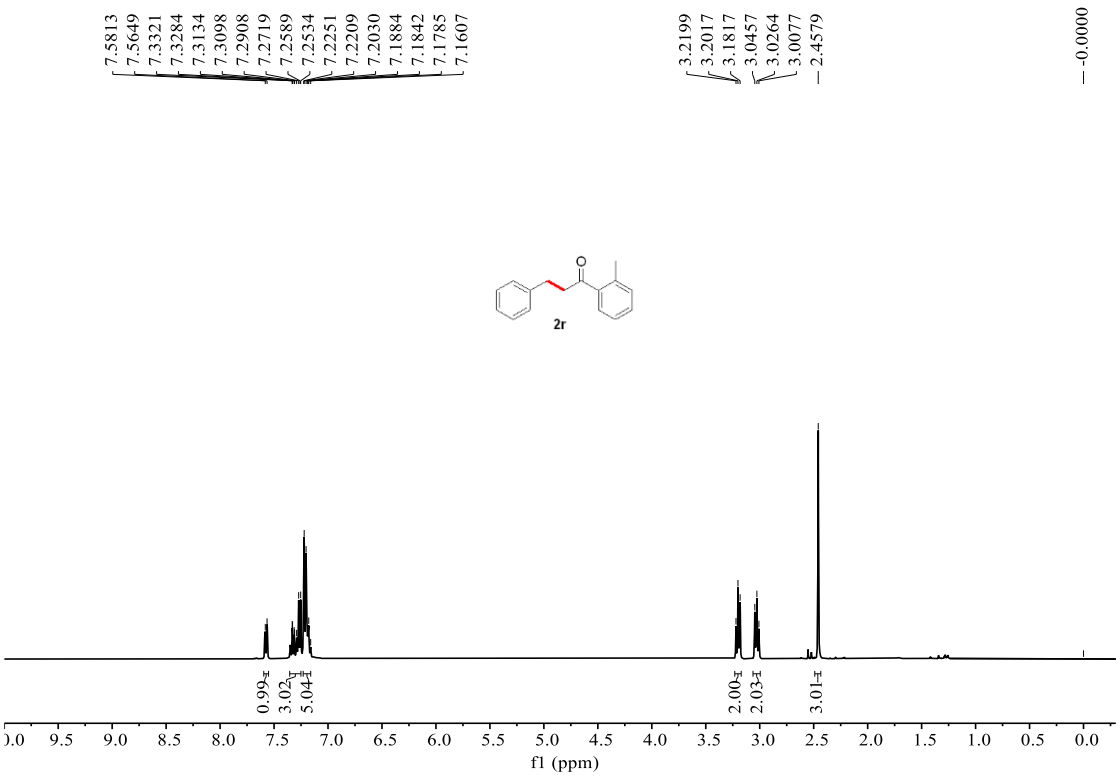
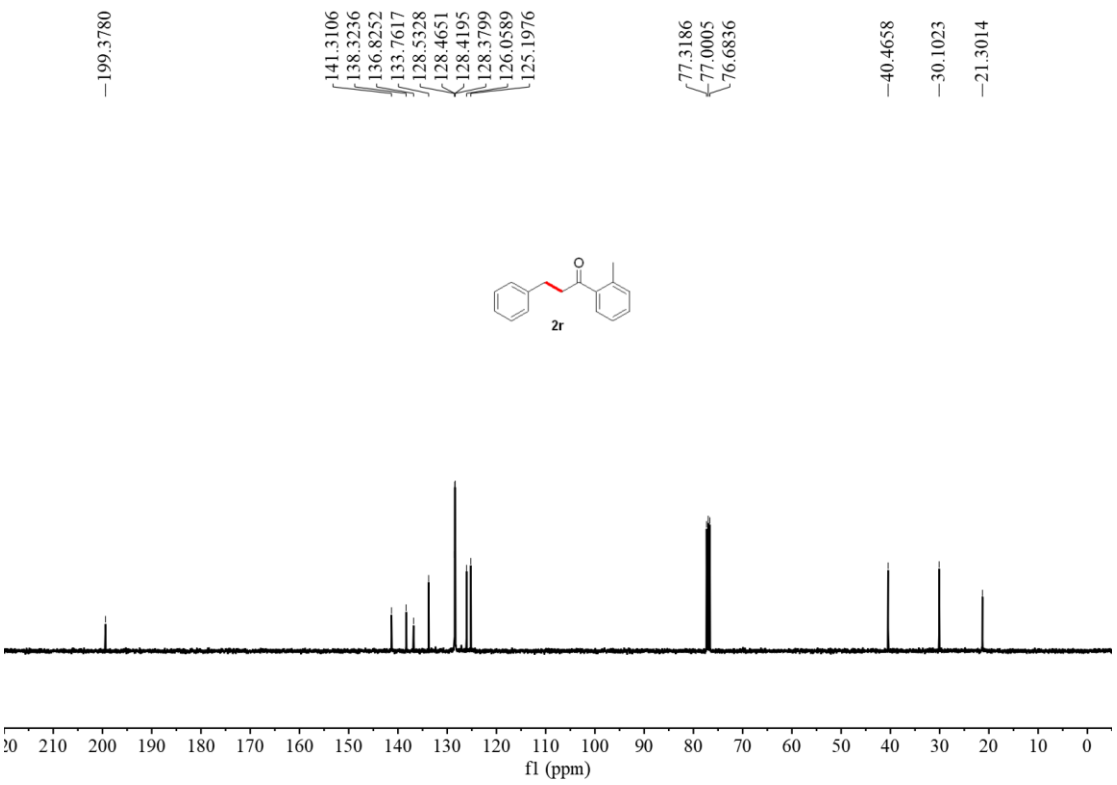
137.3360
131.4309
131.1284
129.4781
129.4407
129.4056
129.2887
128.5999
128.4149
126.2942
125.0124
124.9106
124.8724
124.8347
122.3040
77.3159
76.9996
76.6814
40.5701
29.9165
O
CF3
2q
240 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20 -30 -40
f1 (ppm)


-62.7763
O
CF3
2q
0 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170
f1 (ppm)


7.5813
7.5649
7.3321
7.3284
7.3134
7.3098
7.2908
7.2719
7.2589
7.2534
7.2251
7.2209
7.2030
7.1884
7.1842
7.1785
7.1607
3.2199
3.2017
3.1817
3.0457
3.0264
3.0077
2.4579
0.0000
2r
0.99
3.02
5.04
2.00
2.03
3.01
f1 (ppm)


199.3780
141.3106
138.3236
136.8252
133.7617
128.5328
128.4651
128.4195
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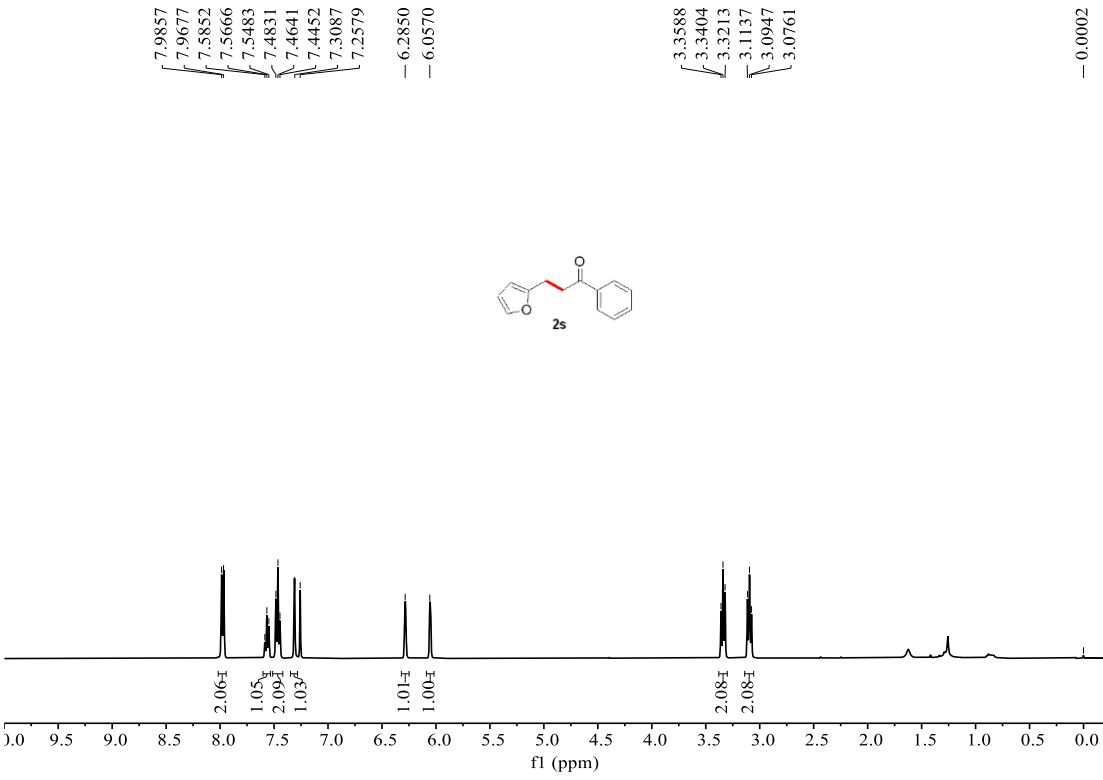
40.4658
30.1023
21.3014
2r
f1 (ppm)


7.9857
7.9677
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7.4831
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7.3087
7.2579
6.2850
6.0570
3.3588
3.3404
3.3213
3.1137
3.0947
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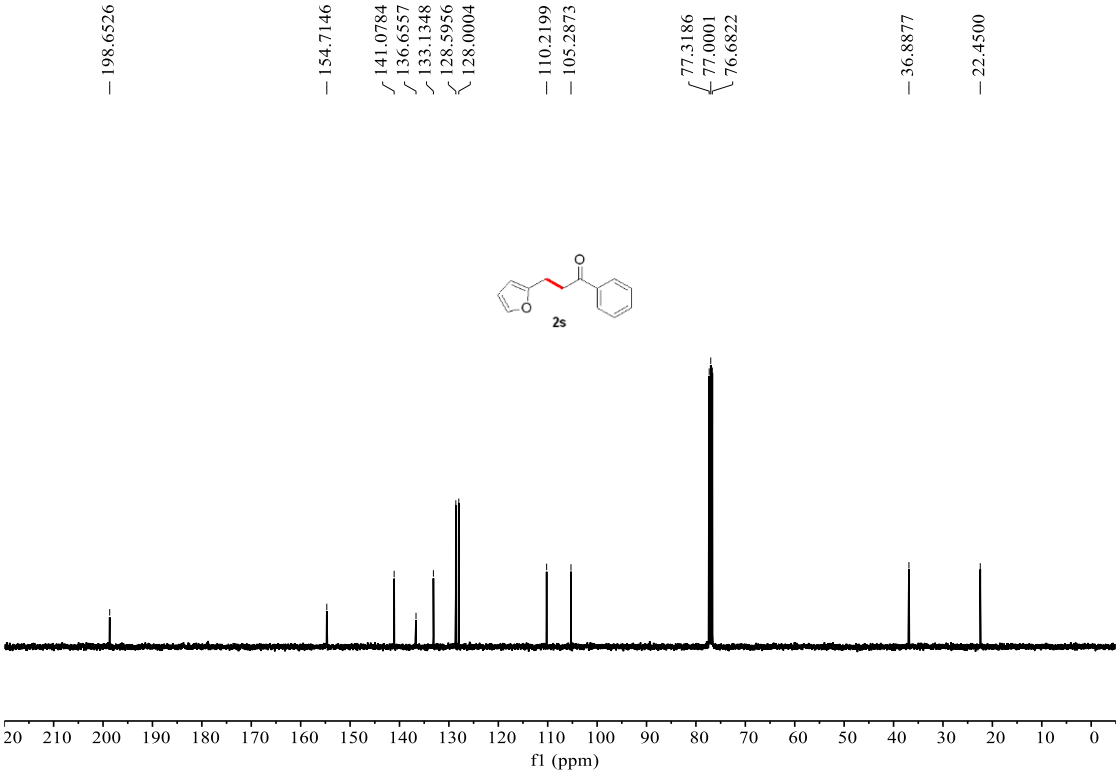
1.05
2.09
1.03
1.01
1.00
2.08
2.08
f1 (ppm)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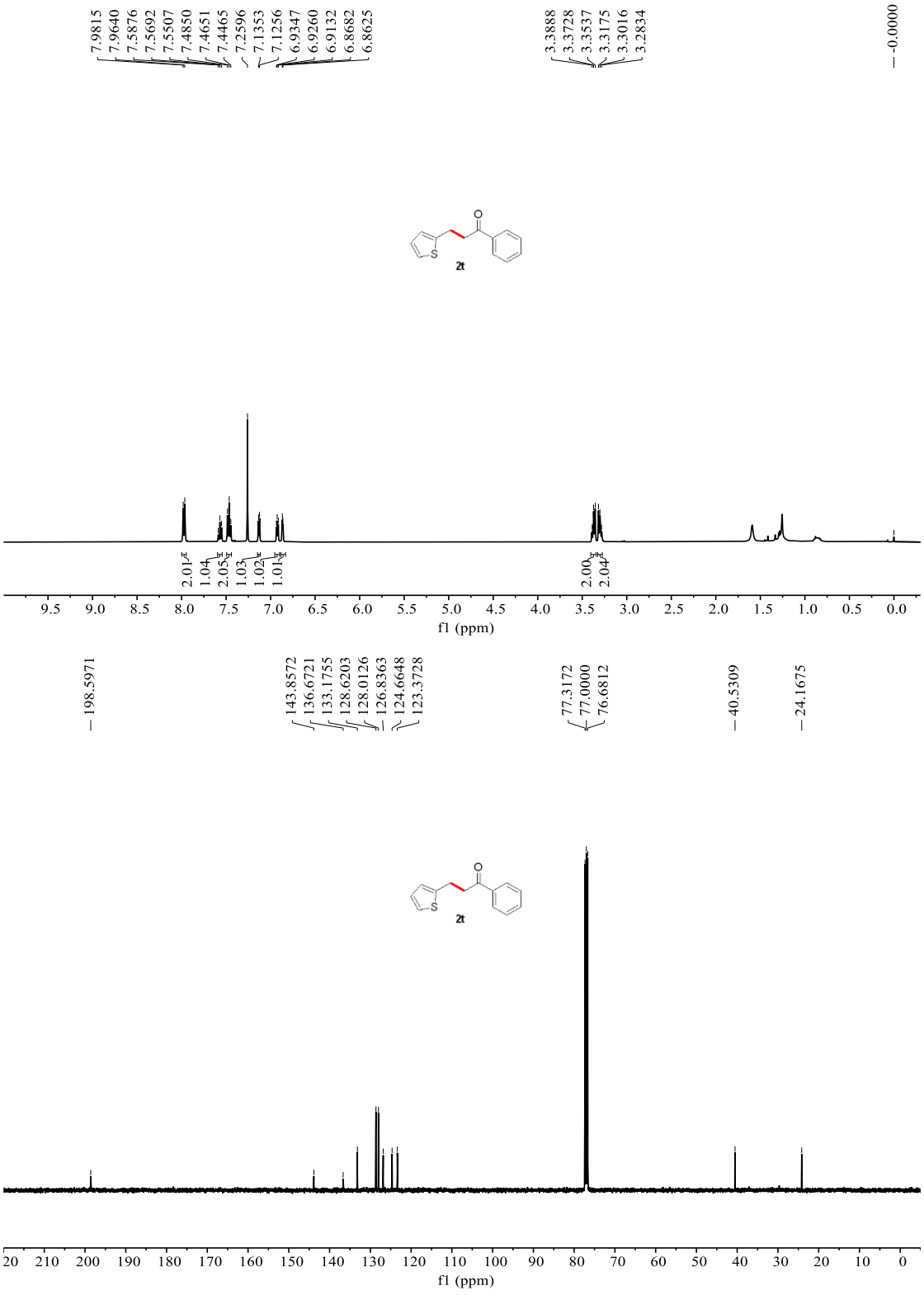
f1 (ppm)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6.9260
6.9132
6.8682
6.8625
3.3888
3.3728
3.3537
3.3175
3.3016
3.2834
-0.0000
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1.04
2.05
1.03
1.02
1.01
2.00
2.04
f1 (ppm)
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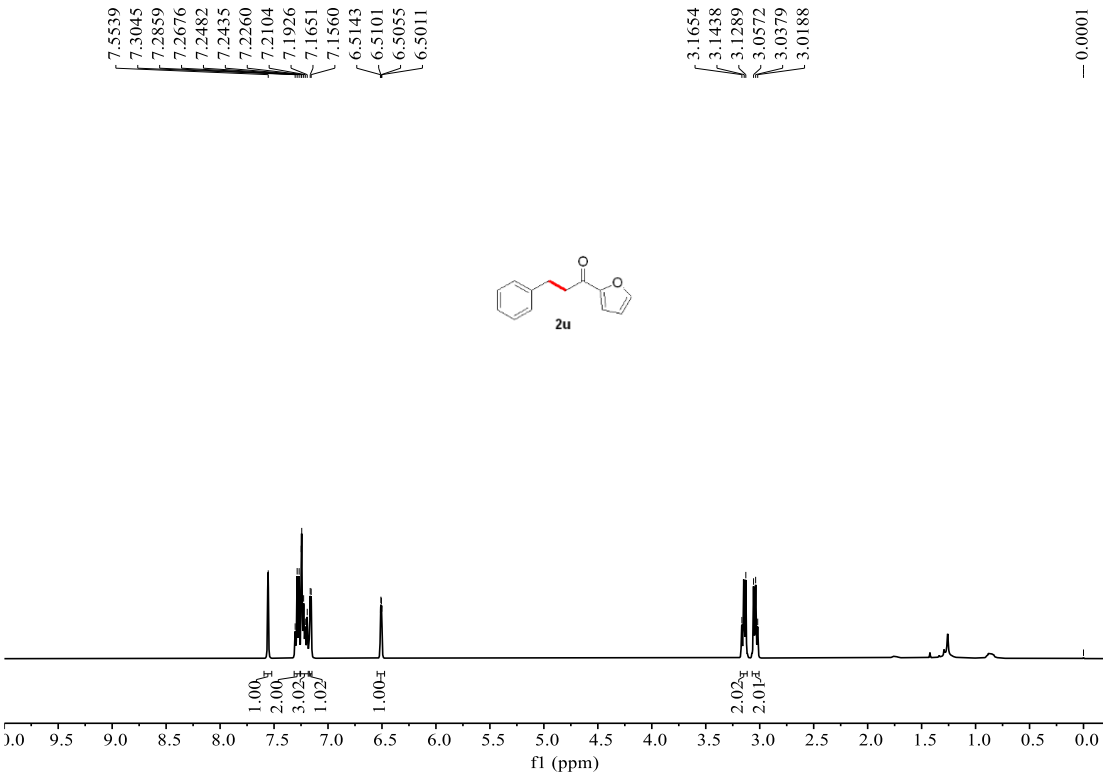
2t
f1 (ppm)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7.2104
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7.1651
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6.5143
6.5101
6.5055
6.5011
3.1654
3.1438
3.1289
3.0572
3.0379
3.0188
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2.00
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1.02
1.00
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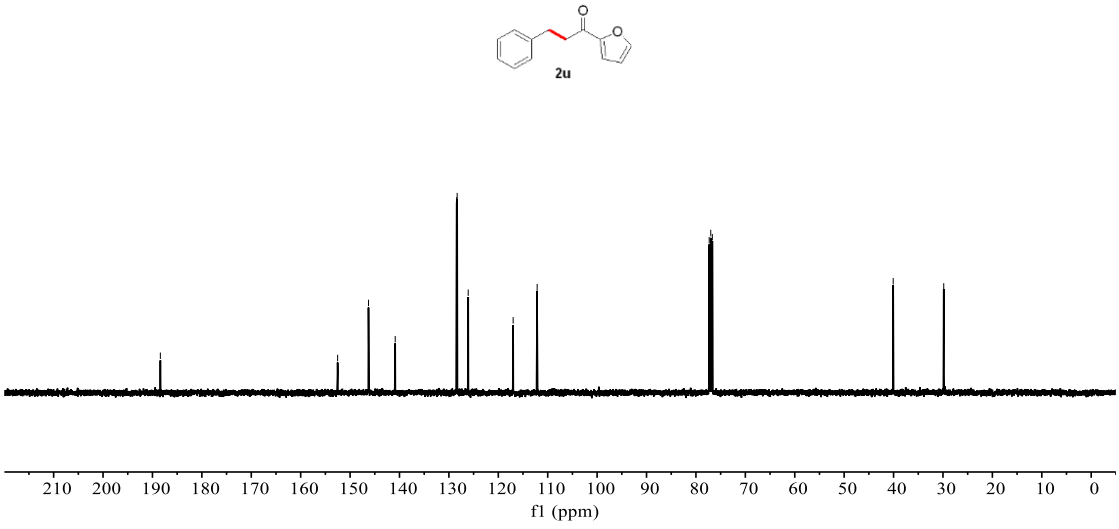
2.01
f1 (ppm)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77.0000
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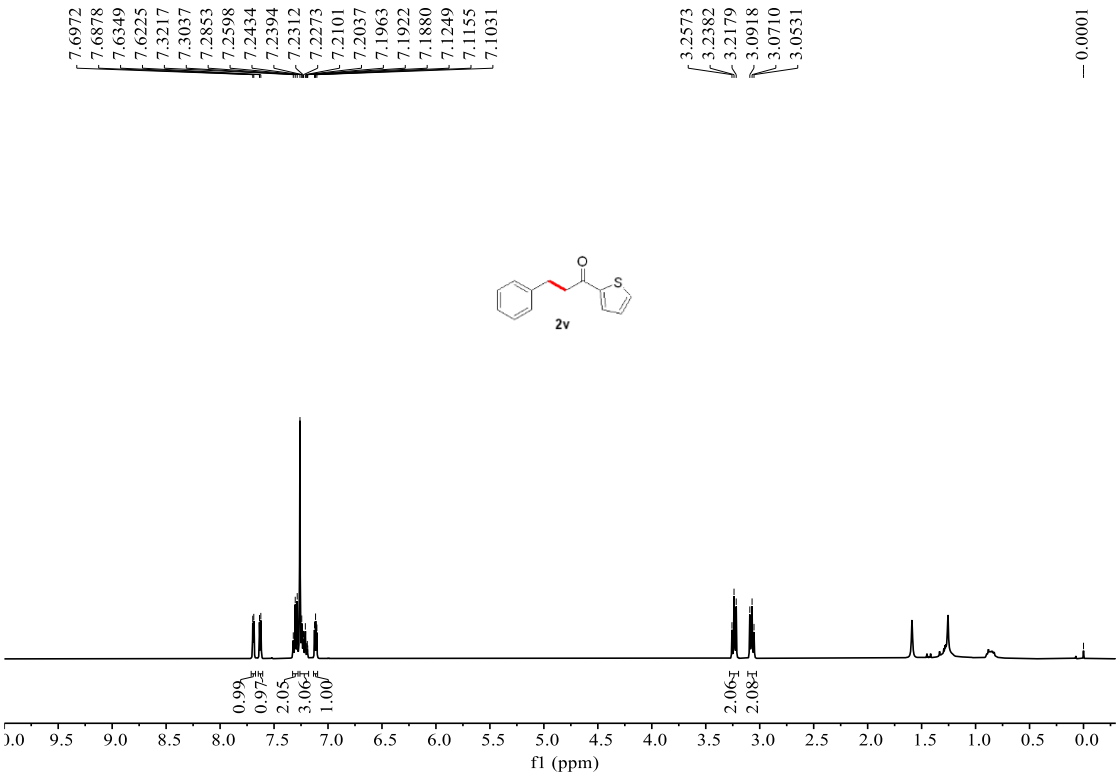
29.8445
2u
f1 (ppm)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7.2853
7.2598
7.2434
7.2394
7.2312
7.2273
7.2101
7.2037
7.1963
7.1922
7.1880
7.1249
7.1155
7.1031
3.2573
3.2382
3.2179
3.0918
3.0710
3.0531
0.0001
2v
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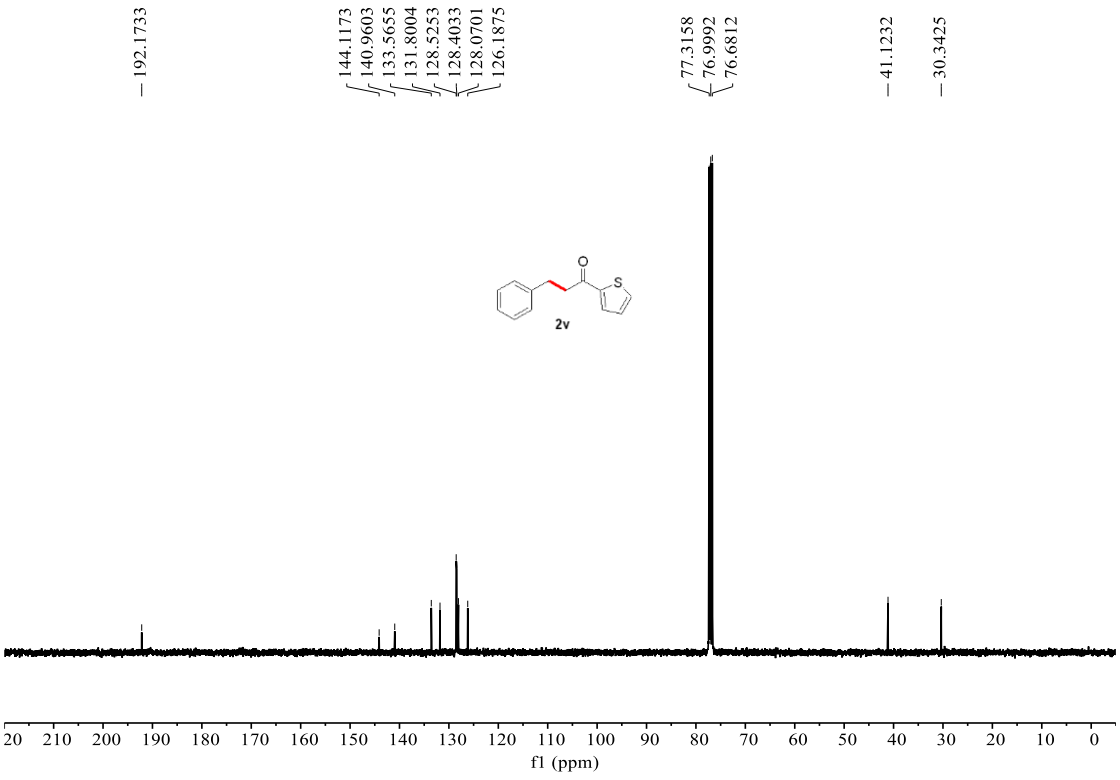
0.97
2.05
3.06
1.00
2.06
2.08
f1 (ppm)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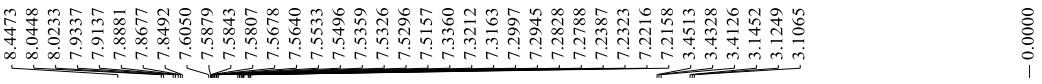
76.6812
41.1232
30.3425
2v
f1 (ppm)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7.5678
7.5640
7.5533
7.5496
7.5359
7.5326
7.5296
7.5157
7.3360
7.3212
7.3163
7.2997
7.2945
7.2828
7.2788
7.2387
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3.4328
3.4126
3.1452
3.1249
3.1065
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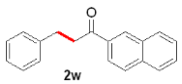
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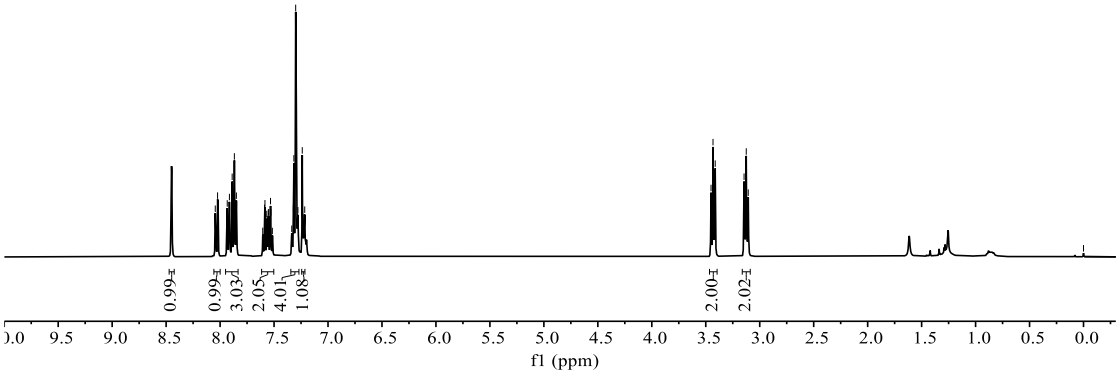
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0.99
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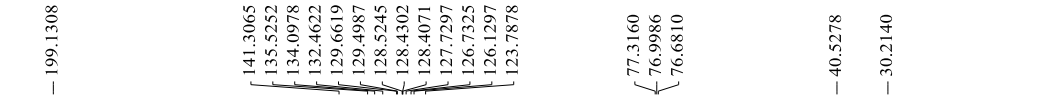
2.05
4.01
1.08
2.00
2.02
f1 (ppm)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134.0978
132.4622
129.6619
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126.7325
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123.7878
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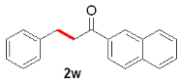
76.9986
76.6810
40.5278
30.2140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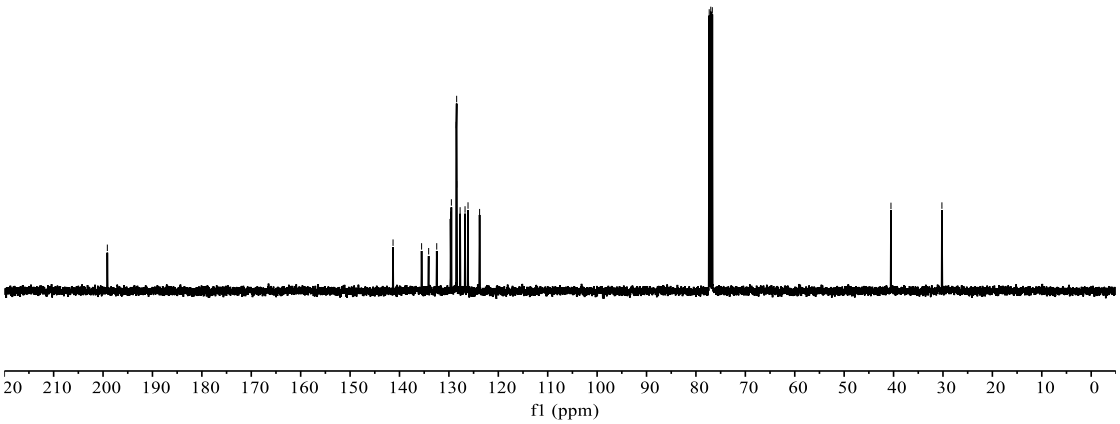
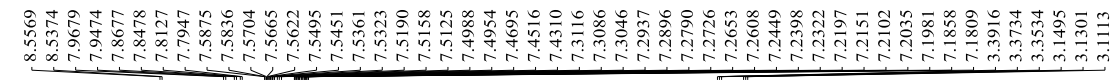

f1 (ppm)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7.5836
7.5704
7.5665
7.5622
7.5495
7.5451
7.5361
7.5323
7.5190
7.5158
7.5125
7.4988
7.4954
7.4695
7.4516
7.4310
7.3116
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7.3046
7.2937
7.2896
7.2790
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7.2398
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7.2102
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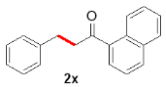
3.3534
3.1495
3.1301
3.1113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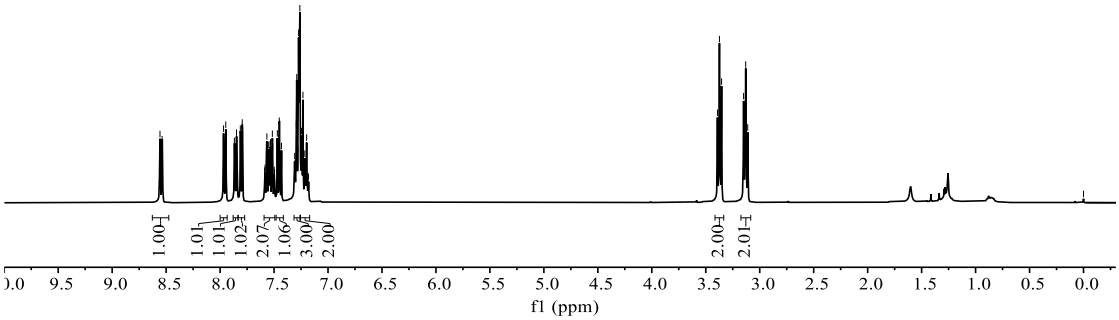
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1.01
1.01
1.02
2.07
1.06
3.00
2.00
2.00
2.01
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


203.5153
141.0582
135.8901
133.8969
132.5506
130.0593
128.4988
128.4192
128.3625
127.8444
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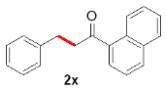
77.0000
76.6818
43.7641
30.5370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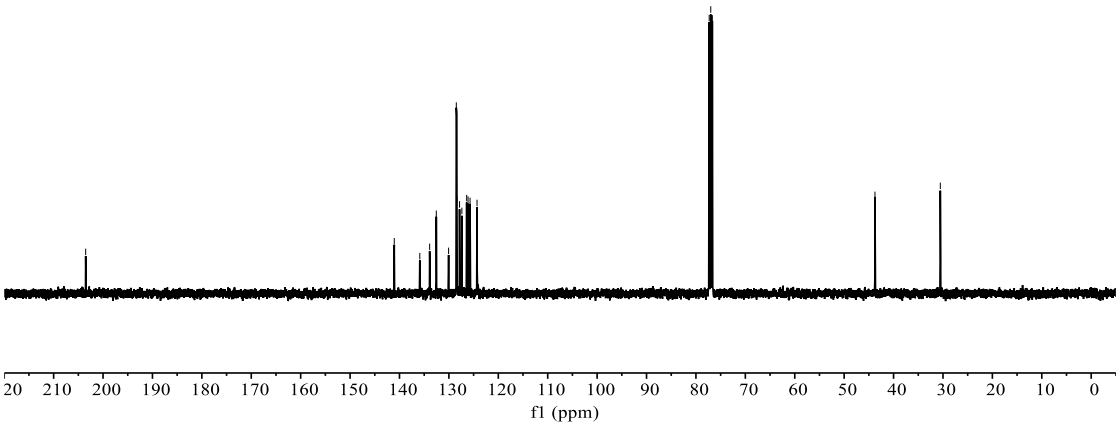
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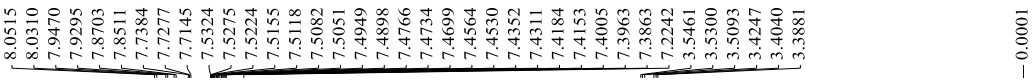
f1 (ppm)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7.5082
7.5051
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7.4898
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7.4734
7.4699
7.4564
7.4530
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7.4311
7.4184
7.4153
7.4005
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3.4247
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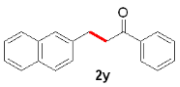
3.3881
0.0001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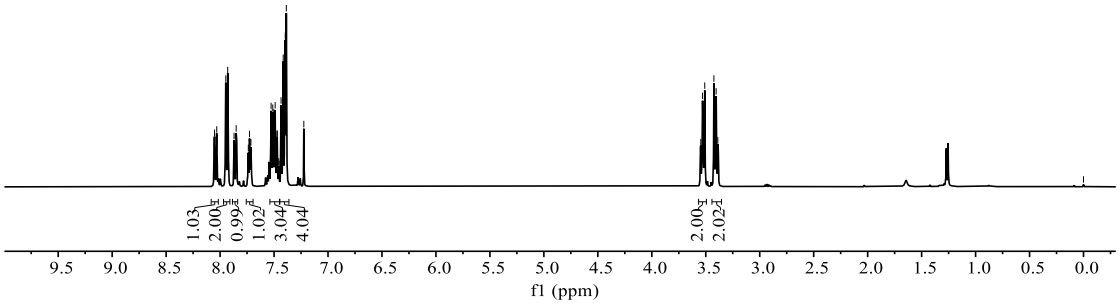
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0.99
1.02
3.04
4.04
2.00
2.02
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


199.2320
137.2999
136.7344
133.8728
133.0599
131.6304
128.8765
128.5557
127.9877
126.9488
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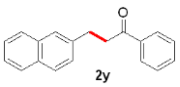
39.6765
27.1347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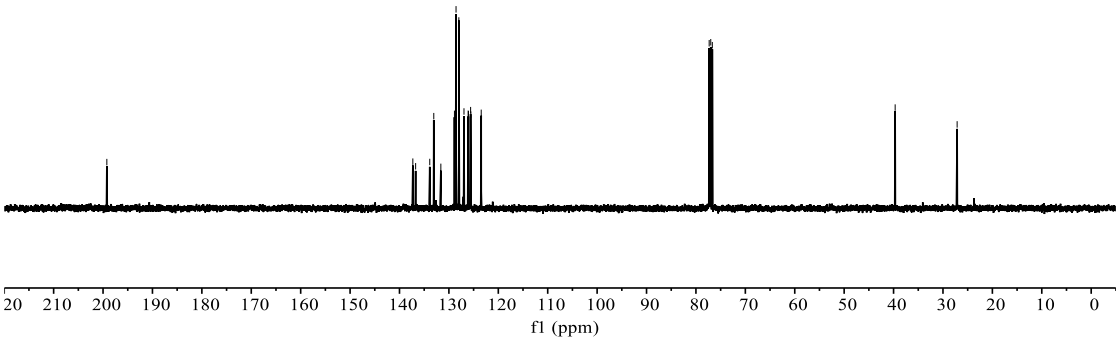
2y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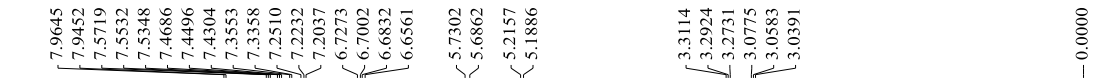
f1 (ppm)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7.2510
7.2232
7.2037
6.7273
6.7002
6.6832
6.6561
5.7302
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5.1886
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3.0391
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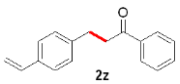
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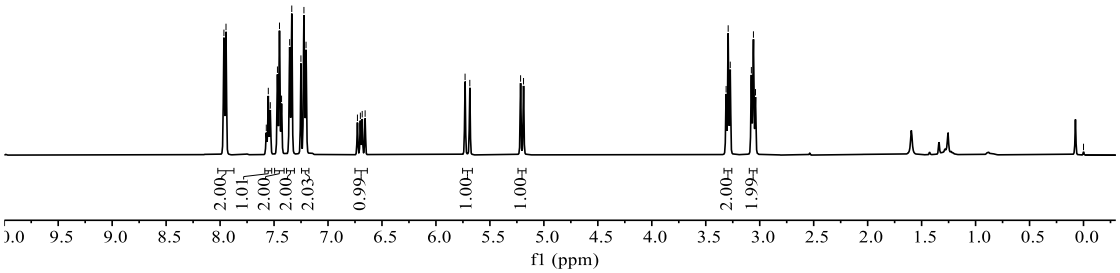
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2.00
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2.03
0.99
1.00
1.00
2.00
1.99
f1 (ppm)


199.1227
140.9627
136.7883
136.5160
135.5603
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128.0040
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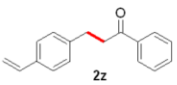
113.2112
77.3184
77.0000
76.6816
40.3038
29.7914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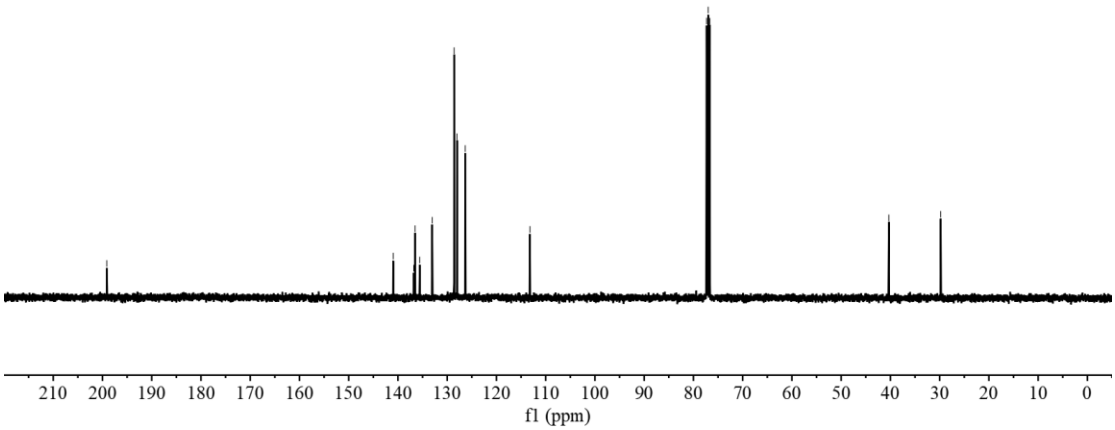
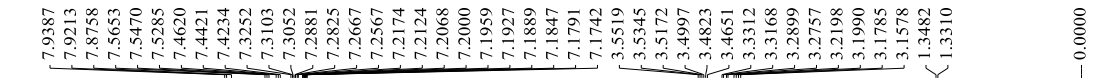

f1 (ppm)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7.2825
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7.2567
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7.2124
7.2068
7.2000
7.1959
7.1927
7.1889
7.1847
7.1791
7.1742
3.5519
3.5345
3.5172
3.4997
3.4823
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3.3312
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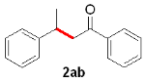
1.3310
0.0000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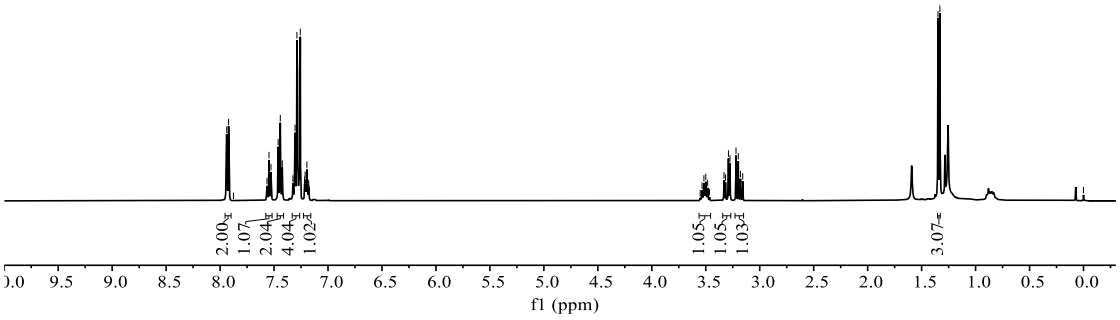
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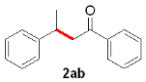
1.07
2.04
4.04
1.02
1.05
1.05
1.03
3.07
f1 (ppm)


199.0805
146.5531
137.1697
132.9601
128.5462
128.5158
128.0549
126.8408
126.2594
77.3188
77.0004
76.6835
47.0072
35.5473
21.8526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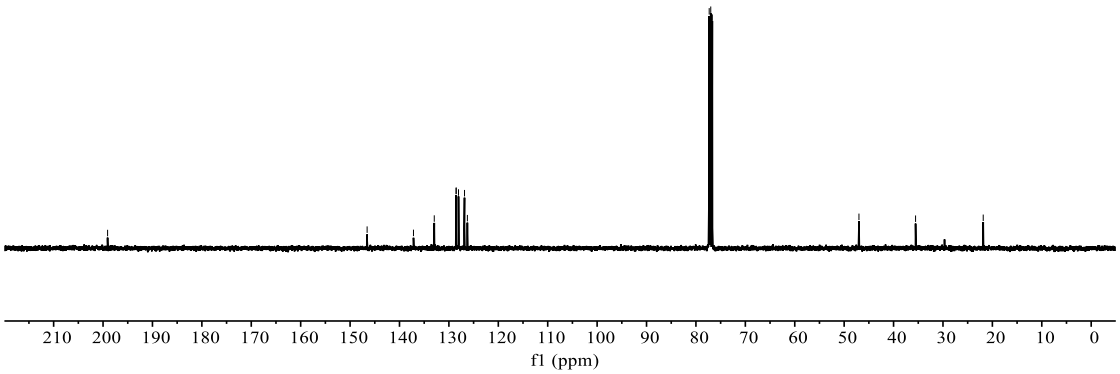
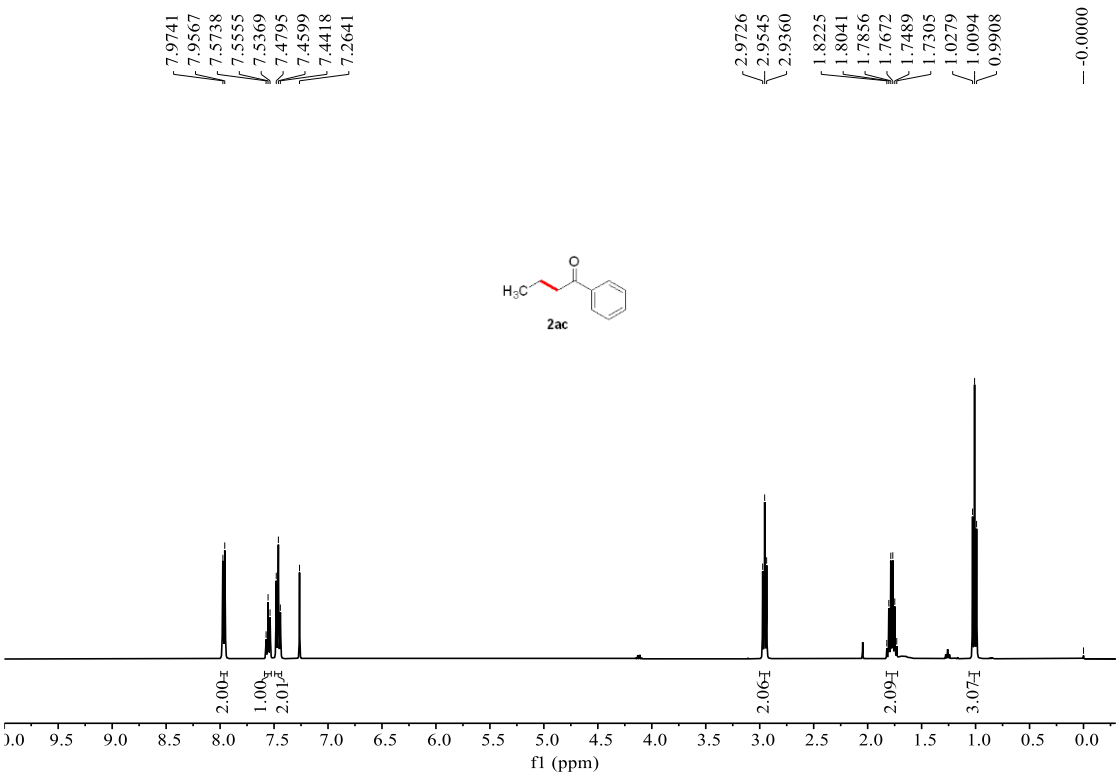

f1 (ppm)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2.9360
1.8225
1.8041
1.7856
1.7672
1.7489
1.7305
1.0279
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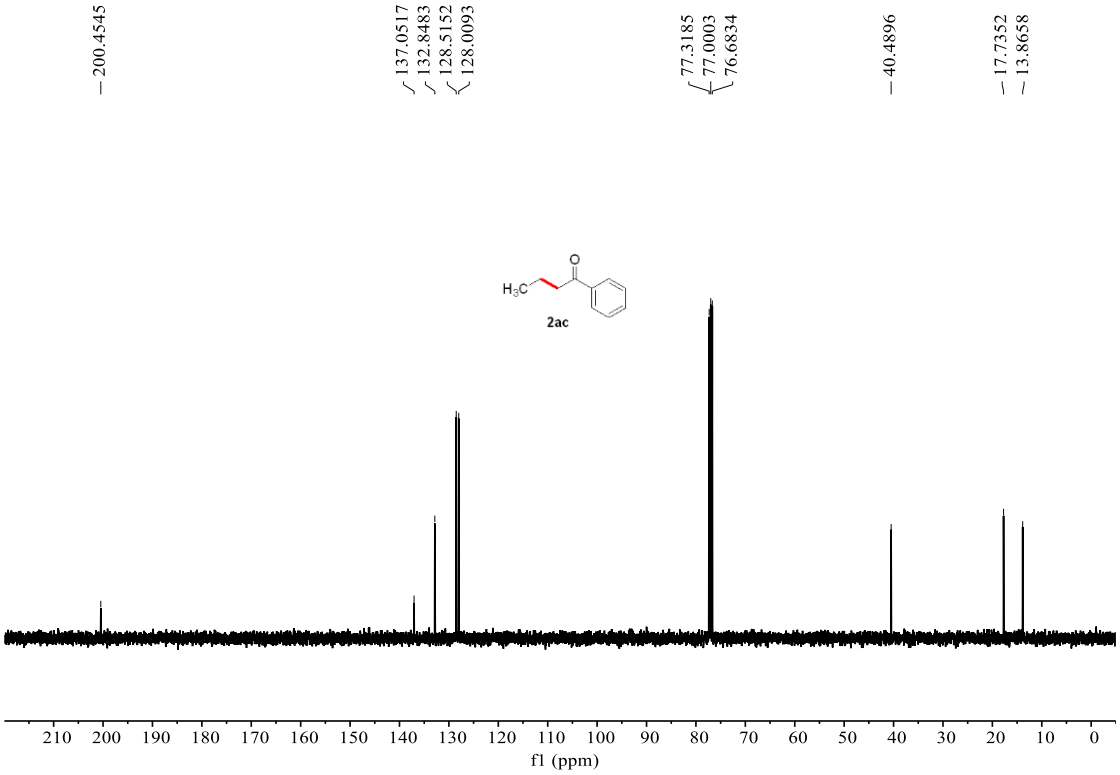
-0.0000
2ac
2.00
1.00
2.01
2.06
2.09
3.07
f1 (ppm)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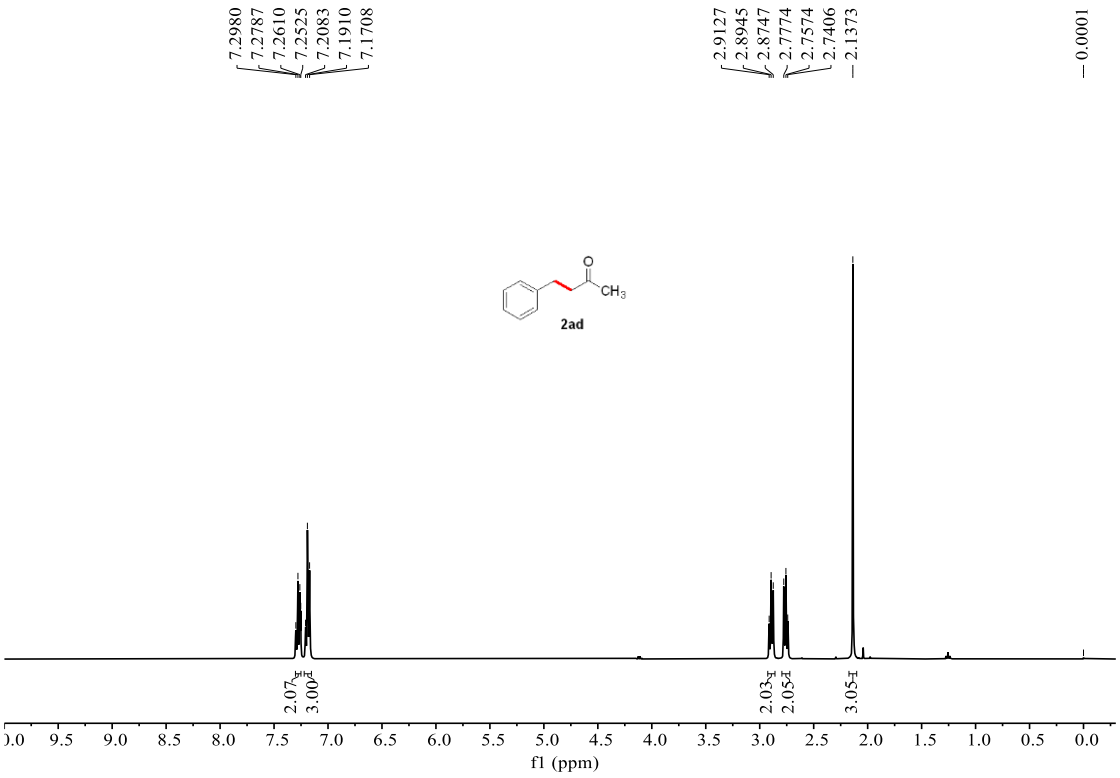
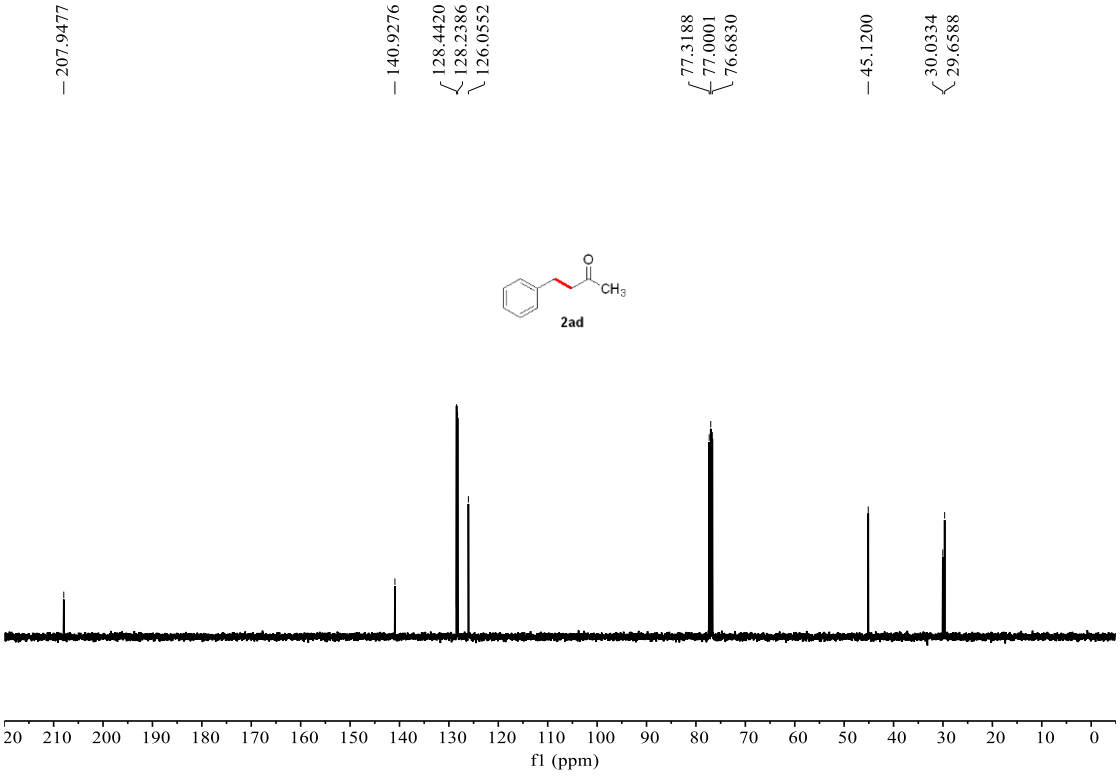
17.7352
13.8658
2ac
f1 (ppm)


7.2980
7.2787
7.2610
7.2525
7.2083
7.1910
7.1708
2.9127
2.8945
2.8747
2.7774
2.7574
2.7406
2.1373
0.0001
O
CH3
2ad
2.07
3.00
2.03
2.05
3.05
f1 (ppm)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128.2386
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77.0001
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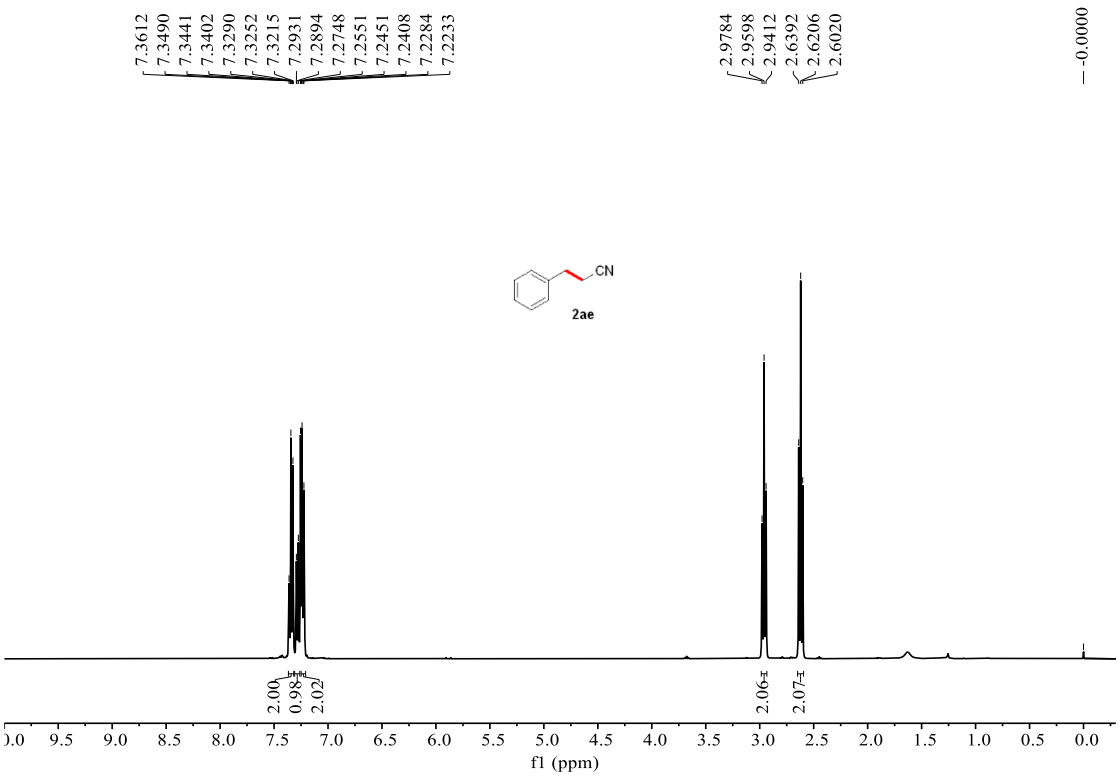
45.1200
30.0334
29.6588
O
CH3
2ad
f1 (ppm)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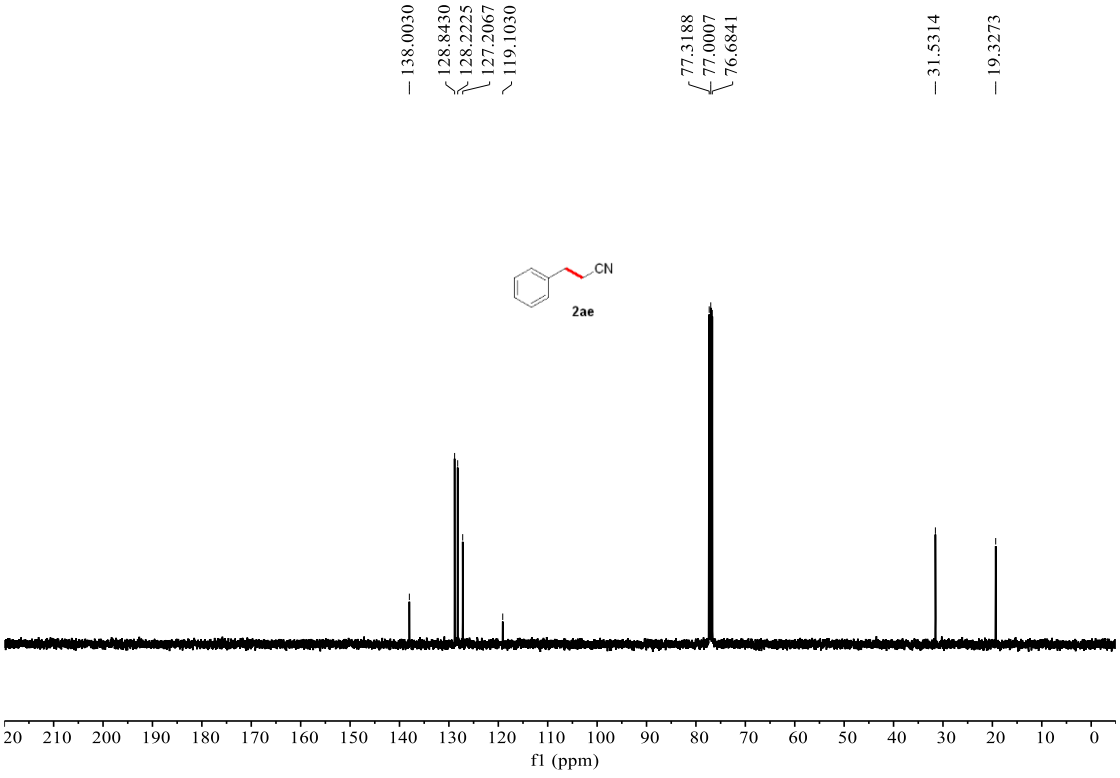
7.3441
7.3402
7.3290
7.3252
7.3215
7.2931
7.2894
7.2748
7.2551
7.2451
7.2408
7.2284
7.2233
2.9784
2.9598
2.9412
2.6392
2.6206
2.6020
-0.0000
CN
2ae
2.00
0.98
2.02
2.06
2.07
f1 (ppm)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128.2225
127.2067
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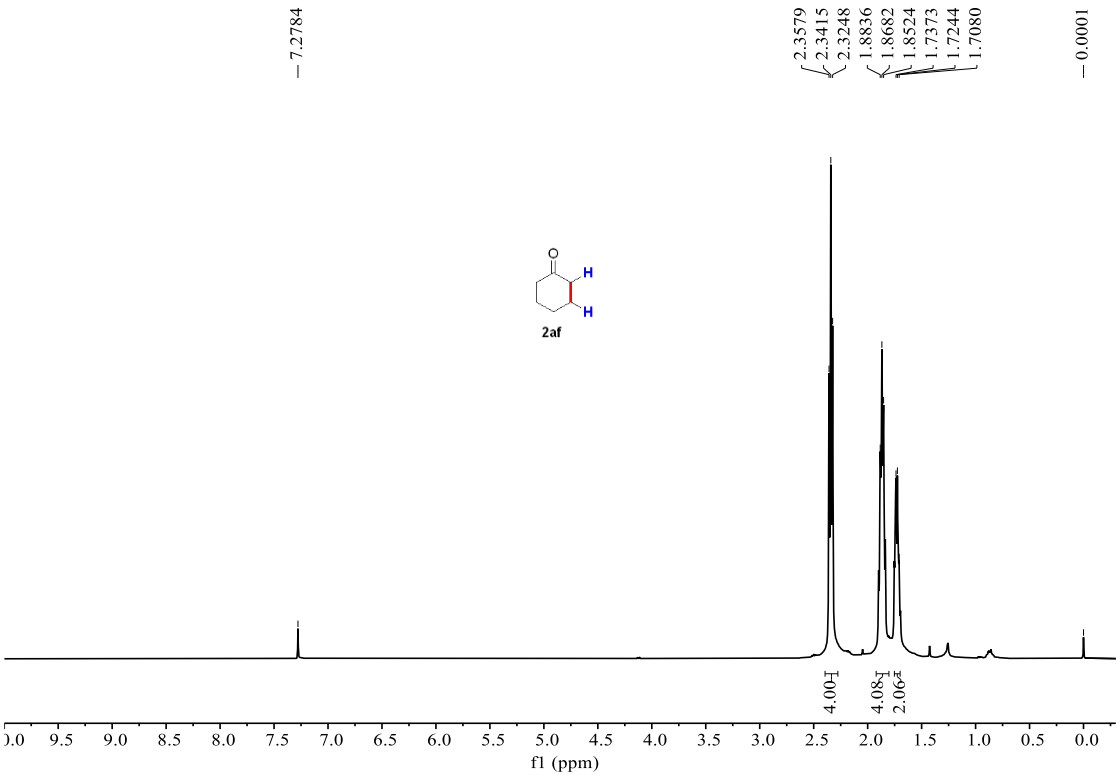
77.0007
76.6841
31.5314
19.3273
CN
2ae
f1 (ppm)


7.2784
2.3579
2.3415
2.3248
1.8836
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1.8524
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1.7080
0.0001
2af
4.00
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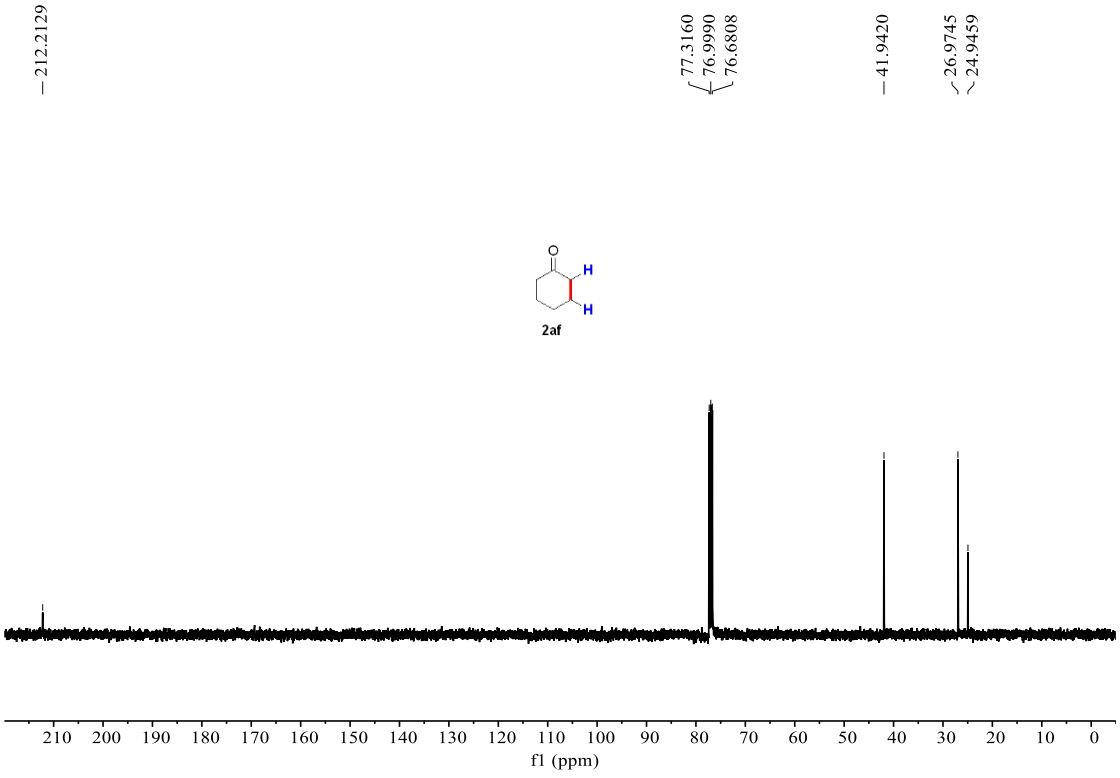
2.06
f1 (ppm)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41.9420
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24.9459
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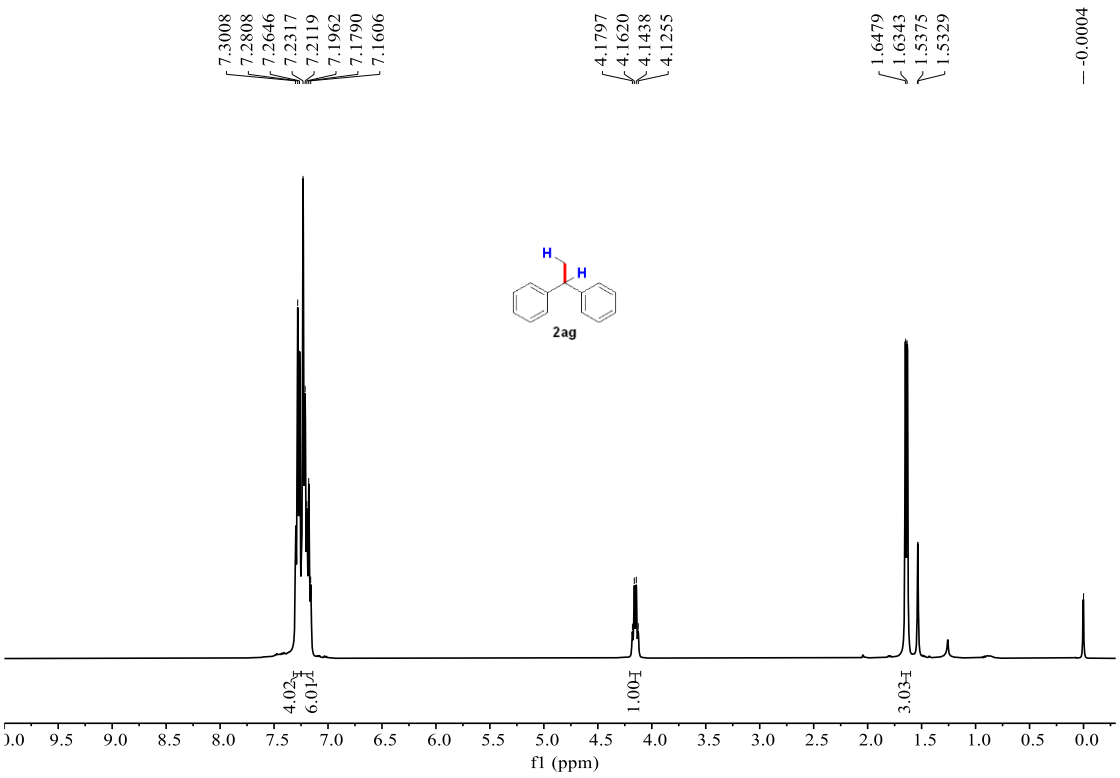
f1 (ppm)


7.3008
7.2808
7.2646
7.2317
7.2119
7.1962
7.1790
7.1606
4.1797
4.1620
4.1438
4.1255
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1.6343
1.5375
1.5329
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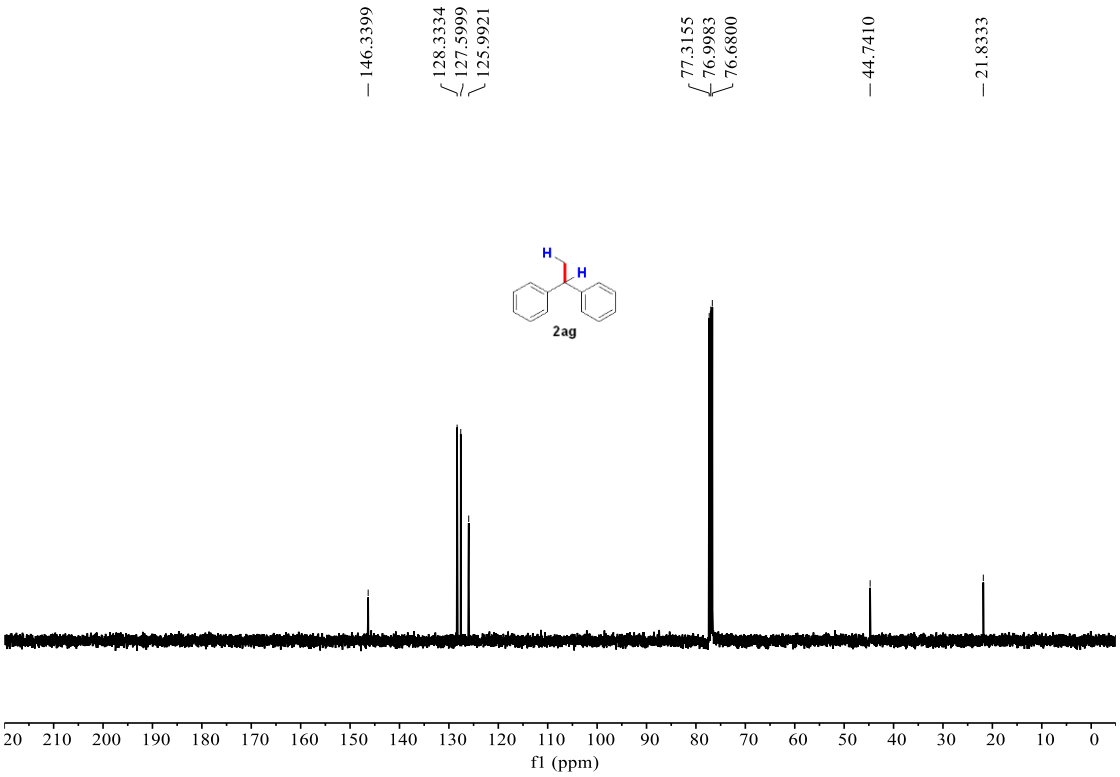
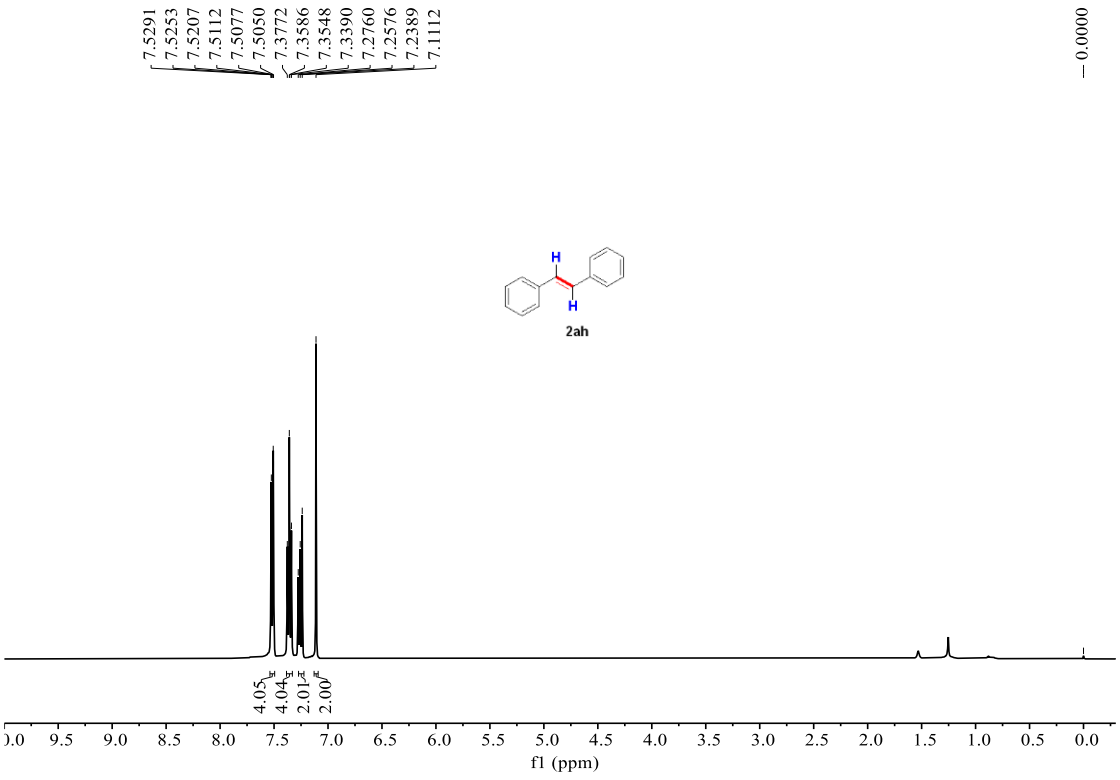
2ag
4.02
6.01
1.00
3.03
f1 (ppm)


146.3399
128.3334
127.5999
125.9921
77.3155
76.9983
76.6800
44.7410
21.8333
2ag
f1 (ppm)


7.5291
7.5253
7.5207
7.5112
7.5077
7.5050
7.3772
7.3586
7.3548
7.3390
7.2760
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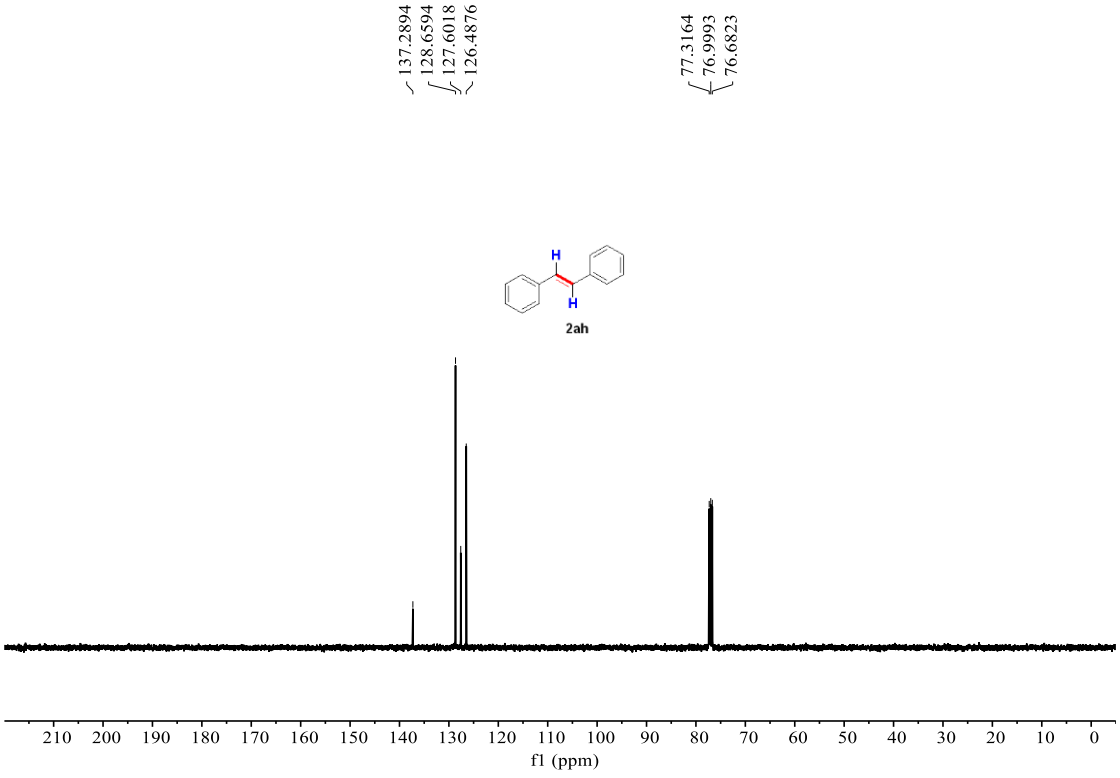
7.2389
7.1112
0.0000
2ah
4.05
4.04
2.01
2.00
f1 (ppm)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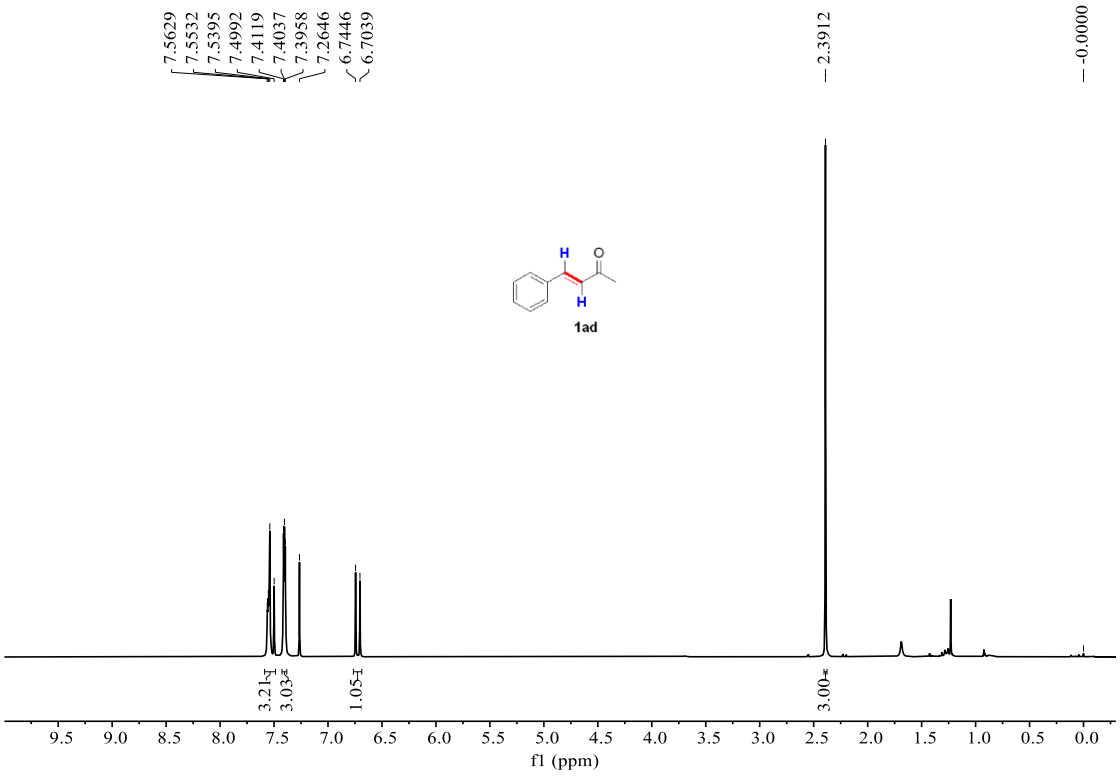
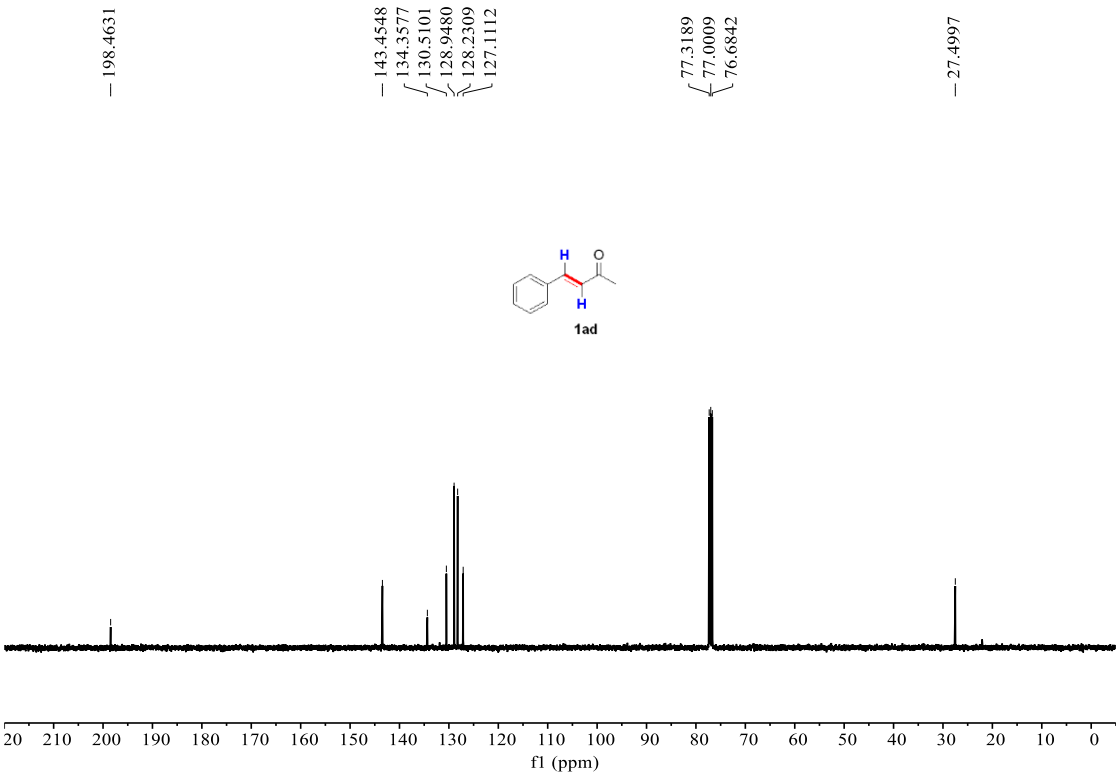
126.4876
77.3164
76.9993
76.6823
2ah
f1 (ppm)


7.5629
7.5532
7.5395
7.4992
7.4119
7.4037
7.3958
7.2646
6.7446
6.7039
2.3912
0.0000
H
O
H
1ad
3.21
3.03
1.05
3.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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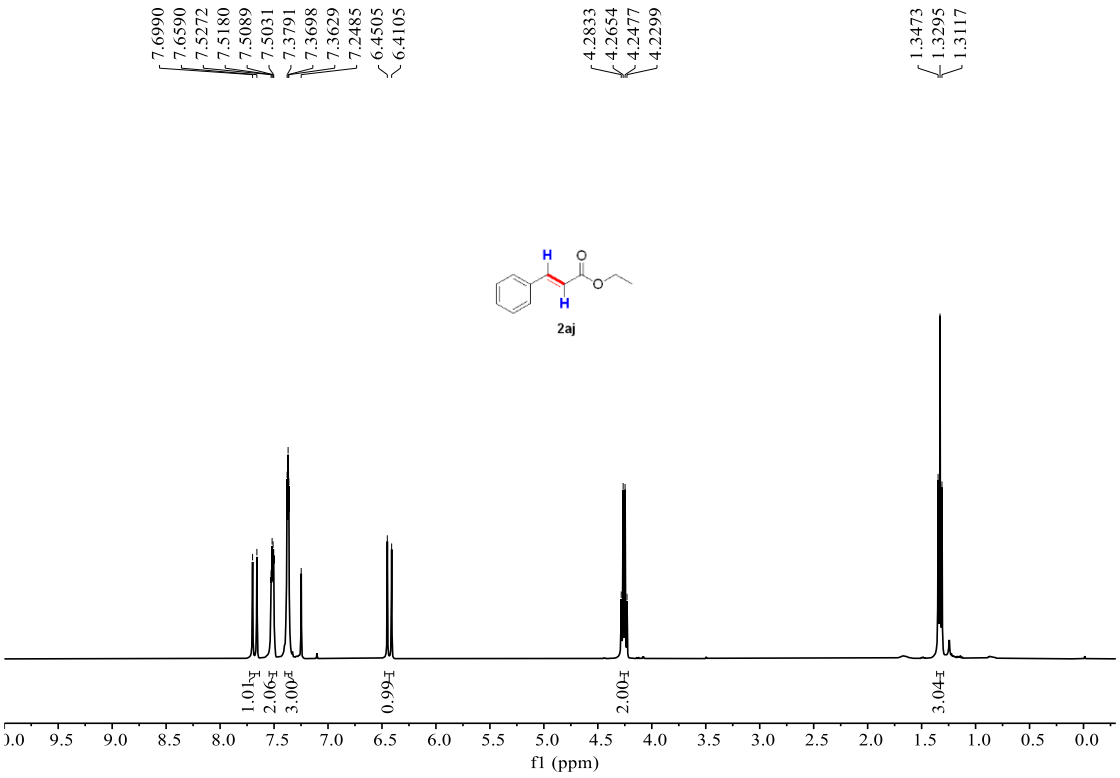
143.4548
134.3577
130.5101
128.9480
128.2309
127.1112
77.3189
77.0009
76.6842
27.4997
H
O
H
1ad
20 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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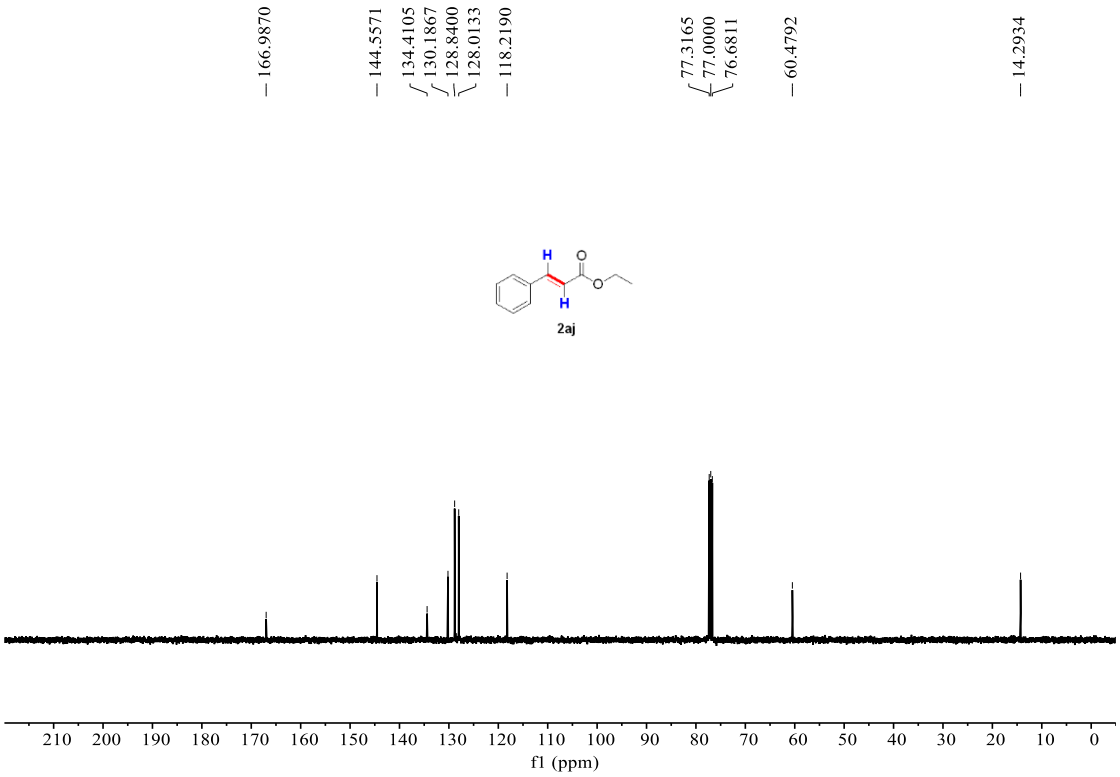
7.6590
7.5272
7.5180
7.5089
7.5031
7.3791
7.3698
7.3629
7.2485
6.4505
6.4105
4.2833
4.2654
4.2477
4.2299
1.3473
1.3295
1.3117
2aj
1.01
2.06
3.00
0.99
2.00
3.04
f1 (ppm)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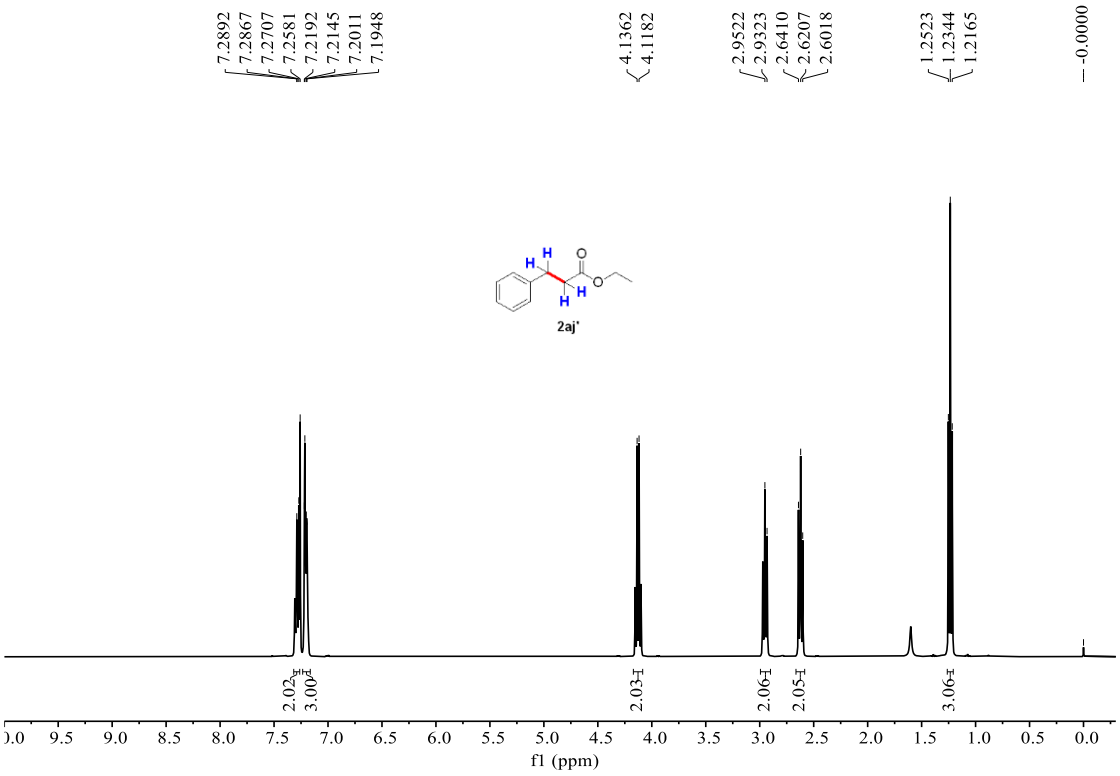
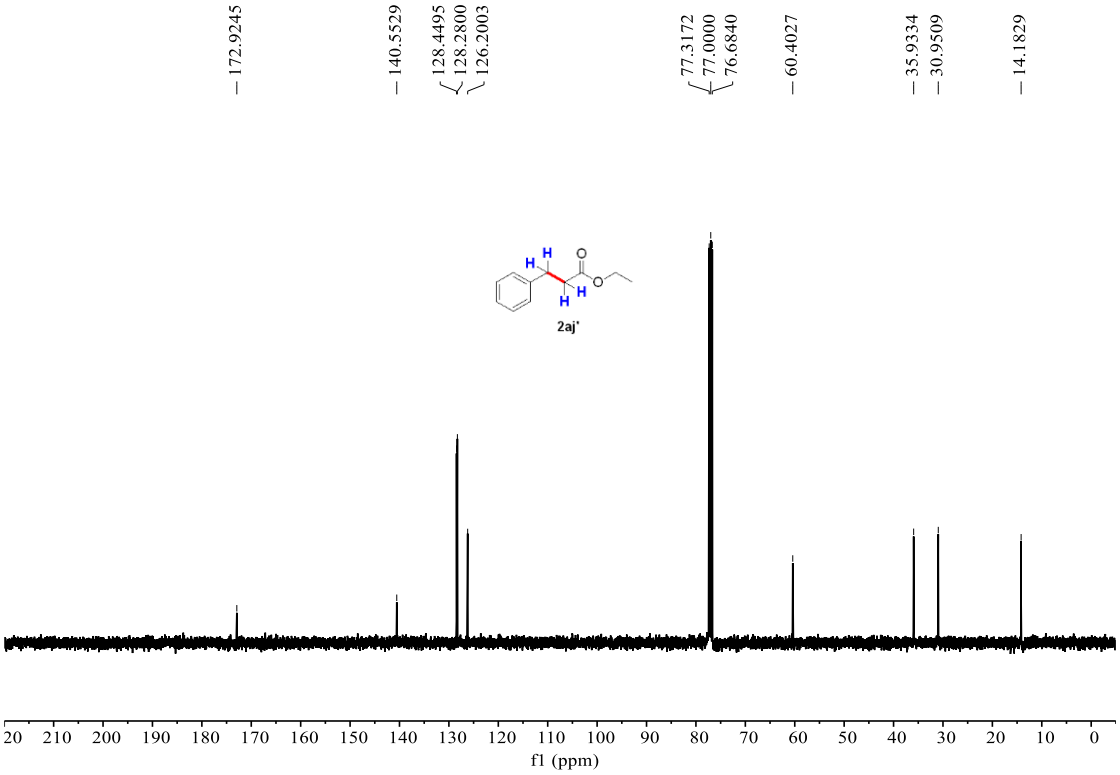
144.5571
134.4105
130.1867
128.8400
128.0133
118.2190
77.3165
77.0000
76.6811
60.4792
14.2934
2aj
f1 (ppm)


7.2892
7.2867
7.2707
7.2581
7.2192
7.2145
7.2011
7.1948
4.1362
4.1182
2.9522
2.9323
2.6410
2.6207
2.6018
1.2523
1.2344
1.2165
-0.0000
2aj'
2.02
3.00
2.03
2.06
2.05
3.06
f1 (ppm)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140.5529
128.4495
128.2800
126.2003
77.3172
77.0000
76.6840
60.4027
35.9334
30.9509
14.1829
2aj'
f1 (ppm)


7.9318
7.9141
7.5676
7.5490
7.5307
7.4644
7.4448
7.4260
7.3119
7.2912
7.2804
7.2742
7.2571
7.2188
7.2016
7.1978
7.1790
3.0015
2.9833
2.9651
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2.7063
2.1243
2.1056
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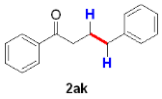
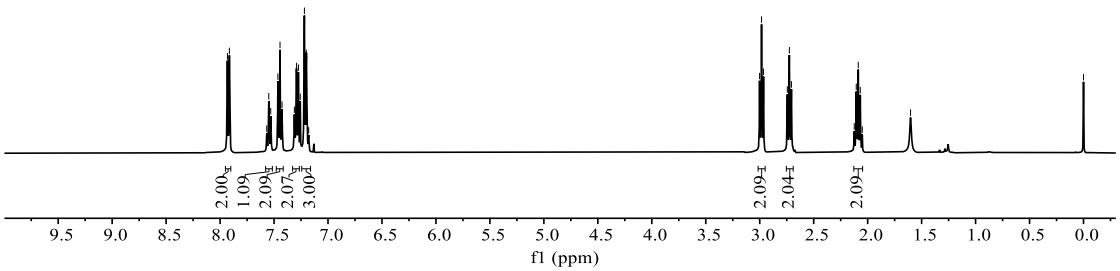
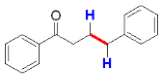
2.0684
2.0499
1.6026
0.0000


O
H
H

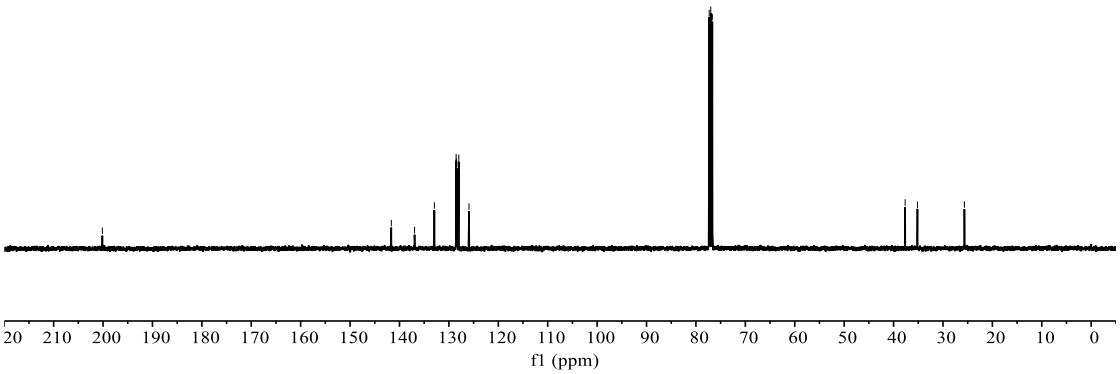
2ak


2.00
1.09
2.09
2.07
3.00
2.09
2.04
2.09
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


200.1384
141.6608
136.9507
132.9412
128.5384
128.4994
128.3785
127.9954
125.9291
77.3186
77.0005
76.6830
37.6600
35.1627
25.6616


O
H
H

2ak


220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)