

**Palladium Supported on Phosphinite Functionalized Fe₃O₄ Nanoparticles as a
New Magnetically Separable Catalyst for Suzuki-Miyaura Coupling Reaction
in Aqueous Media**

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Biji^c

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aghaderi@hormozgan.ac.ir*

*^c Nanotech Research, Innovation and Incubation Center, PSG Institute of
Advanced Studies, Coimbatore-641 004, India.*

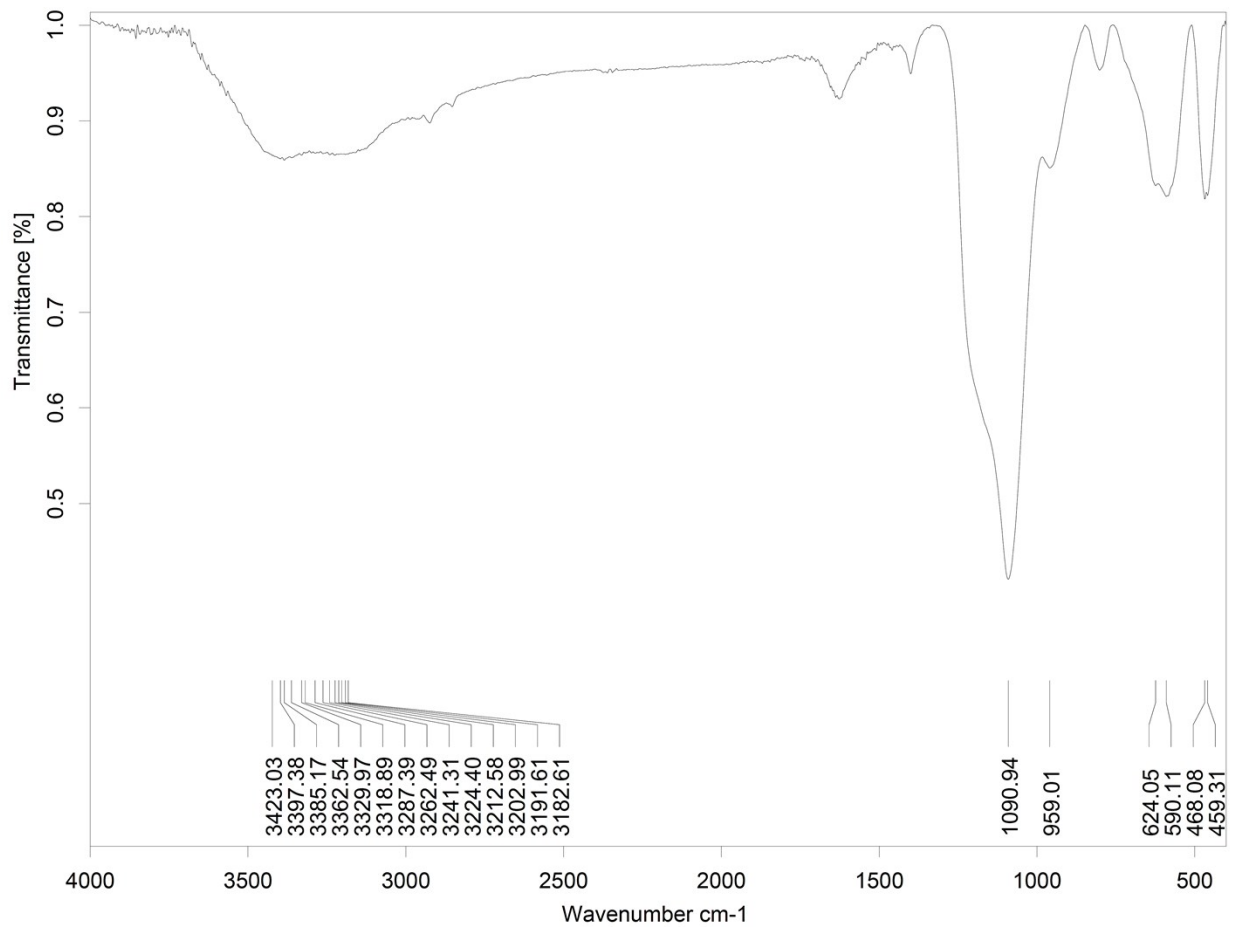


Figure 1. FT-IR of SiO₂@Fe₃O₄

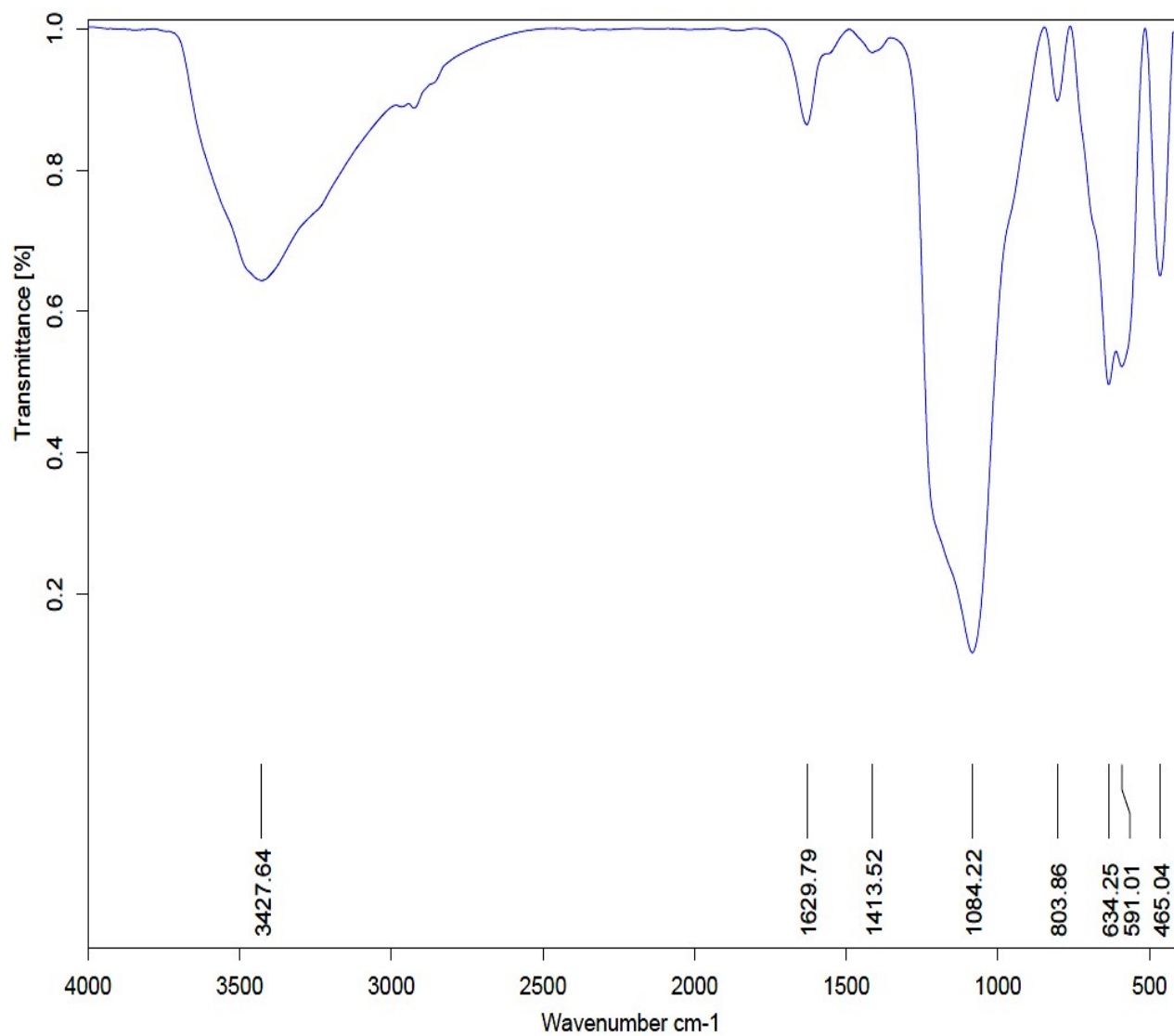
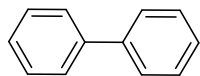


Figure 2. FT-IR of catalyst after 3rd run

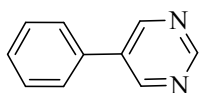
Characterizations of products:

1'-biphenyl ¹:



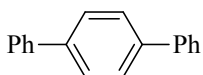
¹H NMR (CDCl₃, 400 MHz): δ 7.63 (d, 2H, *J*=7.6), 7.50-7.46 (t, 2H), 7.40-7.37 (t, 1H). ¹³C NMR (CDCl₃, 101 MHz): δ 141.26, 128.79, 127.79, 127.20 .

5-phenylpyrimidine ¹:



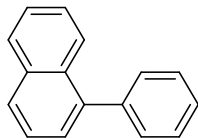
¹H NMR (CDCl₃, 400 MHz): δ 9.26 (s, 1H), 9.01 (s, 2H), 7.63-7.49 (m, 4H). ¹³C NMR (CDCl₃, 101 MHz): δ 157.17, 154.89, 134.48, 134.12, 129.51, 129.15, 127.84, 127.04 .

1,1':4',1''-terphenyl ²:



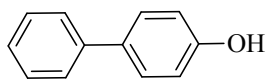
¹H NMR (CDCl₃, 400 MHz): δ 7.72-7.67 (t, 3H), 7.52-7.48 (t, 2H), 7.42-7.38 (t, 1H). ¹³C NMR (CDCl₃, 101 MHz): δ 140.73, 140.14, 128.84, 127.53, 127.37, 127.08.

1-phenylnaphthalene ³:



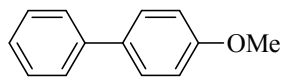
¹H NMR (CDCl₃, 400 MHz): δ 7.96-7.89 (m, 3H), 7.59-7.45 (m, 8H). ¹³C NMR (CDCl₃, 101 MHz): δ 140.79, 140.29, 133.82, 131.64, 130.11, 128.29, 127.66, 127.26, 126.95, 126.05, 125.79, 124.41.

[1,1'-biphenyl]-4-ol ¹:



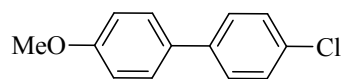
¹H NMR (CDCl₃, 400 MHz): δ 7.77-7.71 (m, 3H), 7.64-7.61 (t, 2H), 7.54-7.50 (t, 2H), 7.47-7.44 (m, 1H), 1.67 (s, 1H). ¹³C NMR (CDCl₃, 101 MHz): δ 145.71, 139.21, 132.63, 129.14, 128.69, 127.77, 127.26, 118.98, 110.94 .

4-methoxy-1,1'-biphenyl ¹:



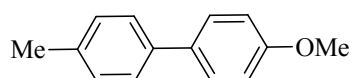
¹H NMR (CDCl₃, 400 MHz): δ 7.60-7.55 (m, 4H), 7.47-7.43 (m, 2H), 7.35-7.32 (t, 1H), 7.03-7.00 (m, 2H), 3.89 (s, 3H). ¹³C NMR (CDCl₃, 101 MHz): δ 159.17, 140.87, 133.81, 128.74, 128.18, 126.76, 126.68, 114.21, 55.37 .

4-chloro-4'-methoxy-1,1'-biphenyl ⁴:



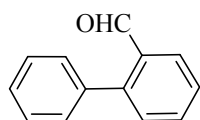
^1H NMR (CDCl_3 , 400 MHz): δ 7.54-7.49 (m, 4H), 7.42-7.40 (m, 2H), 7.03-6.99 (m, 2H), 3.88 (s, 3H). ^{13}C NMR (CDCl_3 , 101 MHz): δ 159.38, 139.29, 132.69, 132.52, 128.86, 128.04, 127.96, 114.33, 55.39 .

4-methoxy-4'-methyl-1,1'-biphenyl ¹:



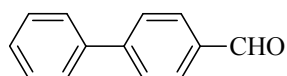
^1H NMR (CDCl_3 , 400 MHz): δ 7.56-7.53 (t, 2H), 7.49 (d, 2H, $J=8.4$), 7.27 (d, 2H, $J=8$), 7.01 (d, 2H, $J=8.4$), 3.88 (s, 3H), 2.42 (s, 3H). ^{13}C NMR (CDCl_3 , 101 MHz): δ 158.95, 137.99, 136.39, 133.77, 129.47, 127.99, 126.61, 114.18, 55.37, 21.09 .

[1,1'-biphenyl]-2-carbaldehyde ¹:



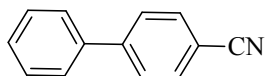
^1H NMR (CDCl_3 , 400 MHz): δ 10.02 (s, 1H), 8.08-8.06 (m, 1H), 7.70-7.66 (m, 1H), 7.55-7.41 (m, 7H). ^{13}C NMR (CDCl_3 , 101 MHz): δ 192.53, 146.01, 137.76, 133.72, 133.61, 130.81, 130.14, 128.47, 128.16, 127.81, 127.59 .

[1,1'-biphenyl]-4-carbaldehyde ¹:



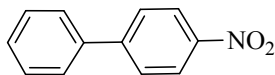
^1H NMR (CDCl_3 , 400 MHz): δ 10.09 (s, 1H), 7.99 (d, 2H, $J=8.4$), 7.80-7.75 (t, 2H), 7.68-7.66 (t, 2H), 7.54-7.45 (m, 3H). ^{13}C NMR (CDCl_3 , 101 MHz): δ 192.02, 147.25, 139.75, 135.20, 130.32, 129.05, 128.51, 127.73, 127.40 .

[1,1'-biphenyl]-4-carbonitrile ¹:



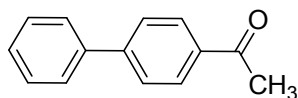
^1H NMR (CDCl_3 , 400 MHz): δ 7.77-7.70 (q, 4H), 7.64-7.62 (t, 2H), 7.54-7.50 (t, 2H), 7.48-7.44 (m, 1H). ^{13}C NMR (CDCl_3 , 101 MHz): δ 145.69, 139.19, 132.64, 129.16, 128.72, 127.77, 127.27, 119.01, 110.92 .

4-nitro-1,1'-biphenyl ¹:



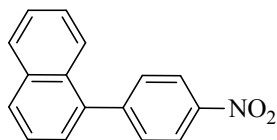
^1H NMR (CDCl_3 , 400 MHz): δ 8.32 (d, 2H, $J=8.8$), 7.76 (d, 2H, $J=2\text{H}$), 7.67-7.65 (t, 2H), 7.55-7.46 (m, 3H). ^{13}C NMR (CDCl_3 , 101 MHz): δ 147.64, 147.08, 138.76, 129.21, 128.98, 127.83, 127.42, 124.14 .

1-([1,1'-biphenyl]-4-yl)ethanone ⁴:



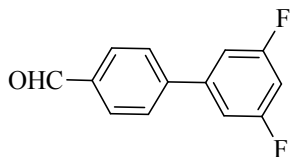
^1H NMR (CDCl_3 , 400 MHz): δ 8.07 (d, 2H, $J=8.4$), 7.72(d, 2H, $J=8.8$), 7.68-7.65(t, 2H), 7.53-7.43 (m, 3H), 2.67 (s, 3H). ^{13}C NMR (CDCl_3 , 101 MHz): δ 145.82, 139.90, 135.86, 128.99, 128.95, 128.26, 127.31, 127.26, 26.72 .

1-(4-nitrophenyl)naphthalene ⁵:



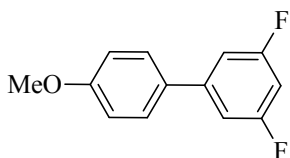
¹H NMR (CDCl₃, 400 MHz): δ 8.40(d, 2H, *J*=8.8), 7.99-7.96(m, 2H), 7.82(d, 1H, *J*=8.4), 7.71(d, 2H, *J*=8.8), 7.61-7.46 (m, 4H). ¹³C NMR (CDCl₃, 101 MHz): δ 147.71, 147.21, 137.81, 133.82, 130.95, 129.00, 128.61, 127.13, 126.77, 126.26, 125.35, 125.17, 123.63 .

3',5'-difluoro-[1,1'-biphenyl]-4-carbaldehyde ⁶:



¹H NMR (CDCl₃, 400 MHz): δ 10.11 (s, 1H), 8.01 (d, 2H, *J*=8), 7.75 (d, 2H, *J*=8), 7.21-7.16 (m, 2H), 6.92-6.87 (m, 1H). ¹³C NMR (CDCl₃, 101 MHz): δ 191.66, 144.64, 143.02, 136.08, 130.41, 127.71, 110.49, 110.42, 110.31, 110.31, 110.23, 103.98, 103.78, 103.48 . ¹⁹F NMR(CDCl₃, 376 MHz): δ – 108.78 .

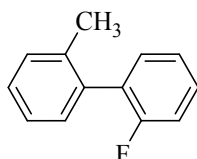
3,5-difluoro-4'-methoxy-1,1'-biphenyl :



¹H NMR (CDCl₃, 400 MHz): δ 7.52(d, 2H, *J*= 8.8), 7.11-7.06 (m, 2H), 7.01(d, 2H, *J*=8.8), 7.79-7.74 (m, 1H), 3.89 (s, 3H). ¹³C NMR (CDCl₃, 101 MHz): δ 164.64, 164.51, 162.18, 162.05, 159.98, 144.24, 144.15, 144.05, 131.37, 131.35, 131.32,

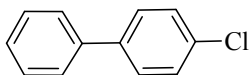
128.11, 114.41, 109.50, 109.44, 109.32, 109.25, 102.08, 101.82, 101.57, 55.40 . ^{19}F NMR(CDCl_3 , 376 MHz): δ -110.03 .

2-fluoro-2'-methyl-1,1'-biphenyl :



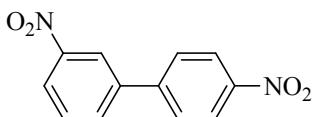
^1H NMR (CDCl_3 , 400 MHz): δ 7.41- 7.15 (m, 7H), 2.25 (s, 3H). ^{13}C NMR (CDCl_3 , 101 MHz): δ 160.89, 136.69, 135.78, 131.61, 131.57, 130.10, 129.98, 129.35, 129.18, 129.11, 129.03, 128.00, 1225.66, 124.02, 123.98, 115.65, 115.43, 19.98, 19.95 . ^{19}F NMR(CDCl_3 , 376 MHz): δ -114.8 .

4-chloro-1,1'-biphenyl 4:



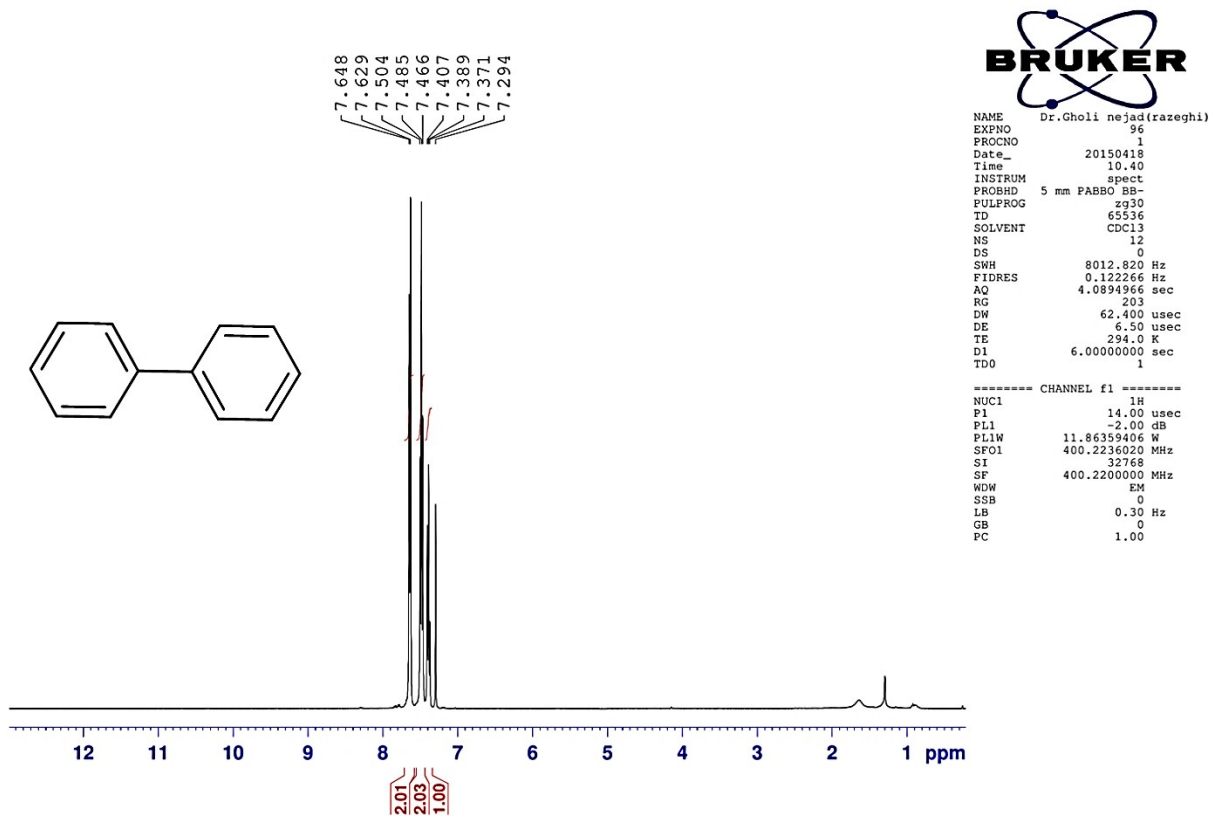
^1H NMR (CDCl_3 , 400 MHz): δ 7.63-7.56 (m, 4H), 7.53-7.41 (m, 5H). ^{13}C NMR (CDCl_3 , 101 MHz): δ 140.04, 139.71, 133.44, 128.98, 128.96, 128.46, 127.66, 127.06 .

3,4'-dinitro-1,1'-biphenyl:

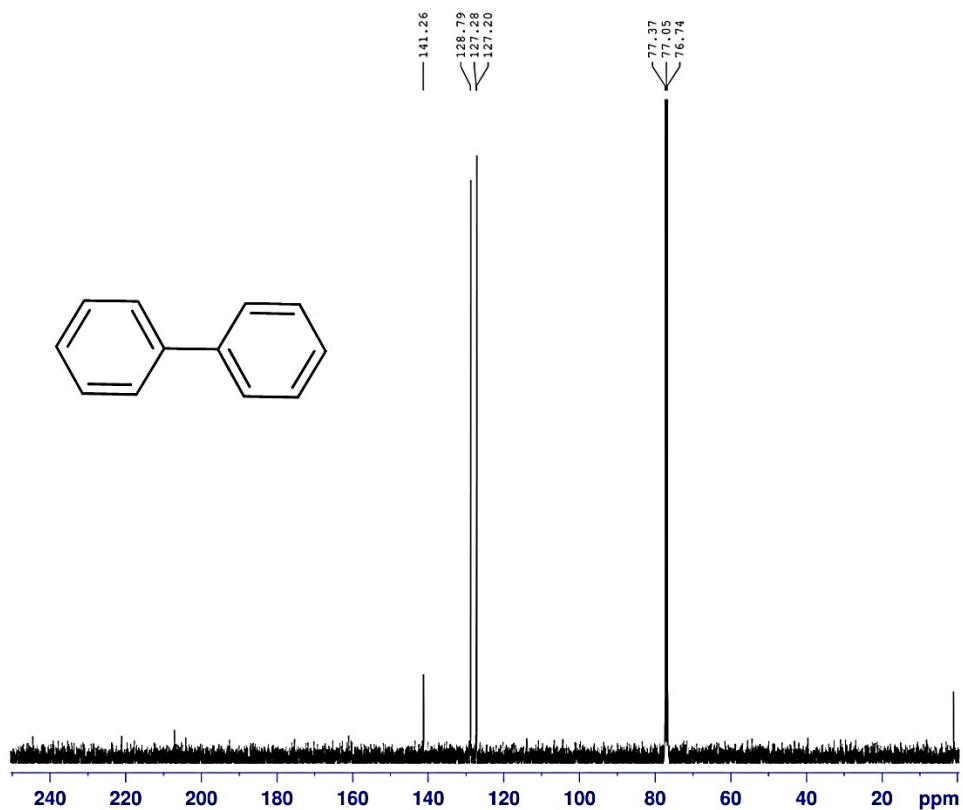


^1H NMR (CDCl_3 , 400 MHz): δ 8.53 (s, 1H), 8.40 (d, 1H, $J=8.8$), 8.36-8.33 (m, 1H), 8.01-7.98 (m, 1H), 7.84-7.84 (t, 1H), 7.76-7.72 (t, 1H). ^{13}C NMR (CDCl_3 , 101 MHz): δ 148.87, 147.93, 144.89, 140.46, 140.36, 133.24, 133.09, 130.30, 128.14, 124.49, 123.59, 123.34, 122.33, 122.15.

Copy of Original ¹H NMR and ¹³C NMR of products



¹H NMR of 1,1'-biphenyl



```

NAME      Dr.Gholi nejad(razeghi)
EXPNO     97
PROCNO    1
Date_     20150418
Time      10.43
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PROBHD    5 mm PABBO BB-
PULPROG   zgpg30
TD         65536
SOLVENT   CDCl3
NS         180
DS         0
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FIDRES     0.385323 Hz
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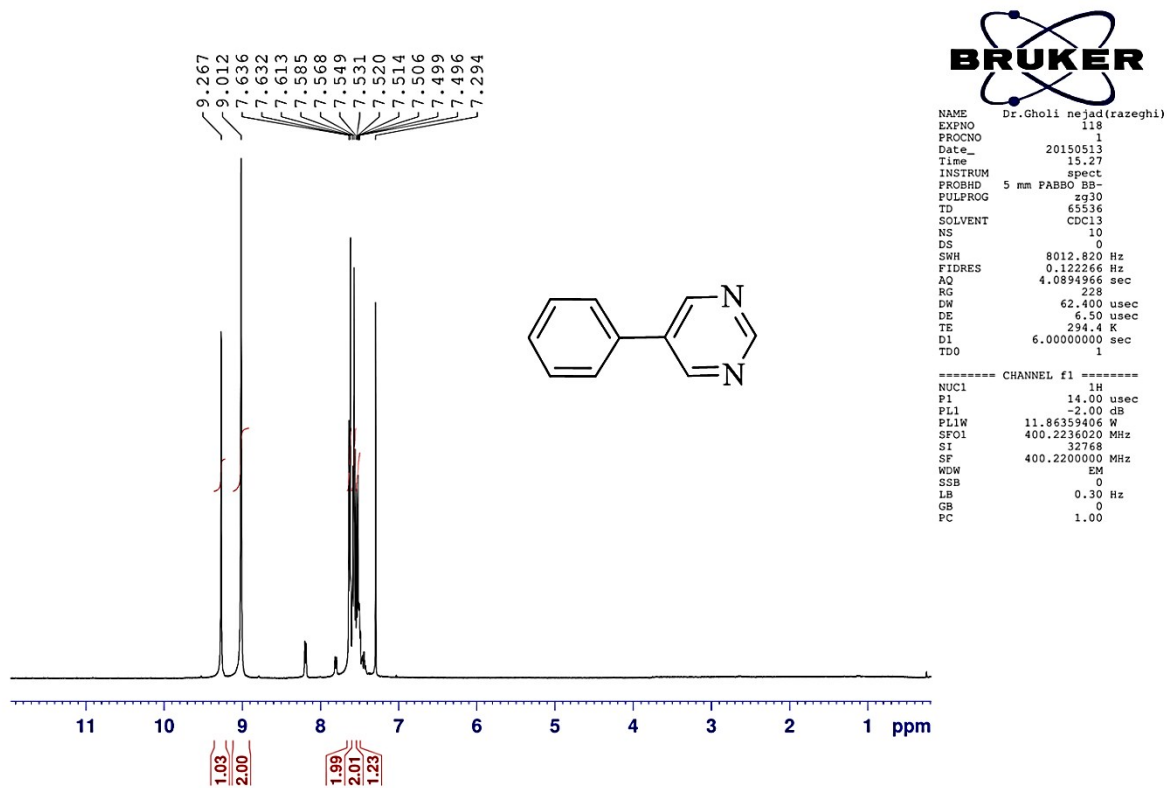
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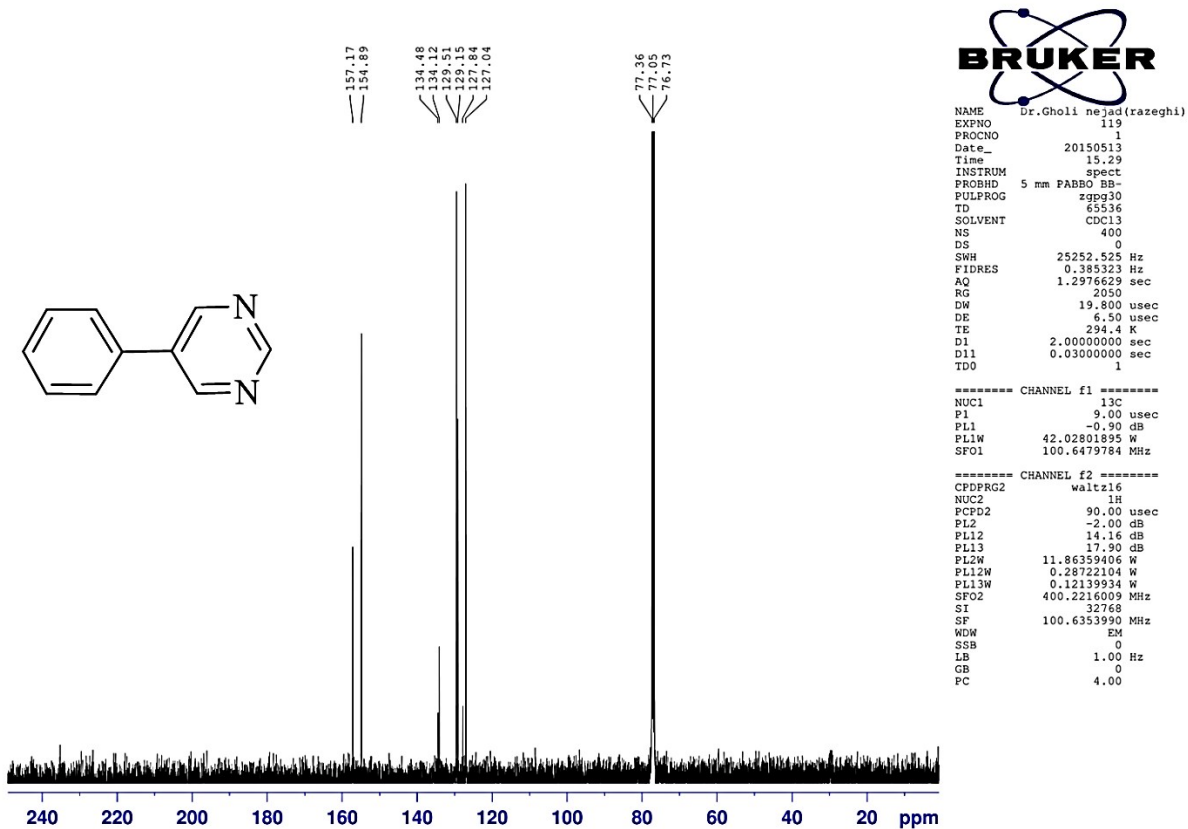
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PL12      14.16 dB
PL13      17.90 dB
PL2W      11.86359406 W
PL12W     0.28722104 W
PL13W     0.12139934 W
SFO2      400.2216009 MHz
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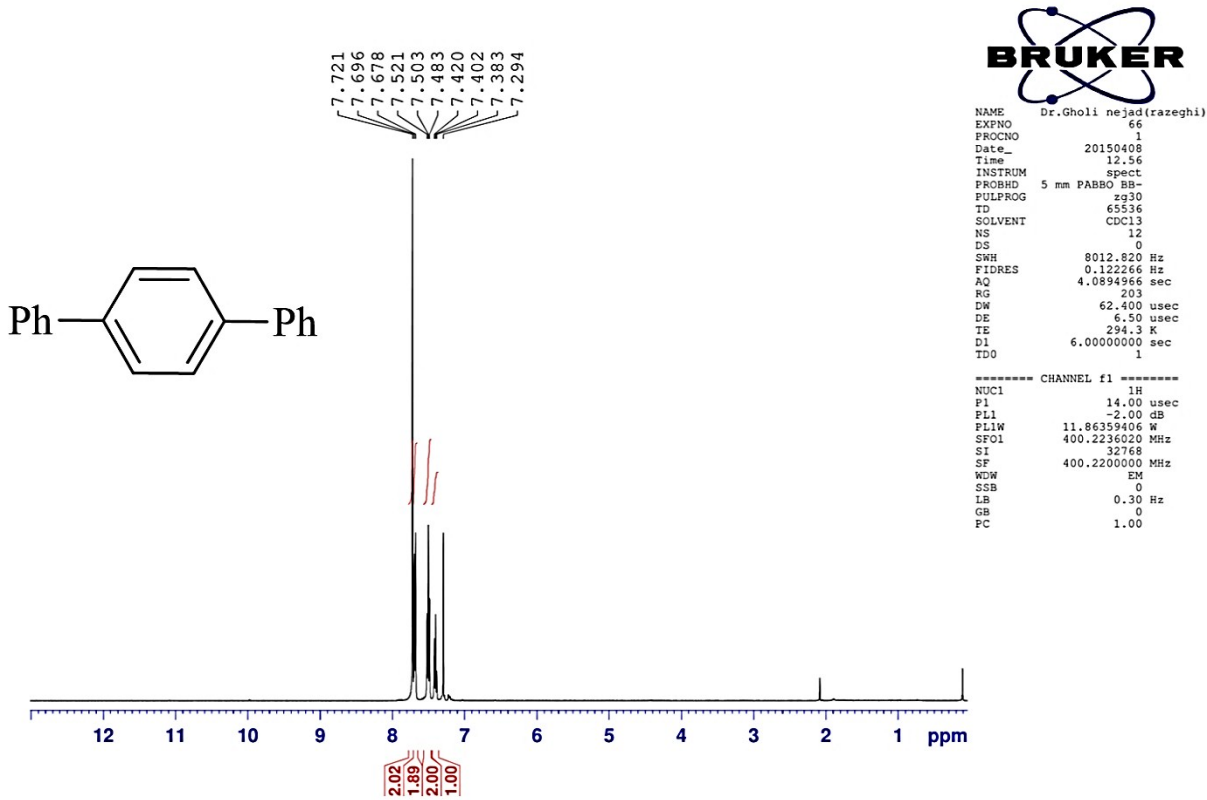
¹³C NMR of 1,1'-biphenyl



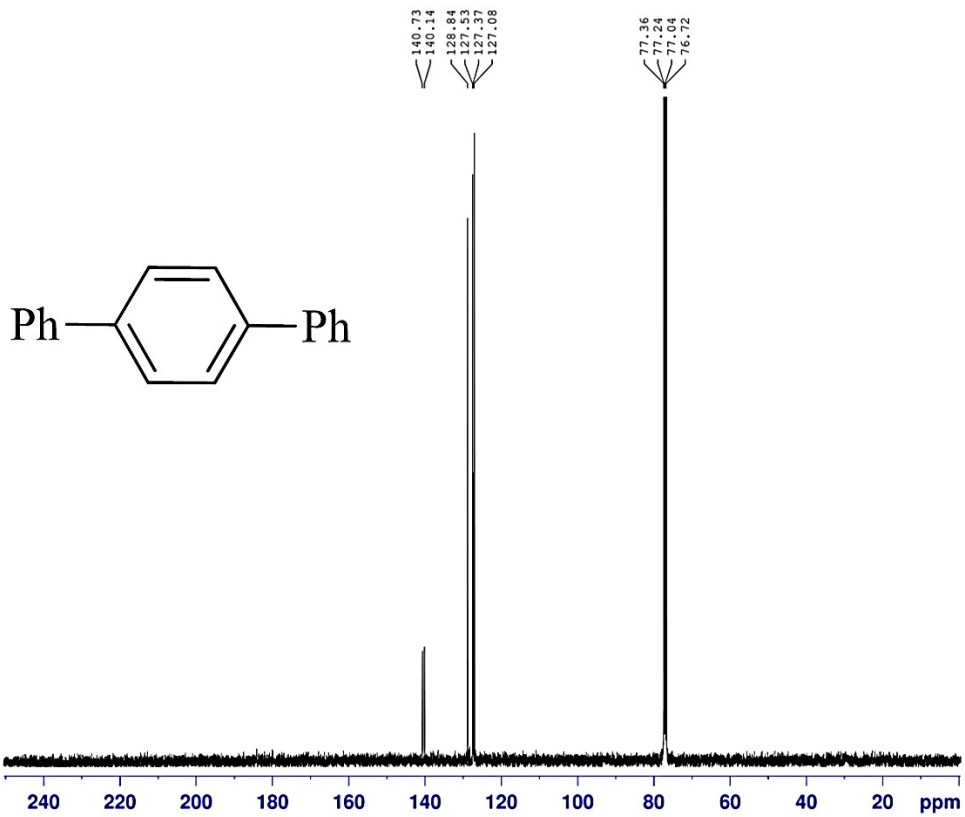
¹H NMR of 5-phenylpyrimidine



¹³C NMR of 5-phenylpyrimidine



¹H NMR of 1,1':4',1''-terphenyl



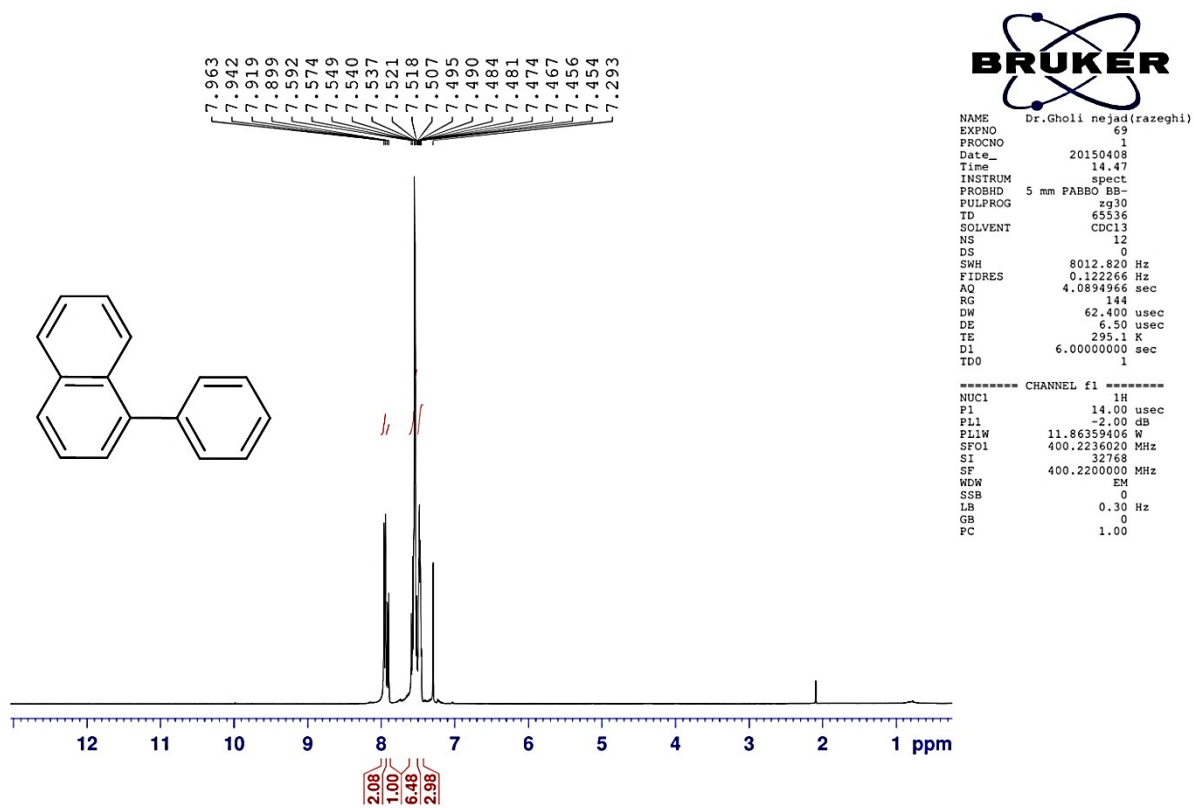
BRUKER

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 Time 14.30
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 TD 65536
 SOLVENT CDCl3
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 FIDRES 0.385323 Hz
 AQ 1.2976623 sec
 RG 2050
 DW 19.800 usec
 DE 6.50 usec
 TE 295.4 K
 D1 2.0000000 sec
 D11 0.0300000 sec
 TDO 1

----- CHANNEL f1 -----
 NUC1 13C
 P1 9.00 usec
 PL1 -0.90 dB
 PL1W 42.02801895 W
 SFO1 100.6479784 MHz

----- CHANNEL f2 -----
 CPDPRG2 waltz16
 NUC2 1H
 PCPD2 90.00 usec
 PL2 -2.00 dB
 PL12 14.16 dB
 PL13 17.90 dB
 PL2W 11.86359406 W
 PL12W 0.28722104 W
 PL13W 0.12139934 W
 SFO2 400.2216009 MHz
 S1 32768
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¹³C NMR of 1,1':4',1''-terphenyl



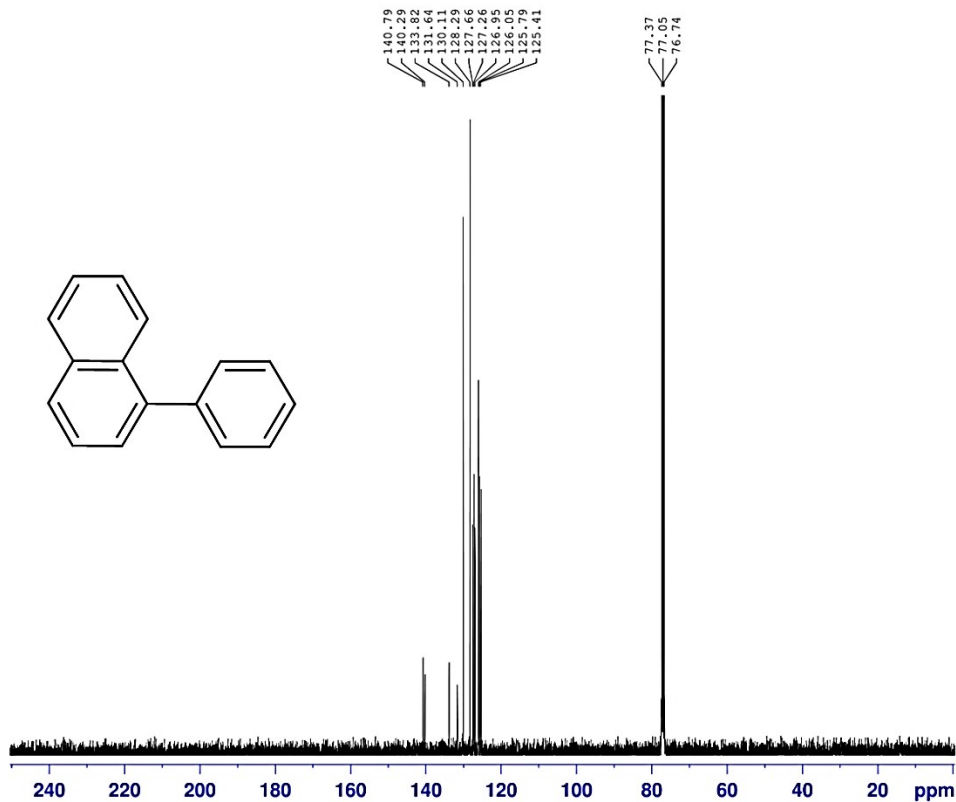
¹H NMR of 1-phenylnaphthalene



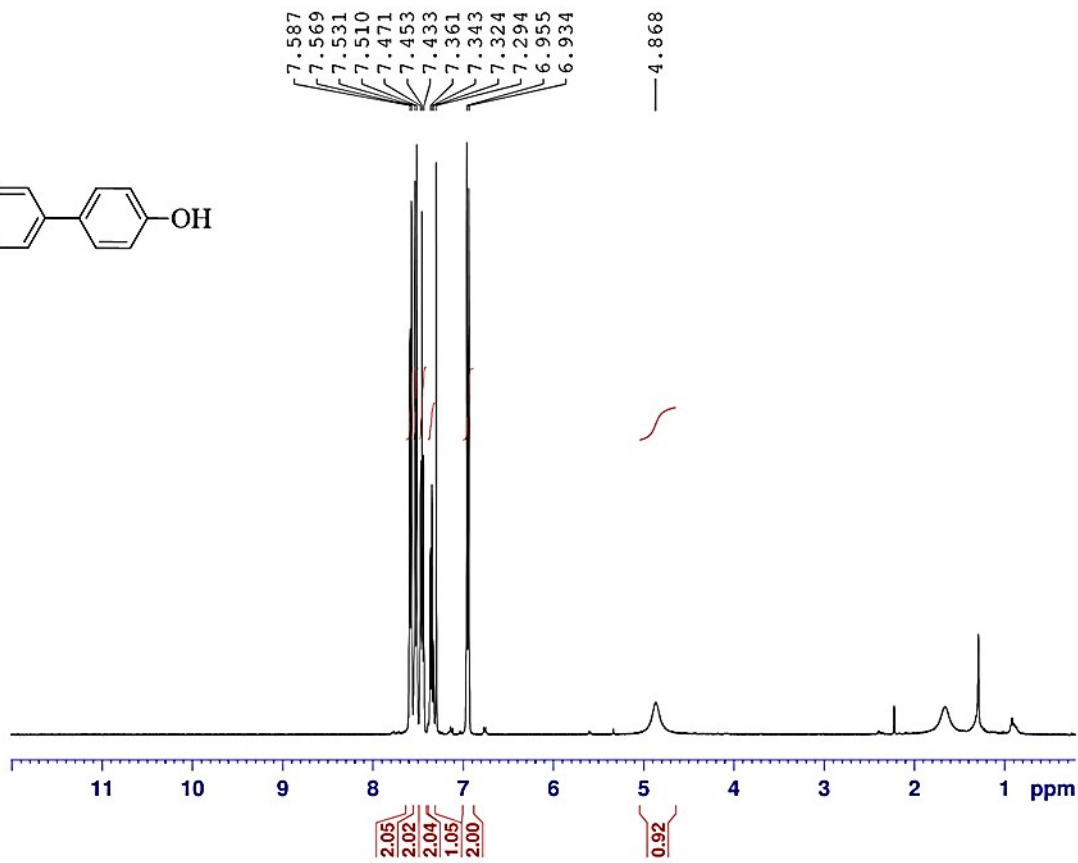
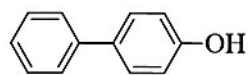
Dr.Gholi nejad (razeghi)
NAME
EXPNO 1
PROCNO 1
Date_ 20150408
Time 14.49
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FIDRES 0.385323 Hz
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RG 2050
DW 19.800 usec
DE 6.50 usec
TE 295.2 K
D1 2.00000000 sec
D11 0.03000000 sec
TDO 1

===== CHANNEL f1 =====
NUC1 13C
P1 9.00 usec
PL1 -0.90 dB
PL1W 42.02801895 W
SFO1 100.6479784 MHz

===== CHANNEL f2 =====
CPDPRG2 waltz16
NUC2 1H
PCPD2 90.00 usec
PL2 -2.00 dB
PL12 14.16 dB
PL13 17.90 dB
PL2W 11.86359406 W
PL12W 0.28722104 W
PL13W 0.12139934 W
SFO2 400.2216009 MHz
SI 32768
SF 100.6353990 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 4.00



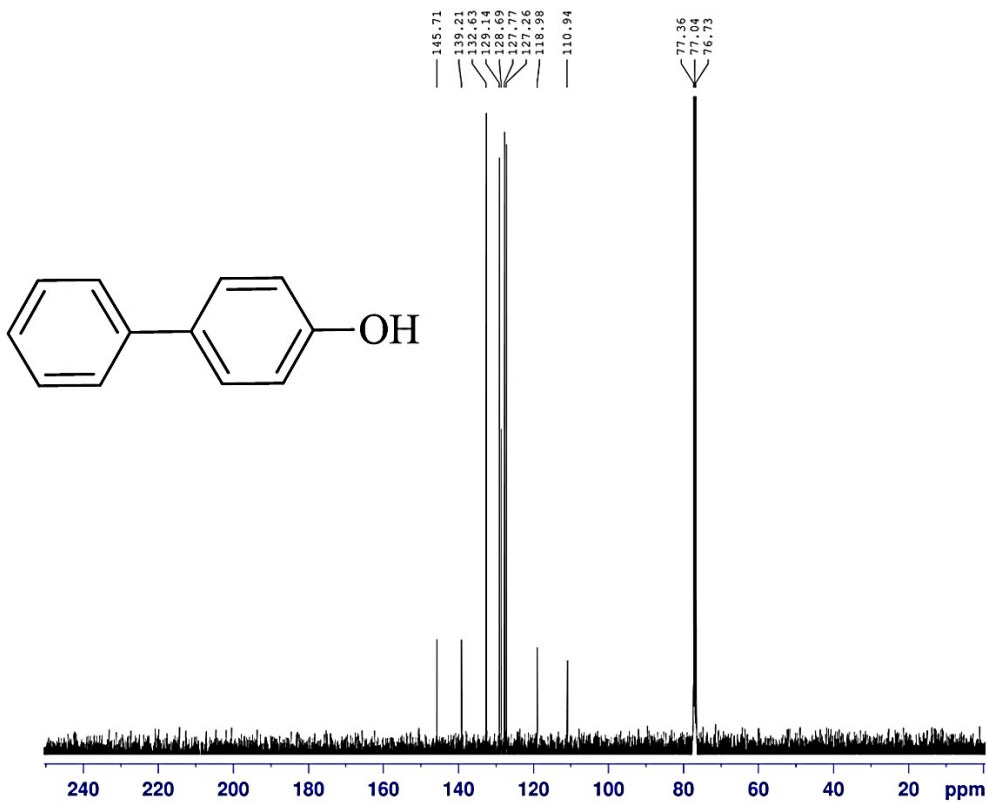
¹³C NMR of 1-phenylnaphthalene



NAME Dr.Gholi nejad(razeghi)
EXPNO 14
PROCNO 1
Date_ 20141015
Time 11.38
INSTRUM spect
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PULPROG zg30
TD 65536
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SWH 8012.820 Hz
FIDRES 0.122266 Hz
AQ 4.0894966 sec
RG 287
DW 62.400 usec
DE 6.50 usec
TE 293.5 K
D1 6.00000000 sec
TDO 1

----- CHANNEL f1 -----
NUC1 1H
P1 14.00 usec
PL1 -2.00 dB
PL1W 11.86359406 W
SFO1 400.2236020 MHz
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¹H NMR of [1,1'-biphenyl]-4-ol



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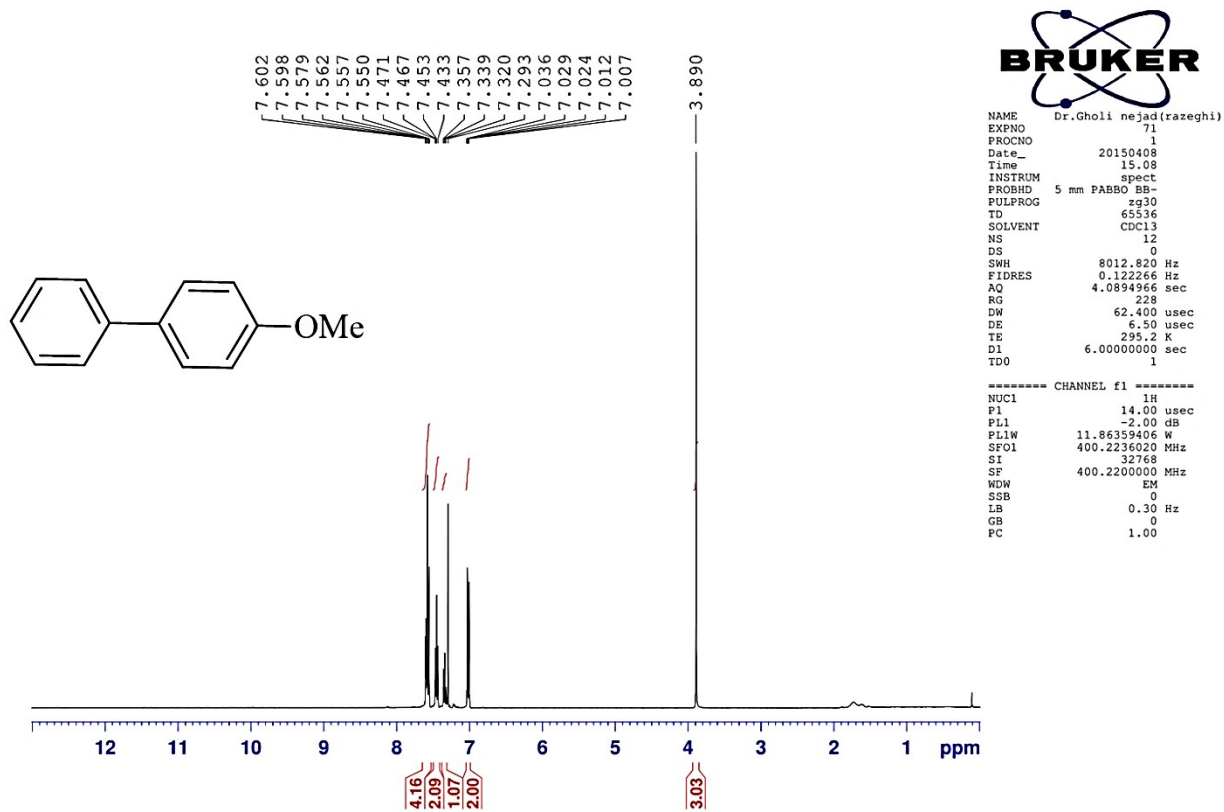
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PROCNO    1
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FIDRES    0.385323 Hz
AQ         1.2976629 sec
RG         2050
DW         19.800 usec
DE         6.50 usec
TE         295.0 K
D1         2.0000000 sec
D11        0.0300000 sec
TD0        1

----- CHANNEL f1 -----
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P1         9.00 usec
PL1        -0.90 dB
PL1W       42.02801895 W
SFO1       100.6479784 MHz

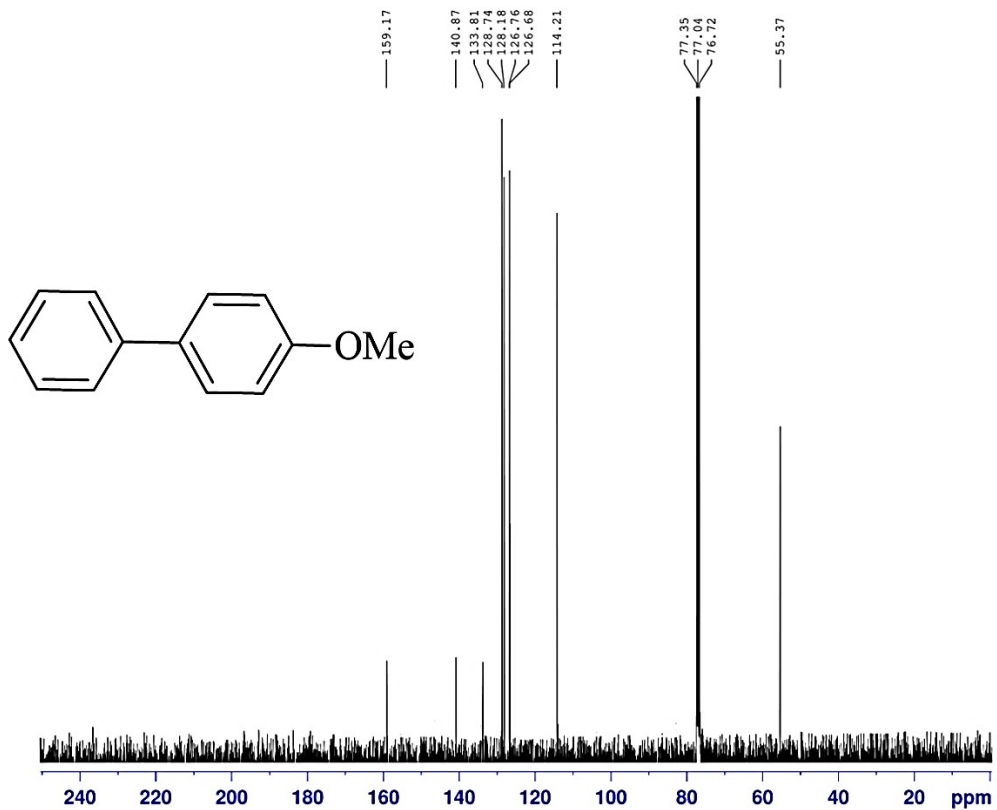
----- CHANNEL f2 -----
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NUC2       1H
PCPD2      90.00 usec
PL2         -2.00 dB
PL12       14.16 dB
PL13       17.90 dB
PL12W      11.86359406 W
PL12W      0.28722104 W
PL13W      0.12139934 W
SFO2       400.2216009 MHz
SI         32768
SF         100.6353990 MHz
WDW        EM
SSB         0
LB          1.00 Hz
GB          0
PC          4.00

```

¹³C NMR of [1,1'-biphenyl]-4-ol



¹H NMR of 4-methoxy-1,1'-biphenyl



```

NAME      Dr.Gholi nejad (razeghi)
EXPNO     1
PROCNO    1
Date_     20150408
Time      15.10
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PROBHD    5 mm PABBO BB-
PULPROG   zgpg30
TD        65536
SOLVENT   CDCl3
NS        300
DS        0
SWH       25252.525 Hz
FIDRES    0.385323 Hz
AQ        1.2975629 sec
RG        2050
DW        19.800 usec
DE        6.50 usec
TE        295.2 K
D1        2.00000000 sec
D11       0.03000000 sec
TDO       1
  
```

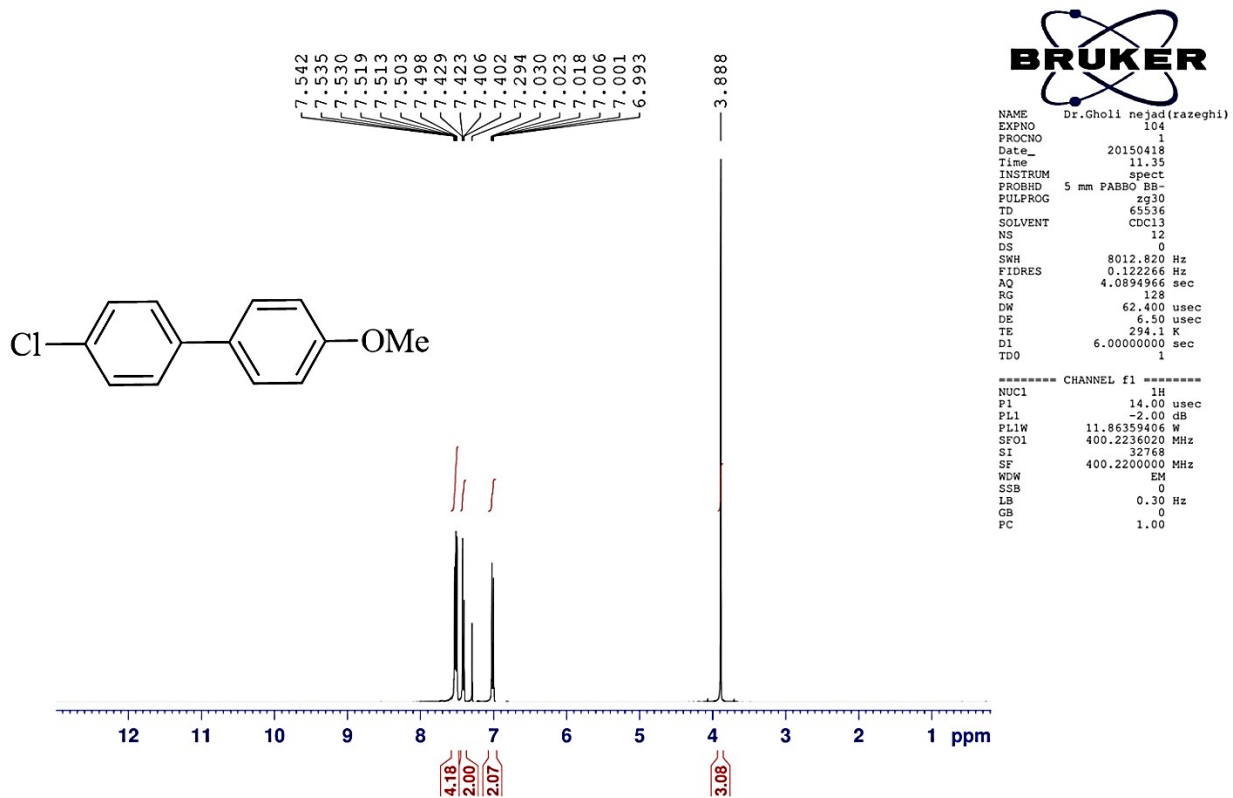
```

===== CHANNEL f1 =====
NUC1      13C
P1        9.00 usec
PL1       -0.90 dB
PL1W     42.02801895 W
SFO1     100.6479784 MHz
  
```

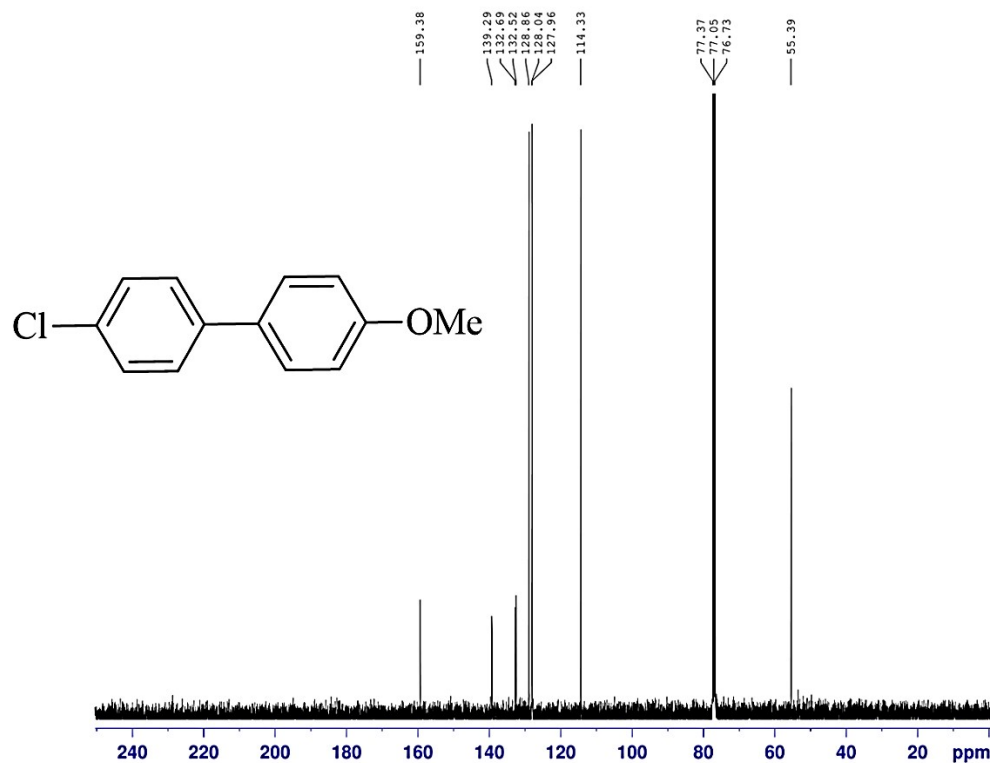
```

===== CHANNEL f2 =====
CPDPRG2   waltz16
NUC2      1H
PCPD2     90.00 usec
PL2       -2.00 dB
PL12      14.16 dB
PL13      17.90 dB
PL12W     11.86359406 W
PL12W     0.28722104 W
PL13W     0.12139934 W
SFO2     400.2215009 MHz
SI        32768
SF        100.6353990 MHz
WDW       EM
SSB       0
LB        1.00 Hz
GB        0
PC        4.00
  
```

¹³C NMR of 4-methoxy-1,1'-biphenyl



¹H NMR of 4-chloro-4'-methoxy-1,1'-biphenyl



```

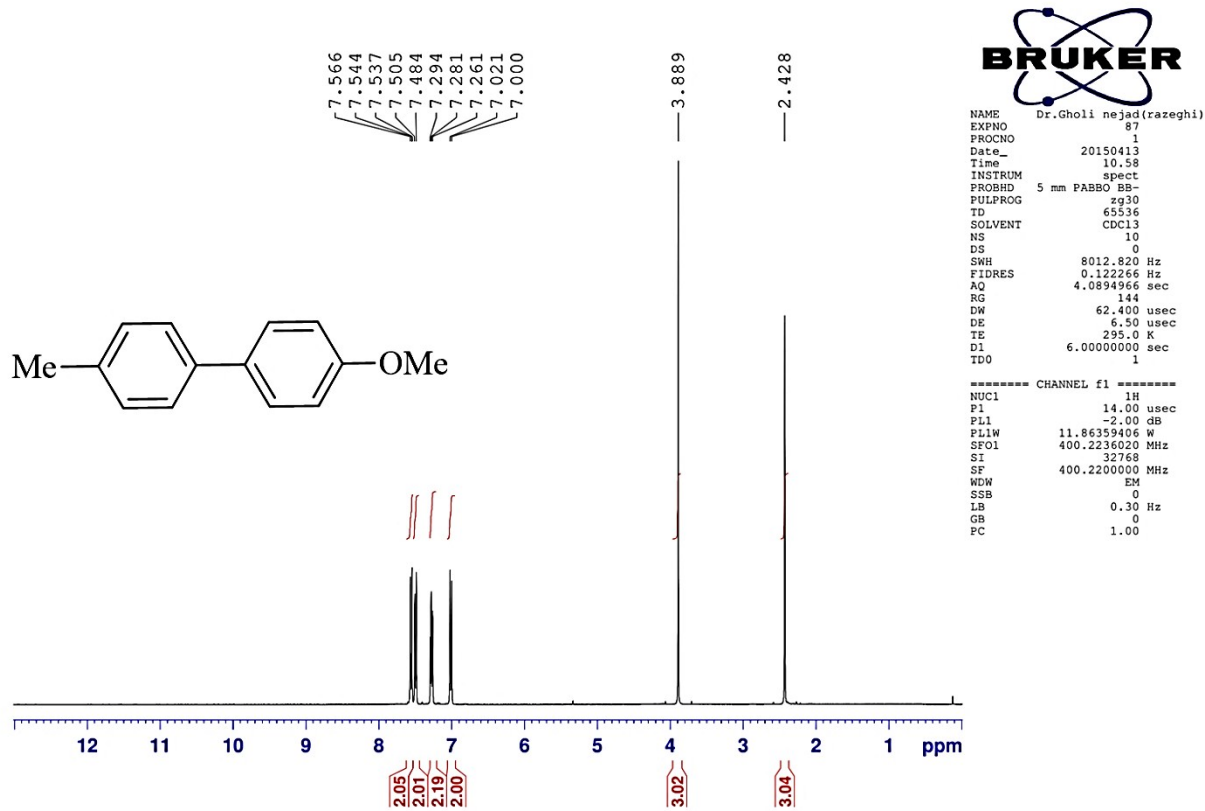
NAME      Dr.Gholi nejad (razeghi)
EXPNO     105
PROCNO    1
Date_     20150418
Time      11.38
INSTRUM   spect
PROBHD    5 mm PABBO BB-
PULPROG   zgpg30
TD        65536
SOLVENT   CDCl3
NS        270
DS        0
SWH       25252.525 Hz
FIDRES    0.385323 Hz
AQ        1.2976629 sec
RG        2050
DM        19.800 usec
DE        6.50 usec
TE        294.4 K
D1        2.0000000 sec
D11       0.0300000 sec
TD0       1

----- CHANNEL f1 -----
NUC1      13C
P1        9.00 usec
PL1       -0.90 dB
PL1W     42.02801895 W
SFO1     100.6479784 MHz

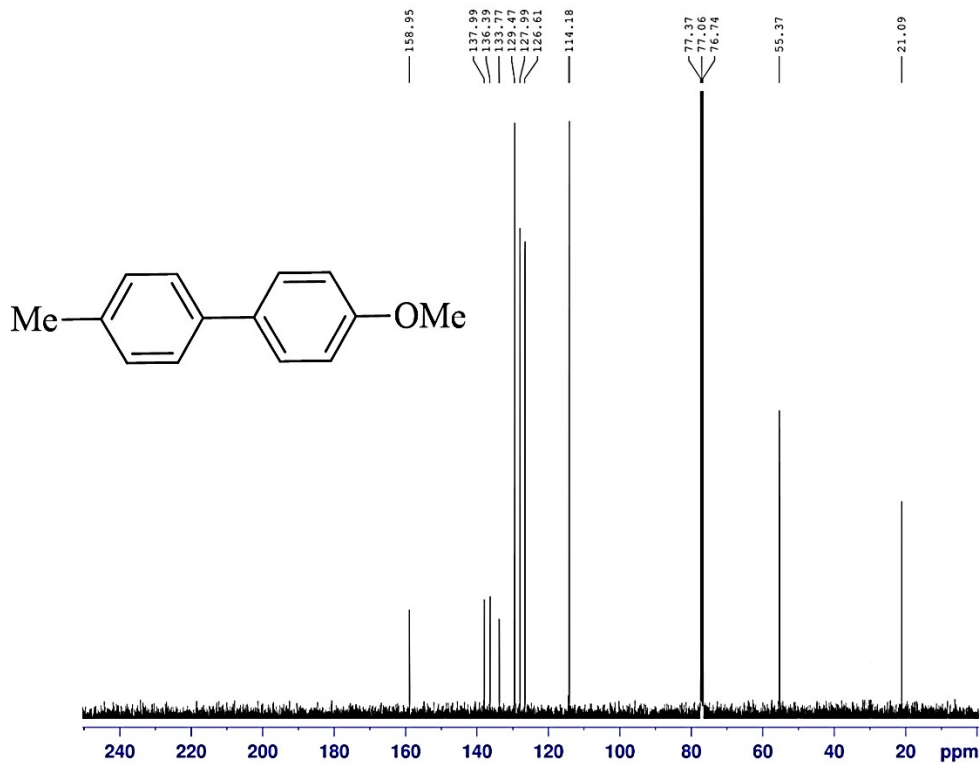
----- CHANNEL f2 -----
CPDPRG2   waltz16
NUC2      1H
PCPD2     90.00 usec
PL2       -2.00 dB
PL12     14.16 dB
PL13     17.90 dB
PL2W     11.86359406 W
PL12W    0.28722104 W
PL13W    0.121399834 W
SFO2     400.2216009 MHz
SI        32768
SF        100.6353990 MHz
WDW       EM
SSB       0
LB        1.00 Hz
GB        0
PC        4.00

```

¹³C NMR of 4-chloro-4'-methoxy-1,1'-biphenyl



¹H NMR of 4-methoxy-4'-methyl-1,1'-biphenyl



```

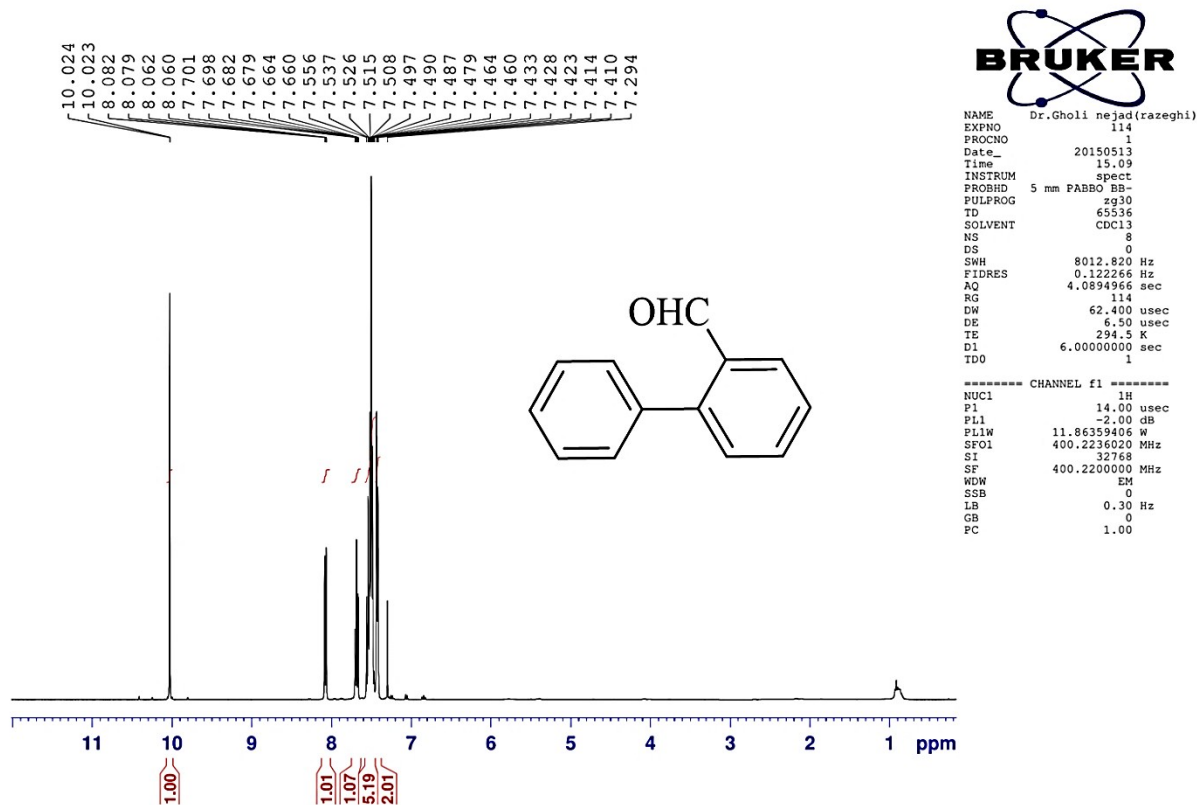
NAME      Dr.Gholi nejad(razeghi)
EXPNO     88
PROCNO    1
Date_     20150413
Time      11.00
INSTRUM   spect
PROBHD    5 mm PABBO BB-
PULPROG   zgpg30
TD        65536
SOLVENT   CDCl3
NS        190
DS        0
SWH       25252.525 Hz
FIDRES    0.385323 Hz
AQ        1.2976629 sec
RG        2050
DW        19.800 usec
DE        6.50 usec
TE        295.1 K
D1        2.00000000 sec
D11       0.03000000 sec
TD0       1

===== CHANNEL f1 =====
NUC1      13C
P1        9.00 usec
PL1       -0.90 dB
PL1W      42.02801895 W
SFO1      100.6479784 MHz

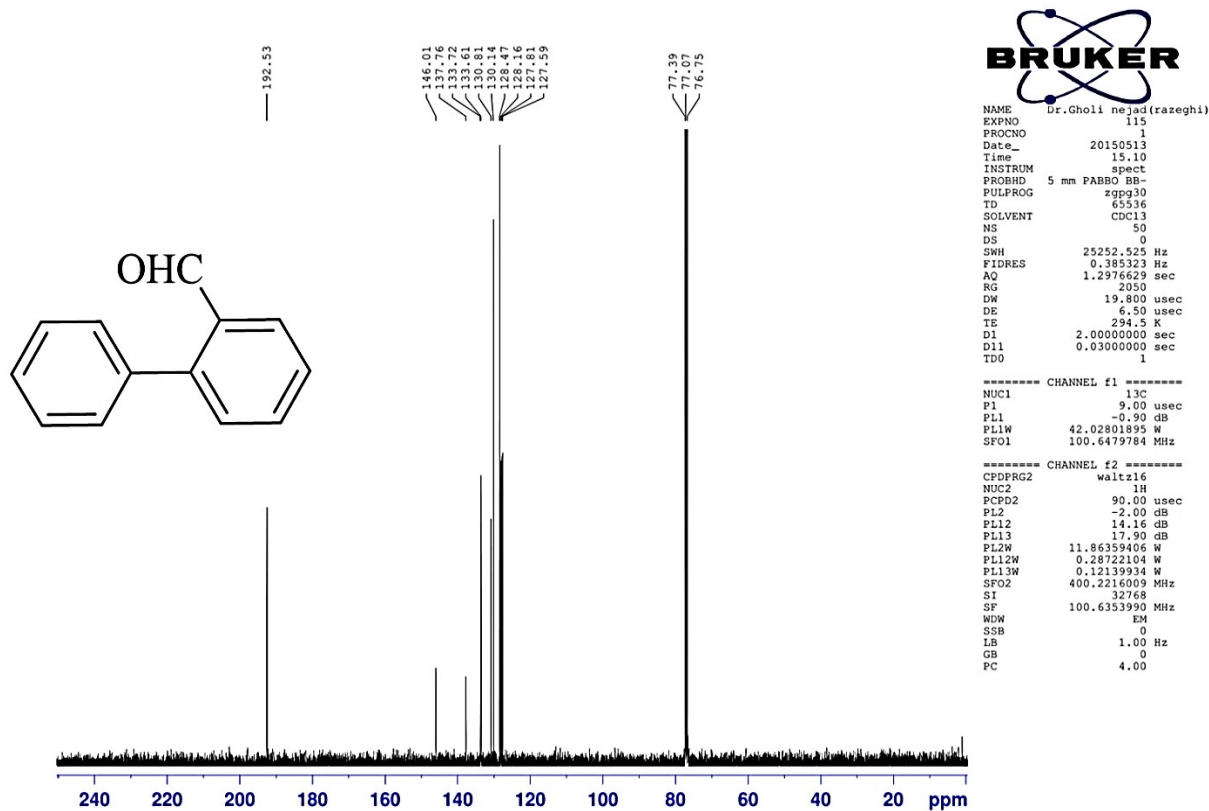
===== CHANNEL f2 =====
CPDPRG2   waltz16
NUC2      1H
PCPD2     90.00 usec
PL2       -2.00 dB
PL12      14.16 dB
PL13      17.50 dB
PL2W      11.86359406 W
PL12W     0.28722104 W
PL13W     0.12139934 W
SFO2      400.2216009 MHz
SI        32768
SF        100.6353990 MHz
WDW       EM
SSB       0
LB        1.00 Hz
GB        0
PC        4.00

```

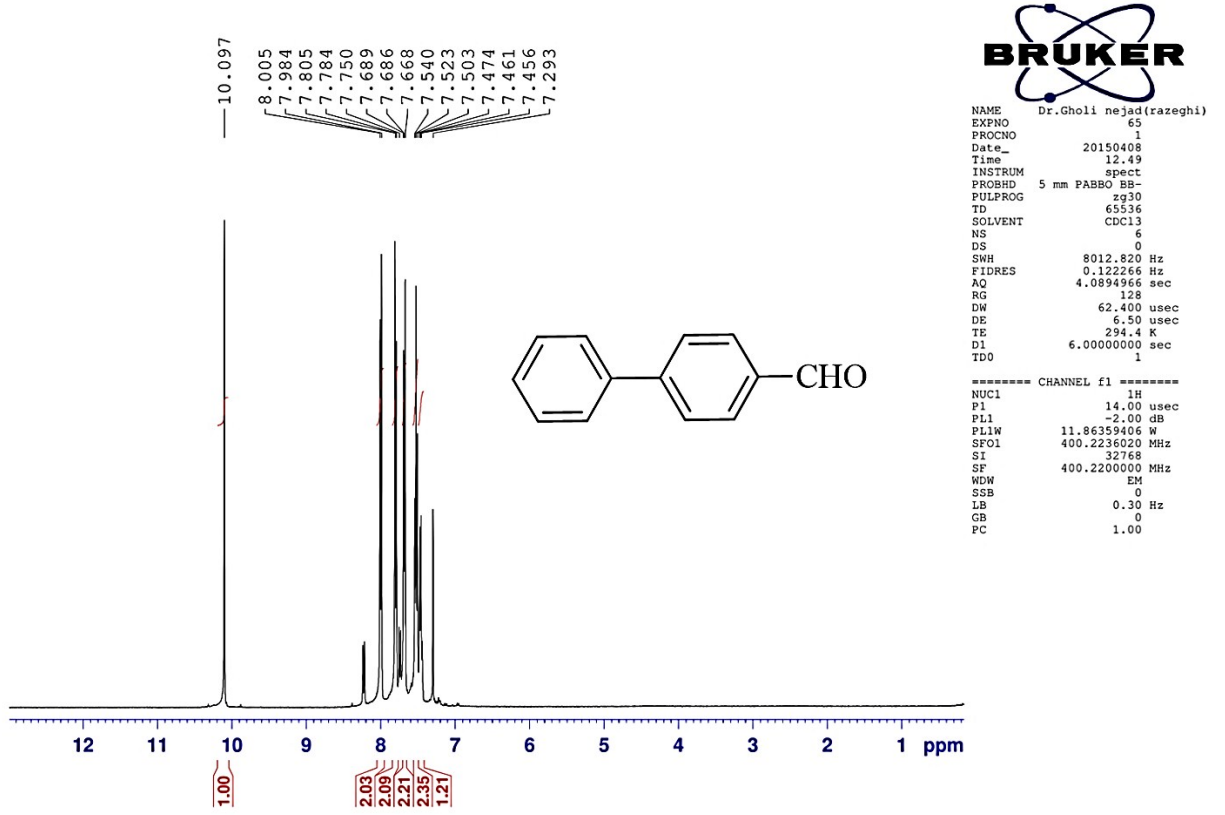
¹³C NMR of 4-methoxy-4'-methyl-1,1'-biphenyl



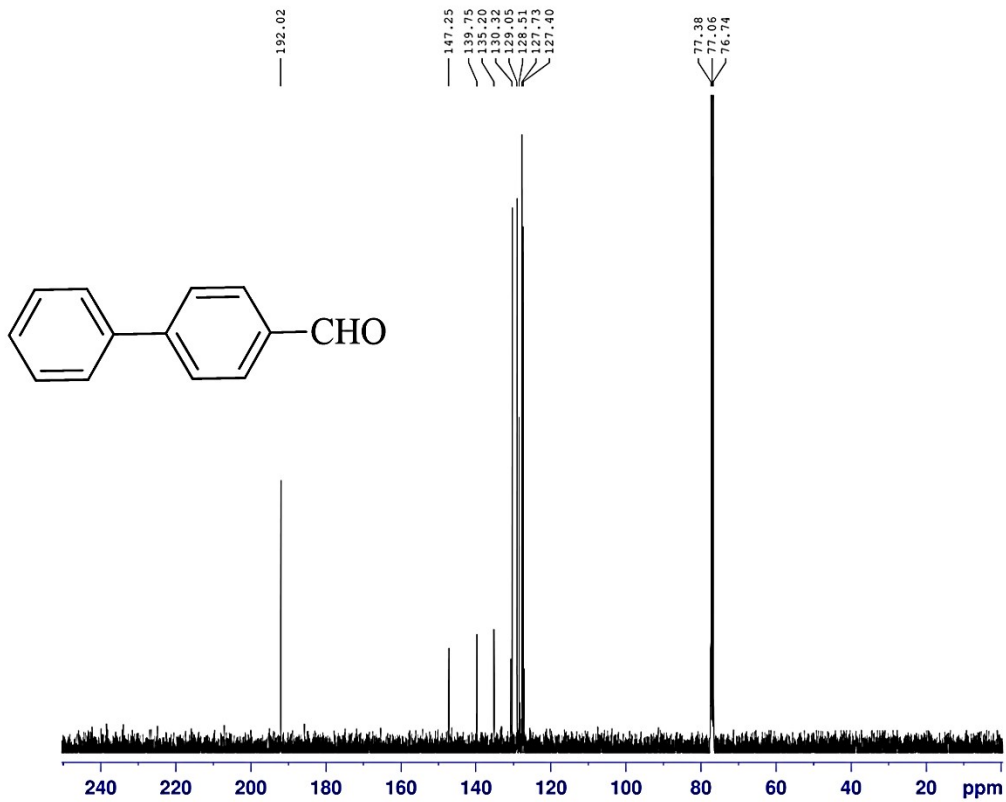
¹H NMR of [1,1'-biphenyl]-2-carbaldehyde



¹³C NMR of [1,1'-biphenyl]-2-carbaldehyde



¹H NMR of [1,1'-biphenyl]-4-carbaldehyde



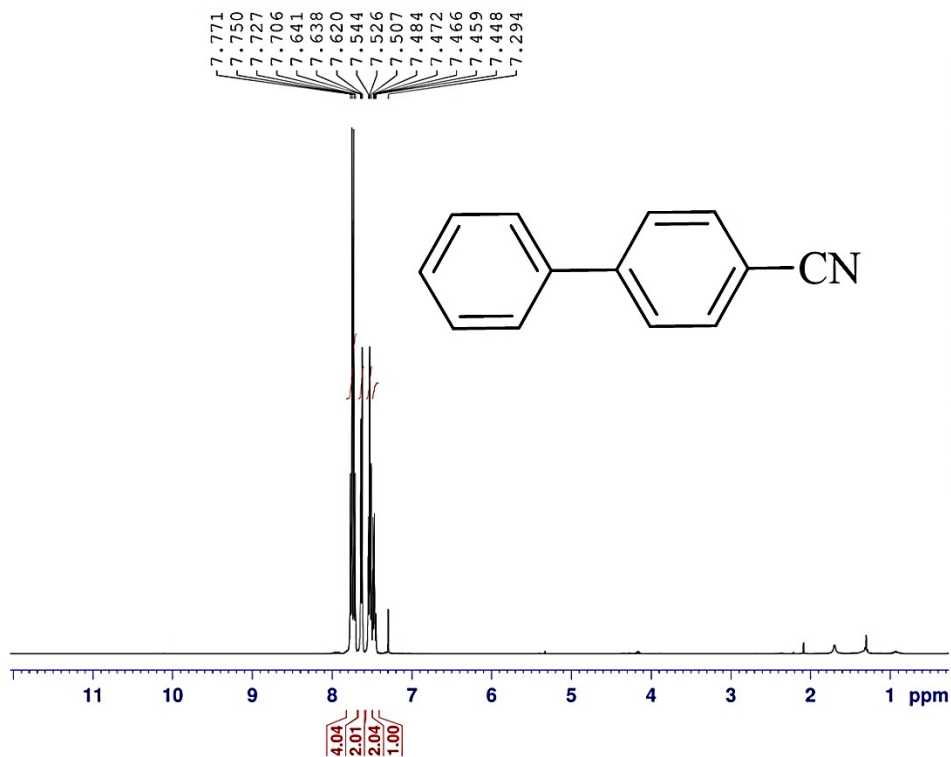
BRUKER

NAME Dr.Gholi nejad(razeghi)
 EXPNO 64
 PROCNO 1
 Date_ 20150408
 Time 12.37
 INSTRUM spect
 PROBHD 5 mm PABBO BB-
 PULPROG zgpg30
 TD 65536
 SOLVENT CDCl3
 NS 201
 DS 0
 SWH 25252.525 Hz
 FIDRES 0.385323 Hz
 AQ 1.2976629 sec
 RG 2050
 DW 19.800 usec
 DE 6.50 usec
 TE 294.3 K
 D1 2.0000000 sec
 D11 0.0300000 sec
 TDO 1

----- CHANNEL f1 -----
 NUC1 13C
 P1 9.00 usec
 PL1 -0.90 dB
 PL1W 42.02801895 W
 SFO1 100.6479784 MHz

----- CHANNEL f2 -----
 CPDPRG2 waltz16
 NUC2 1H
 PCPD2 90.00 usec
 PL2 -2.00 dB
 PL12 14.16 dB
 PL13 17.90 dB
 PL2W 11.86359406 W
 PL12W 0.28722104 W
 PL13W 0.12139934 W
 SFO2 400.2216009 MHz
 SI 32768
 SF 100.6353990 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 4.00

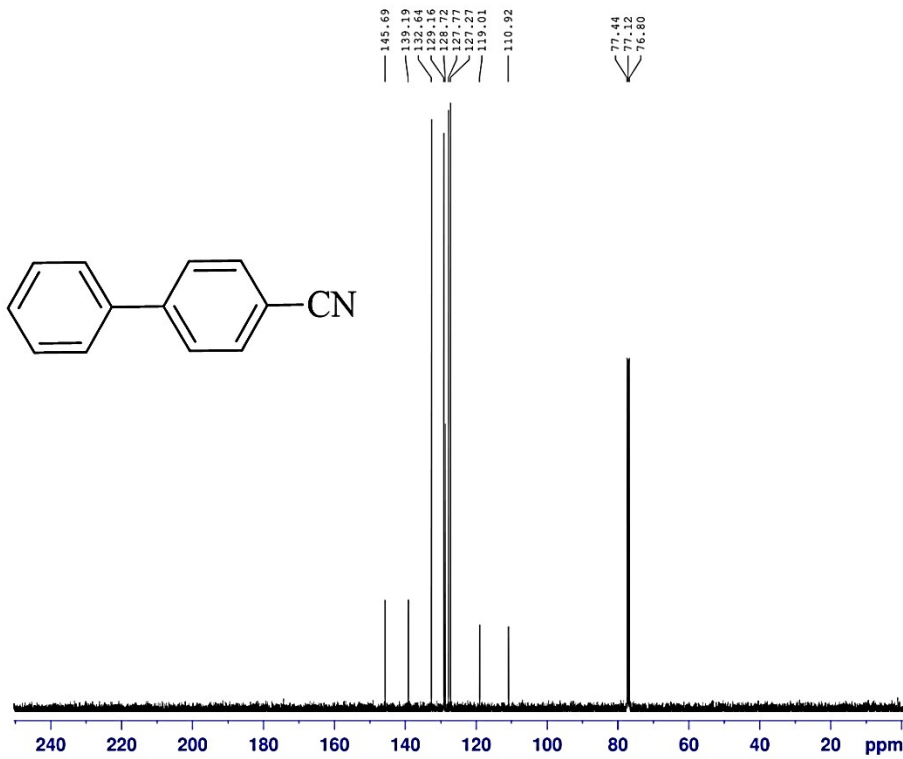
¹³C NMR of [1,1'-biphenyl]-4-carbaldehyde



NAME Dr.Gholi nejad(razeghi)
EXPNO 110
PROCNO 1
Date_ 20150511
Time 12.32
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDC13
NS 8
DS 0
SWH 8012.820 Hz
FIDRES 0.122266 Hz
AQ 4.0894966 sec
RG 101
DW 62.400 usec
DE 6.50 usec
TE 294.1 K
D1 6.0000000 sec
TD0 1

***** CHANNEL f1 *****
NUC1 1H
P1 14.00 usec
PL1 -2.00 dB
PL1W 11.86359406 W
SF01 400.2236020 MHz
SI 32768
SF 400.2200000 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00

¹H NMR of [1,1'-biphenyl]-4-carbonitrile



```

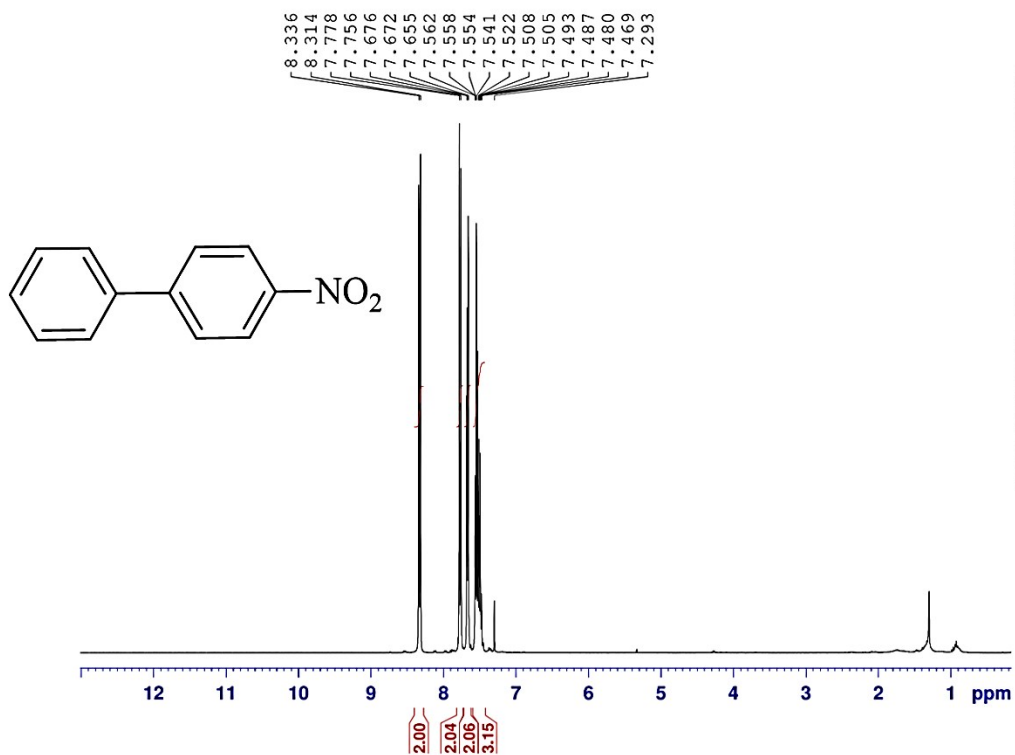
NAME      Dr.Gholi nejad(razeghi)
EXPNO     111
PROCNO    1
Date_     20150511
Time      12.34
INSTRUM   spect
PROBHD    5 mm PABBO BB-
PULPROG   zgpg30
TD        65536
SOLVENT   CDCl3
NS        40
DS        0
SWH       25252.525 Hz
FIDRES    0.385323 Hz
AQ        1.2976629 sec
RG        2050
DW        19.800 usec
DE        6.50 usec
TE        294.5 K
D1        2.0000000 sec
D11       0.0300000 sec
TDO       1

===== CHANNEL f1 =====
NUC1      13C
P1        9.00 usec
PL1       -0.90 dB
PL1W     42.02801899 W
SFO1     100.6479784 MHz

===== CHANNEL f2 =====
CPDPRG2   waltz16
NUC2      1H
PCPD2     90.00 usec
PL2       -2.00 dB
PL12     14.16 dB
PL13     17.90 dB
PL2W     11.86359406 W
PL12W    0.28722104 W
PL13W    0.12139934 W
SFO2     400.2216009 MHz
SI        32768
SF        100.6353990 MHz
WDW       EM
SSB       0
LB        1.00 Hz
GB        0
PC        4.00

```

¹³C NMR of [1,1'-biphenyl]-4-carbonitrile



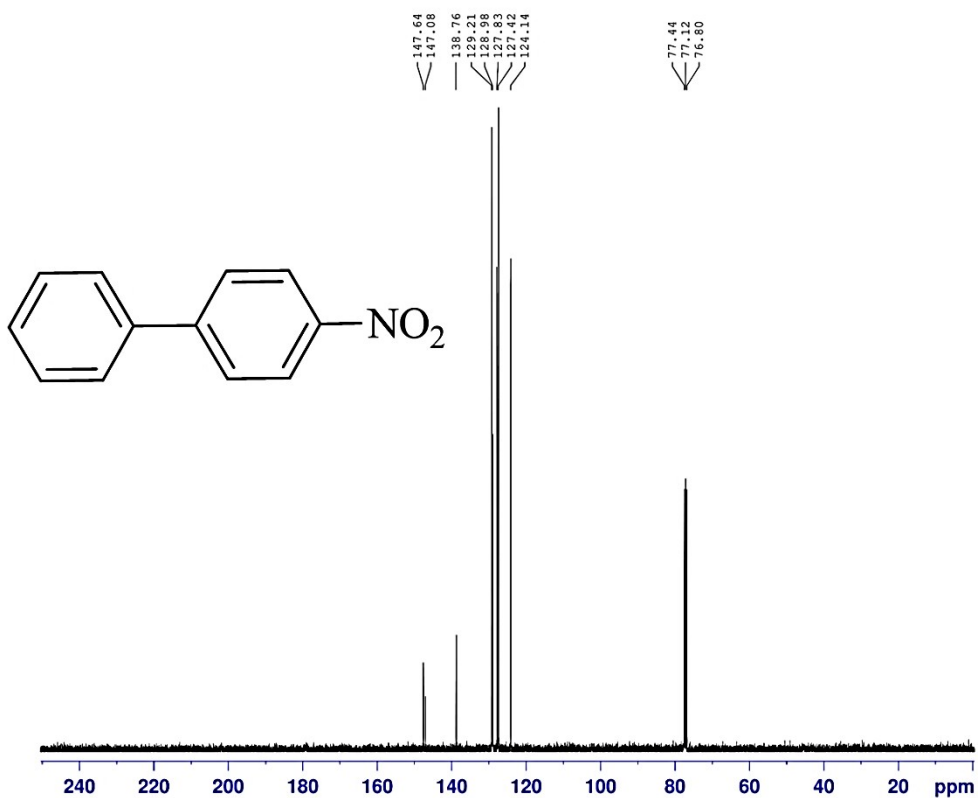
```

NAME      Dr.Gholi nejadi(razeghi)
EXPNO     1
PROCNO    1
Date_     20150518
Time      10.29
INSTRUM   spect
PROBHD    5 mm PABBO BB-
PULPROG   zg30
TD         65536
SOLVENT   CDCl3
NS         6
DS         0
SWH       8012.820 Hz
FIDRES    0.122266 Hz
AQ         4.0894966 sec
RG         50.8
DW         62.400 usec
DE         6.50 usec
TE         293.6 K
D1         6.0000000 sec
TDO        1

===== CHANNEL f1 =====
NUC1      1H
P1        14.00 usec
PL1       -2.00 dB
PL1W      11.86359406 W
SFO1      400.2236020 MHz
SI         32768
SF         400.2200000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00

```

¹H NMR of 4-nitro-1,1'-biphenyl



```

NAME      Dr.Gholi nejad(razeghi)
EXPNO     121
PROCNO    1
Date_     20150518
Time      10.31
INSTRUM   spect
PROBHD    5 mm PABBO BB-
PULPROG   zgpg30
TD         65536
SOLVENT   CDCl3
NS         40
DS         0
SWH        25252.525 Hz
FIDRES     0.385323 Hz
AQ         1.2976629 sec
RG         2050
DW         19.800 usec
DE         6.50 usec
TE         293.8 K
D1         2.0000000 sec
D11        0.0300000 sec
TD0        1
  
```

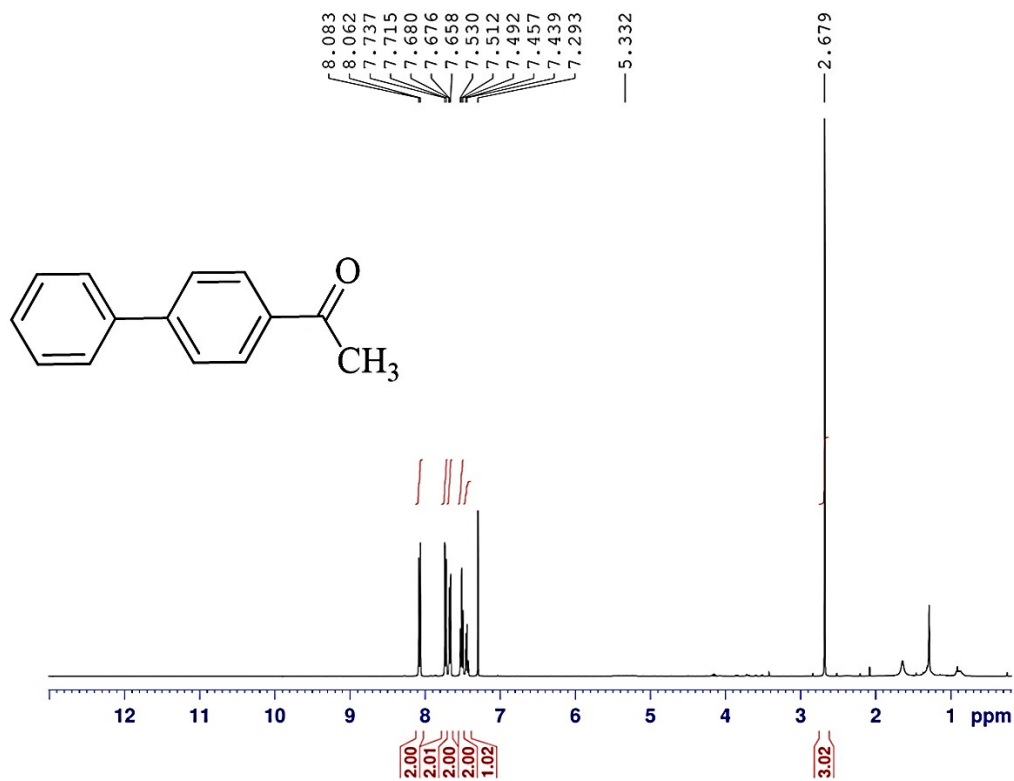
```

----- CHANNEL f1 -----
NUC1       13C
P1         9.00 usec
PL1        -0.90 dB
PL1W       42.02801895 W
SFO1       100.6479784 MHz
  
```

```

----- CHANNEL f2 -----
CPDPRG2    waltz16
NUC2        1H
PCPD2      90.00 usec
PL2         -2.00 dB
PL12        14.16 dB
PL13        17.90 dB
PL2W       11.86359406 W
PL12W       0.28722104 W
PL13W       0.12139934 W
SFO2       400.2216009 MHz
SI         32768
SF         100.6353990 MHz
WDM        EM
SSB         0
LB         1.00 Hz
GB          0
PC          4.00
  
```

¹³C NMR of 4-nitro-1,1'-biphenyl



BRUKER

Dr.Gholi nejad (kazeghi)

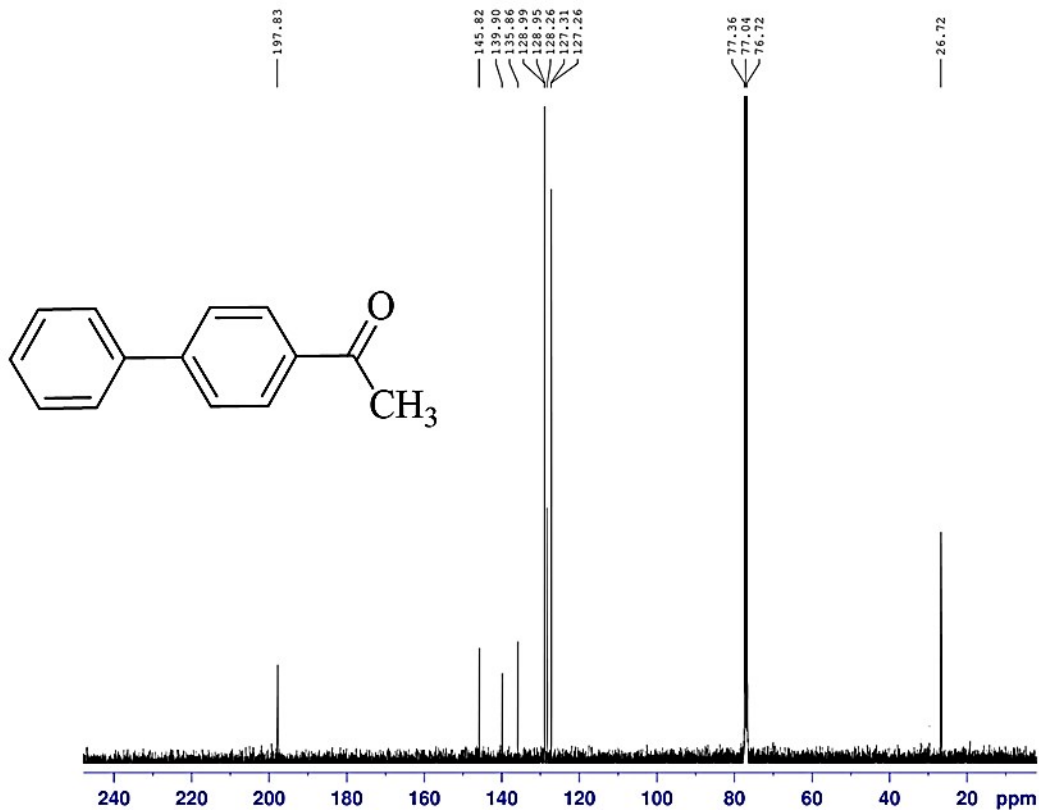
```

NAME
EXPNO 1
PROCNO 91
Date_ 20150413
Time 11.30
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 12
DS 0
SWH 8012.820 Hz
FIDRES 0.122266 Hz
AQ 4.0894966 sec
RG 228
DW 62.400 usec
DE 6.50 usec
TE 294.9 K
D1 6.00000000 sec
TD0 1

----- CHANNEL f1 -----
NUC1 1H
P1 14.00 usec
PL1 -2.00 dB
PLW 11.86359406 W
SFO1 400.2236020 MHz
SI 32768
SF 400.2200000 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00

```

¹H NMR of 1-([1,1'-biphenyl]-4-yl)ethanone



```

NAME          Dr.Gholi nejad(razeghi)
EXPNO         92
PROCNO        1
Date_         20150413
Time          11.35
INSTRUM       spect
PROBHD        5 mm PABBO BB-
PULPROG       zgpg30
TD            65536
SOLVENT       CDCl3
NS            1161
DS            0
SWH           25252.525 Hz
FIDRES        0.385323 Hz
AQ            1.2976629 sec
RG            2050
DW            19.800 usec
DE            6.50 usec
TE            295.2 K
D1            2.0000000 sec
D11           0.0300000 sec
TDO           1

----- CHANNEL f1 -----
NUC1          13C
P1            9.00 usec
PL1           -0.90 dB
PL1W          42.02801895 W
SFO1          100.6479784 MHz

----- CHANNEL f2 -----
CPDPRG2       waltz16
NUC2          1H
PCPD2         90.00 usec
PL2           -2.00 dB
PL12          14.16 dB
PL13          17.90 dB
PL2W          11.86359406 W
PL12W         0.28722104 W
PL13W         0.12139934 W
SFO2          400.2216009 MHz
SI            32768
SF            100.6353990 MHz
WDW           EM
SSB           0
LB            1.00 Hz
GB            0
PC            4.00

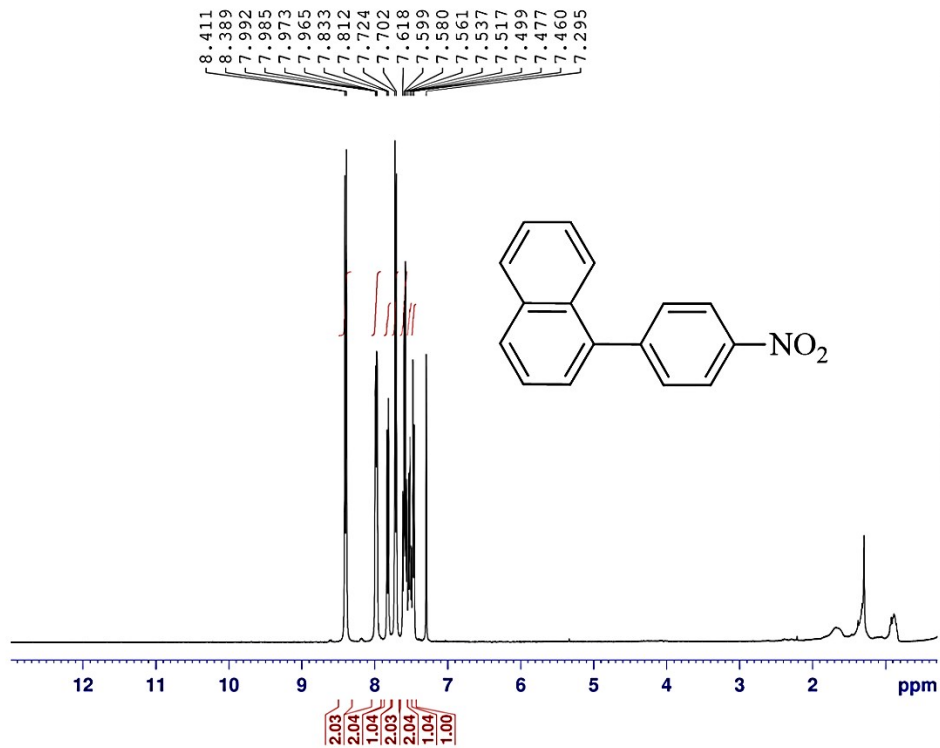
```

¹³C NMR of 1-([1,1'-biphenyl]-4-yl)ethanone

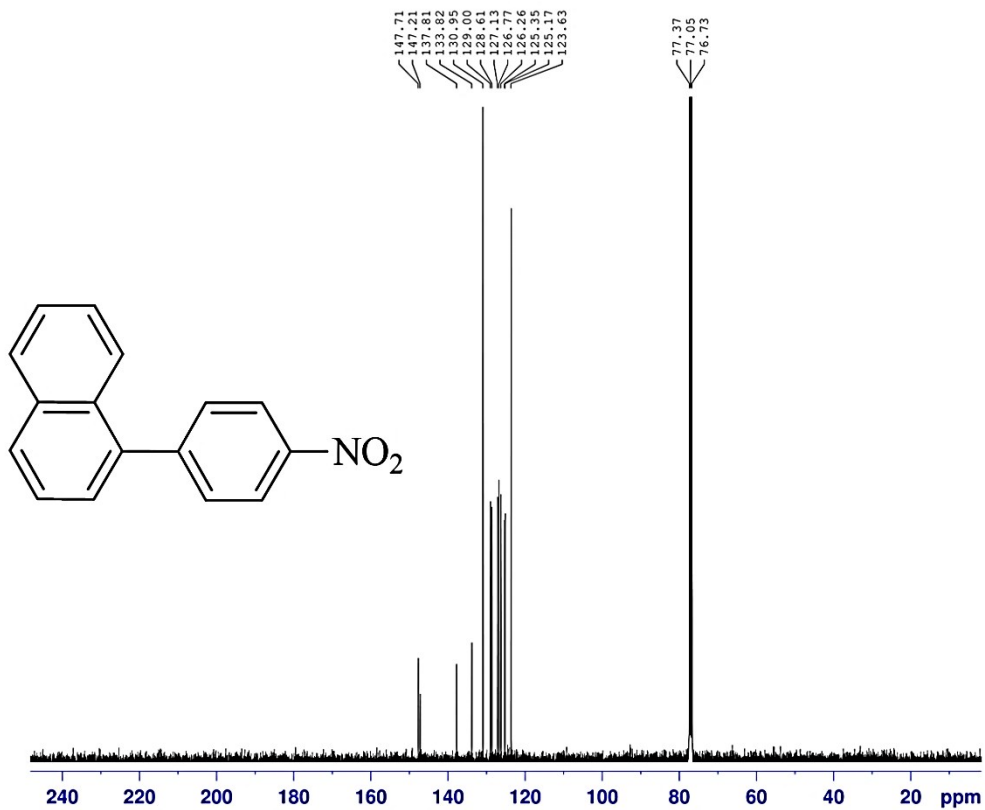


Dr.Gholi nejad(razeghi)
NAME
EXPNO 77
PROCNO 1
Date_ 20150411
Time 11.16
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 12
DS 0
SWH 8012.820 Hz
FIDRES 0.122266 Hz
AQ 4.0894966 sec
RG 128
DW 62.400 usec
DE 6.50 usec
TE 296.5 K
D1 6.0000000 sec
TDO 1

----- CHANNEL f1 -----
NUC1 1H
P1 14.00 usec
PL1 -2.00 dB
PL1W 11.86359406 W
SFO1 400.2236020 MHz
SI 32768
SF 400.2200000 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00



¹H NMR of 1-(4-nitrophenyl)naphthalene

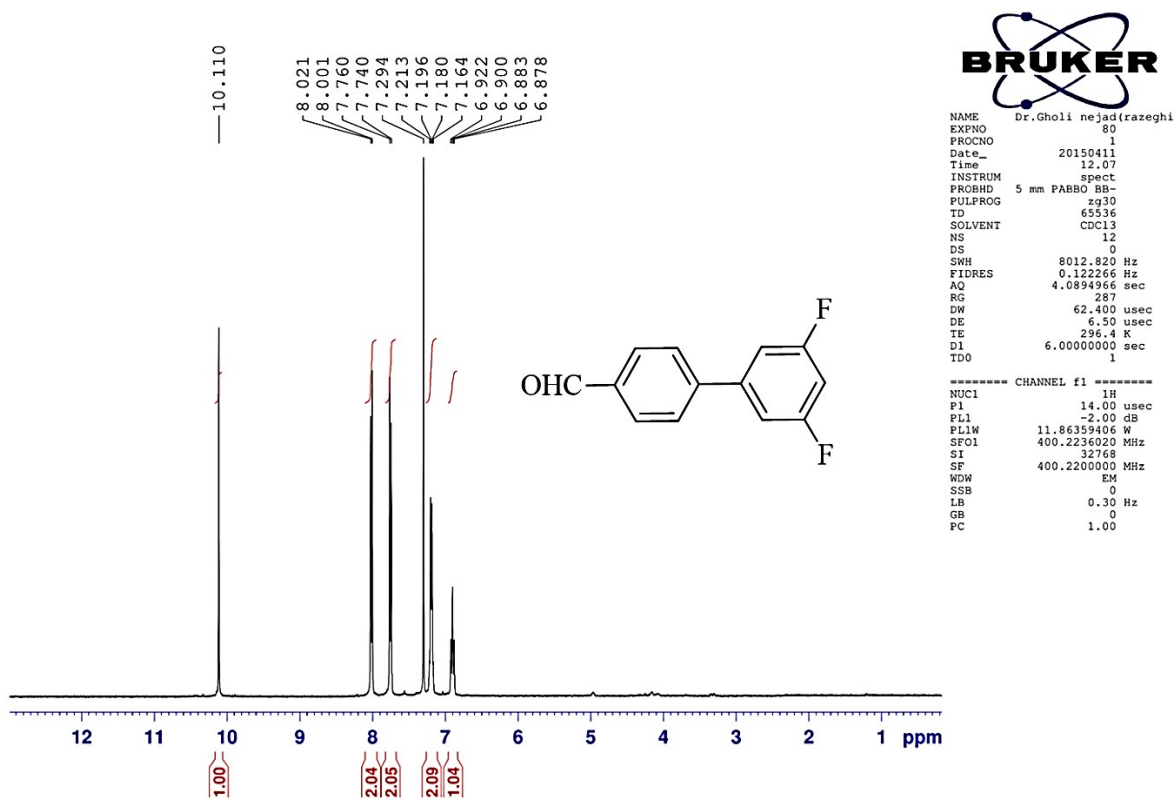


NAME Dr.Gholi nejad(razeghi)
 EXPNO 78
 PROCNO 1
 Date_ 20150411
 Time 11.18
 INSTRUM spect
 PROBHD 5 mm PABBO BB-
 PULPROG zgpg30
 TD 65336
 SOLVENT CDCl3
 NS 500
 DS 0
 SWH 25252.525 Hz
 FIDRES 0.385323 Hz
 AQ 1.2976629 sec
 RG 2050
 DW 19.800 usec
 DE 6.50 usec
 TE 296.6 K
 D1 2.0000000 sec
 D11 0.0300000 sec
 TDO 1

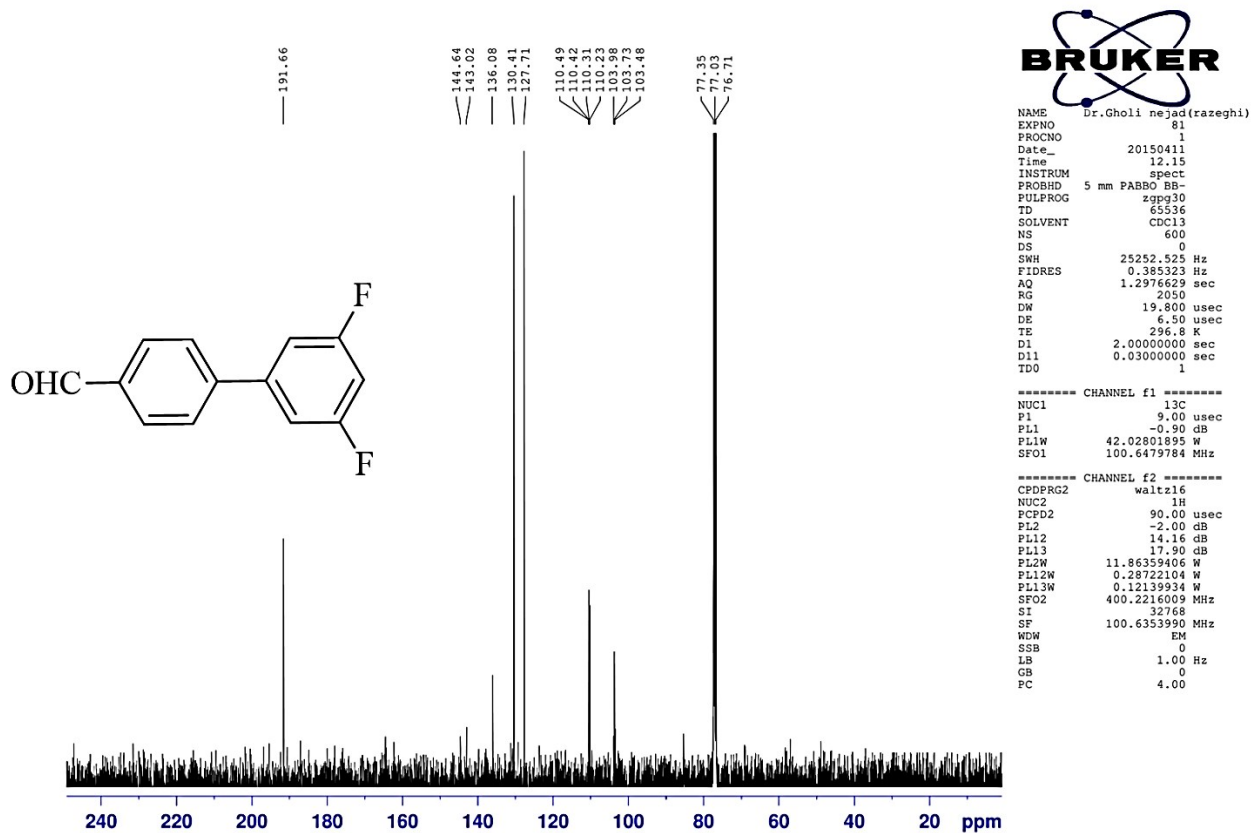
===== CHANNEL f1 =====
 NUC1 13C
 P1 9.00 usec
 PL1 -0.90 dB
 PL1W 42.02801895 W
 SF01 100.6479784 MHz

===== CHANNEL f2 =====
 CPDPRG2 waltz16
 NUC2 1H
 PCPD2 90.00 usec
 PL2 -2.00 dB
 PL12 14.16 dB
 PL13 17.90 dB
 PL2W 11.86359406 W
 PL12W 0.28722104 W
 PL13W 0.12139934 W
 SF02 400.2216009 MHz
 S1 32768
 SF 100.6353990 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 FC 4.00

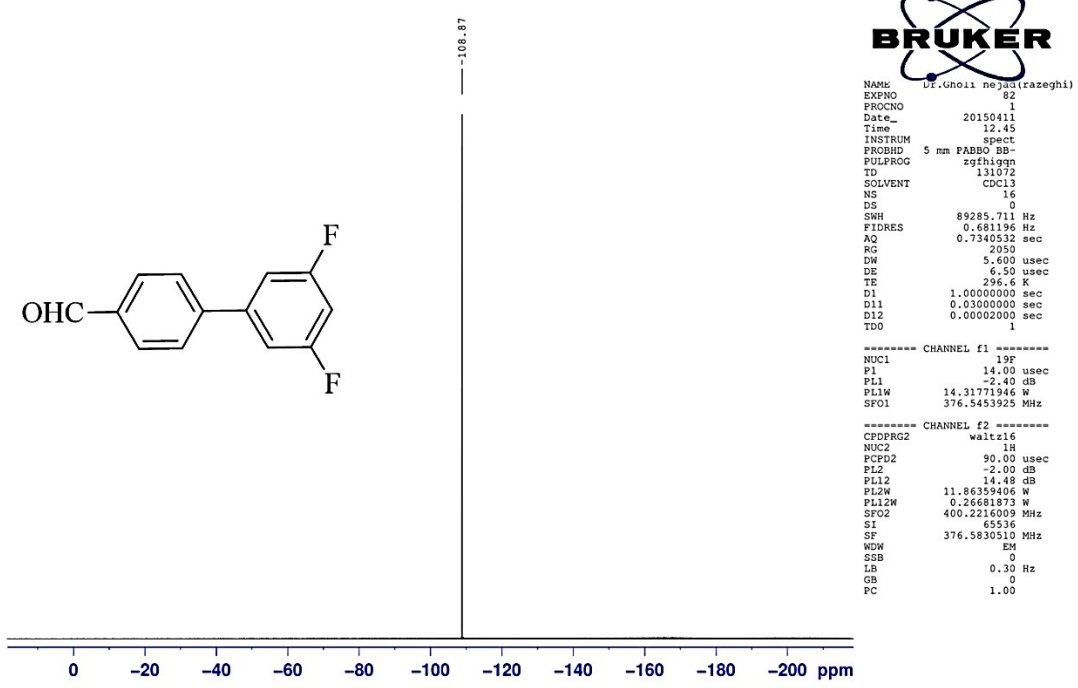
¹³C NMR of 1-(4-nitrophenyl)naphthalene



¹H NMR of 3',5'-difluoro-[1,1'-biphenyl]-4-carbaldehyde



¹³C NMR of 3',5'-difluoro-[1,1'-biphenyl]-4-carbaldehyde



```

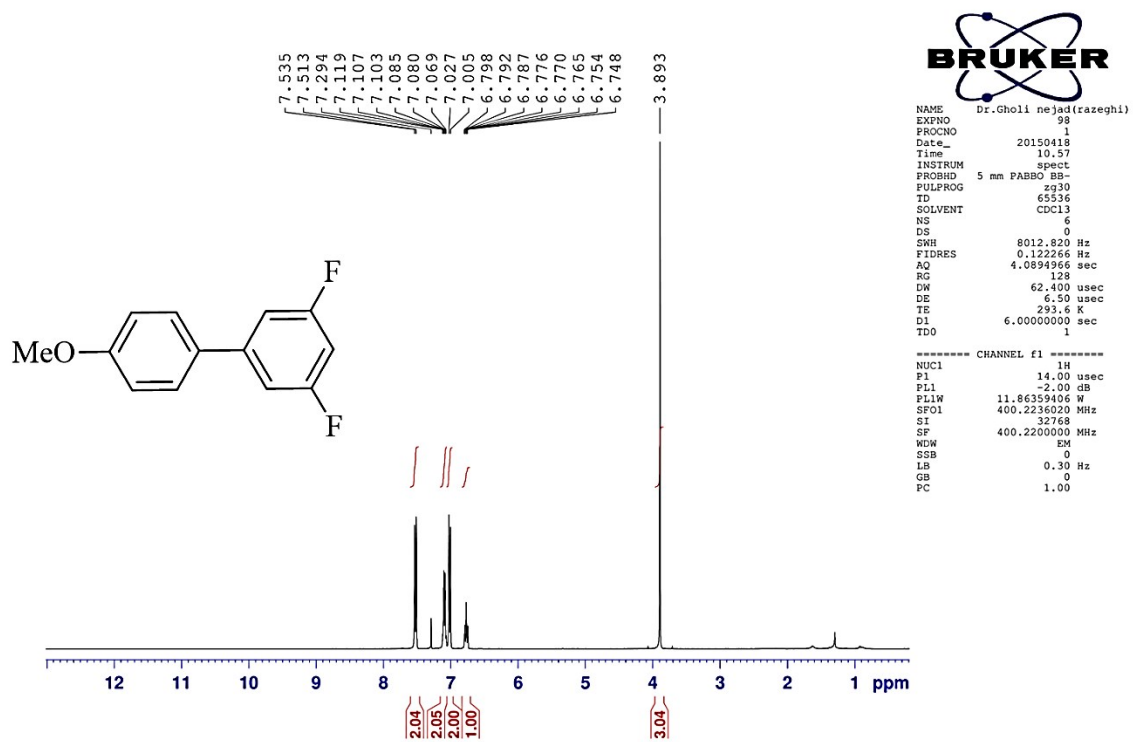
NAME      DE.Gho11 nejau (azeghi)
EXPNO     82
PROCNO    1
Date_     20150411
Time      12.45
INSTRUM   spect
PROBHD    5 mm PABBO BB-
PULPROG   zgpg30
TD         131072
SOLVENT   CDCl3
NS         16
DS         0
SWH        89295.711 Hz
FIDRES     0.681196 Hz
AQ         0.7340532 sec
RG         2050
DW         5.600 usec
DE         6.50 usec
TE         296.6 K
D1         1.0000000 sec
D11        0.0300000 sec
D12        0.0002000 sec
TD0        1

----- CHANNEL f1 -----
NUC1       19F
P1         14.00 usec
PL1        -2.40 dB
PL1W       14.3171946 W
SFO1       376.5453925 MHz

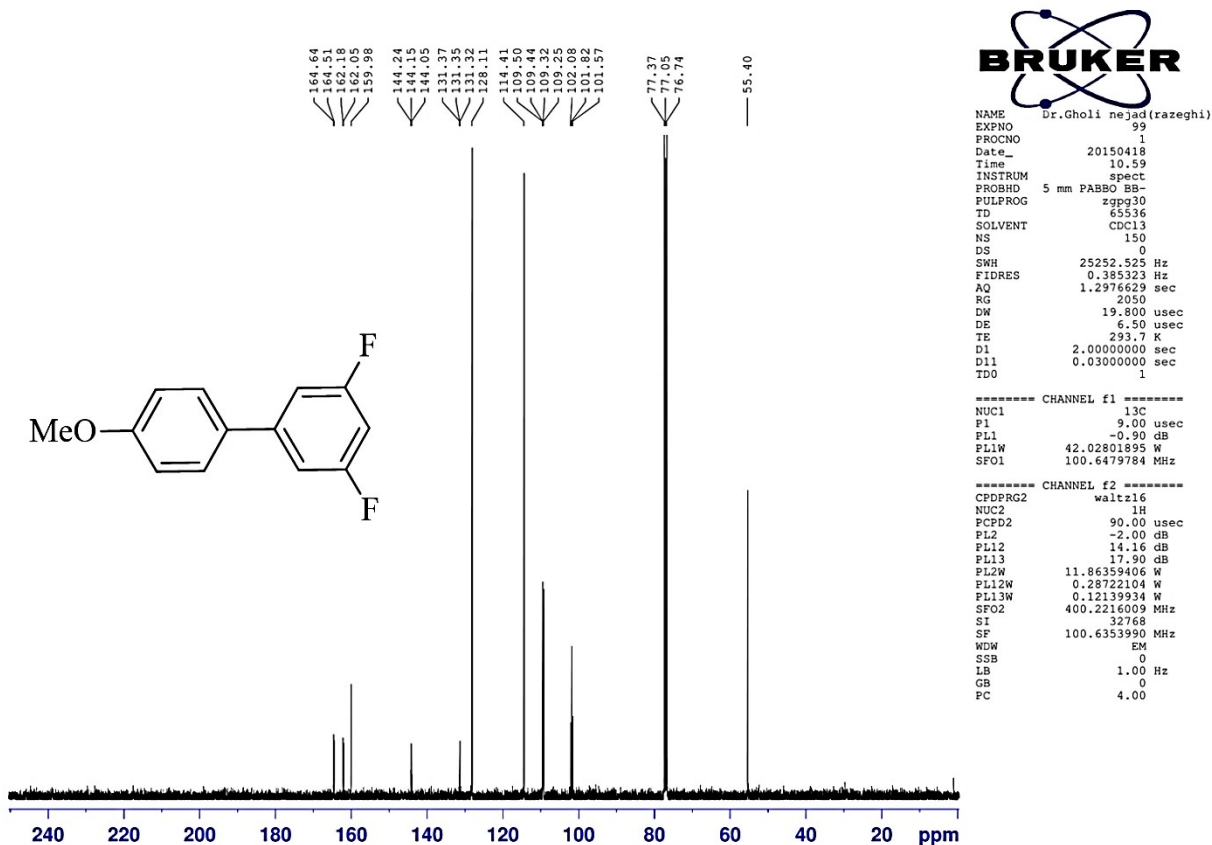
----- CHANNEL f2 -----
CPDPRG2    waltz16
NUC2        1H
PCPD2       90.00 usec
PL2         -2.00 dB
PL12        14.48 dB
PL2W       11.86359406 W
PL12W      0.26681873 W
SFO2       400.2216009 MHz
SI          65536
SF          376.5830510 MHz
WDW         EM
SSB         0
LB          0.30 Hz
GB          0
PC          1.00

```

¹⁹F NMR of 3',5'-difluoro-[1,1'-biphenyl]-4-carbaldehyde



¹H NMR of 3,5-difluoro-4'-methoxy-1,1'-biphenyl



¹³C NMR of 3,5-difluoro-4'-methoxy-1,1'-biphenyl



```

NAME      DE.Gho11 Rejad(Razeghi)
EXPNO     1
PROCNO    1
Date_     20150418
Time      11.08
INSTRUM   spect
PROBHD    5 mm PABBO BB-
PULPRG    zgfglqgn
TD         131072
SOLVENT   CDCl3
NS         16
DS         0
SWH        89285.711 Hz
FDRRES    0.681196 Hz
AQ         0.7340532 sec
RG         2050
DW         5.600 usec
DE         6.50 usec
TE         293.6 K
D1         1.0000000 sec
D11        0.0300000 sec
D12        0.0002000 sec
TD0        1
  
```

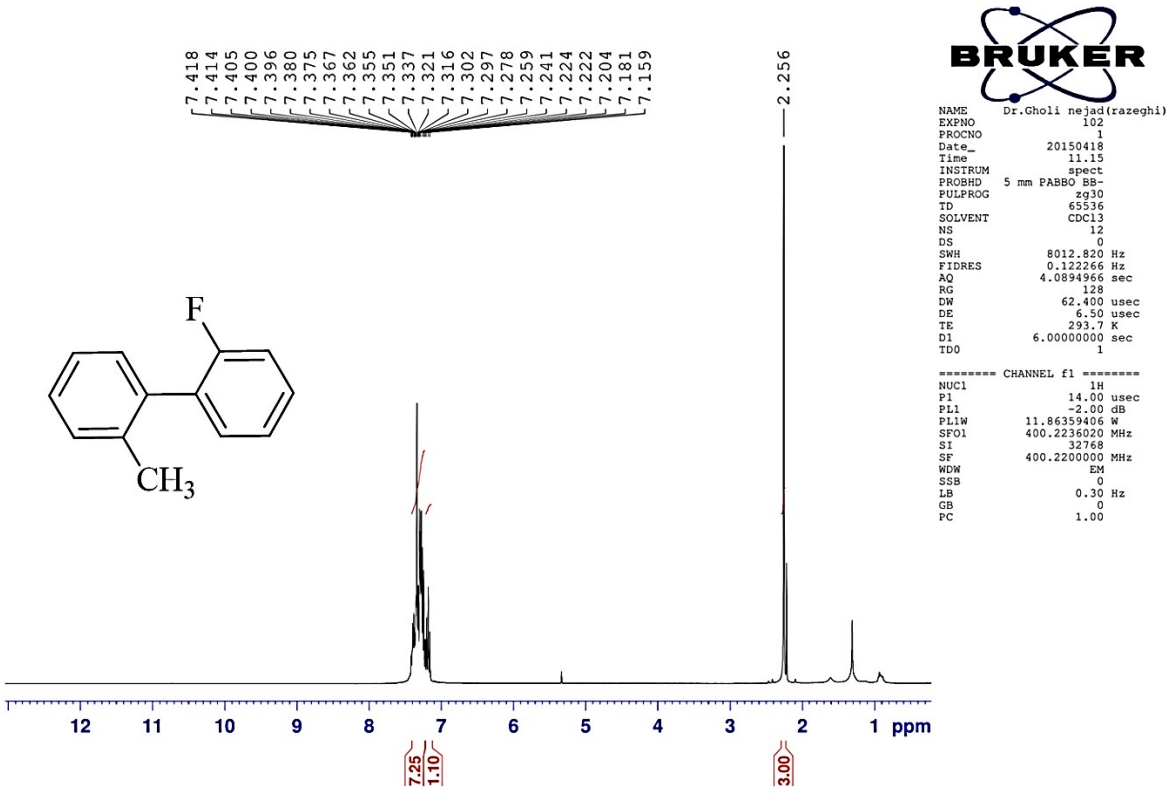
```

----- CHANNEL f1 -----
NUC1       19F
P1         14.00 usec
PL1        -2.40 dB
PL1W       14.3171946 W
SFO1       376.5453925 MHz
  
```

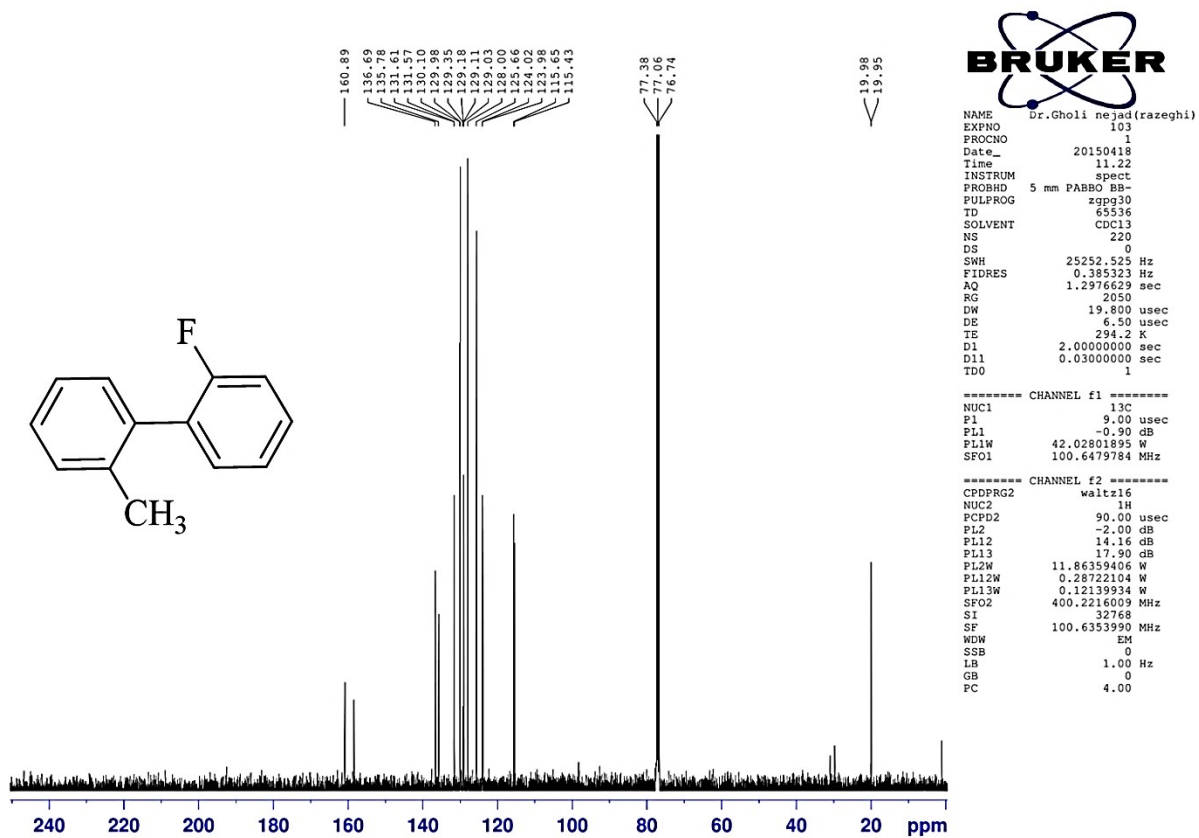
```

----- CHANNEL f2 -----
CPDPRG2    waltz16
NUC2       1H
PCPD2      90.00 usec
PL2        -2.00 dB
PL12       14.48 dB
PL2W       11.86359406 W
PL12W      0.26681873 W
SFO2       400.2216009 MHz
SI         65536
SF         376.5830510 MHz
WDW         EM
SSB         0
LB         0.30 Hz
GB         0
PC         1.00
  
```

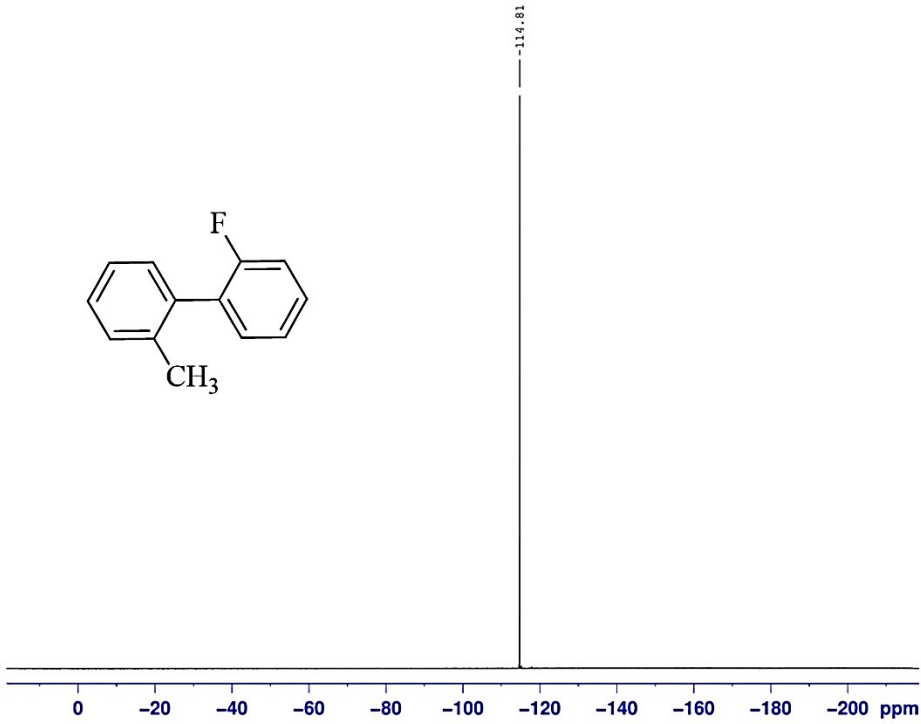
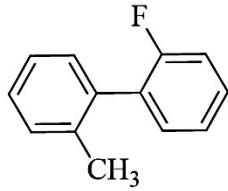
¹⁹F NMR of 3,5-difluoro-4'-methoxy-1,1'-biphenyl



¹H NMR of 2-fluoro-2'-methyl-1,1'-biphenyl



¹³C NMR 2-fluoro-2'-methyl-1,1'-biphenyl



```

NAME      Dr.Gholi nejati(razeghi)
EXPNO     101
PROCNO    1
Date_     20150418
Time      11.13
INSTRUM   spect
PROBHD    5 mm PABBO BB-
PULPROG   zgpg30
TD         131072
SOLVENT   CDCl3
NS         16
DS         0
SWH        89285.711 Hz
FIDRES     0.681196 Hz
AQ         0.7340532 sec
RG         2050
DW         5.600 usec
DE         6.50 usec
TE         293.7 K
D1         1.00000000 sec
D11        0.03000000 sec
D12        0.00002000 sec
TD0        1
  
```

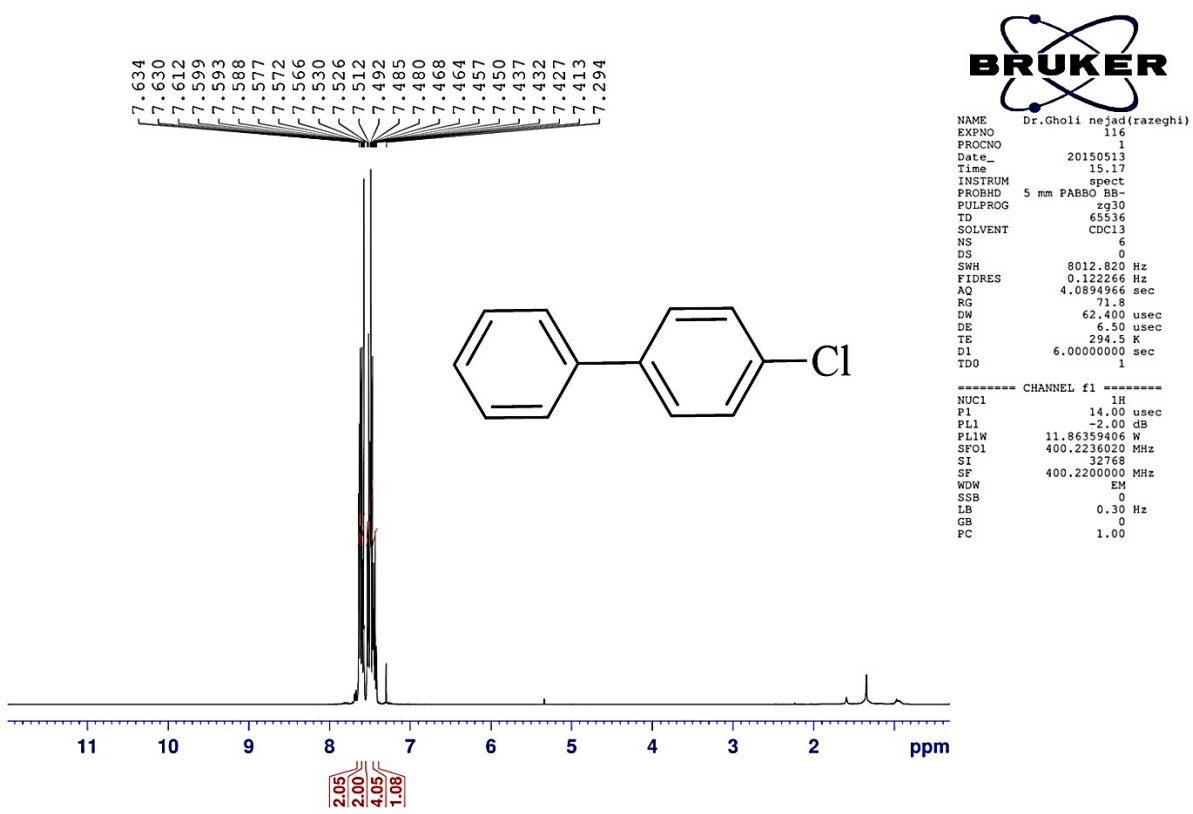
```

===== CHANNEL f1 =====
NUC1      19F
P1         14.00 usec
PL1        -2.40 dB
PL1W      14.3171946 W
SFO1      376.5453925 MHz
  
```

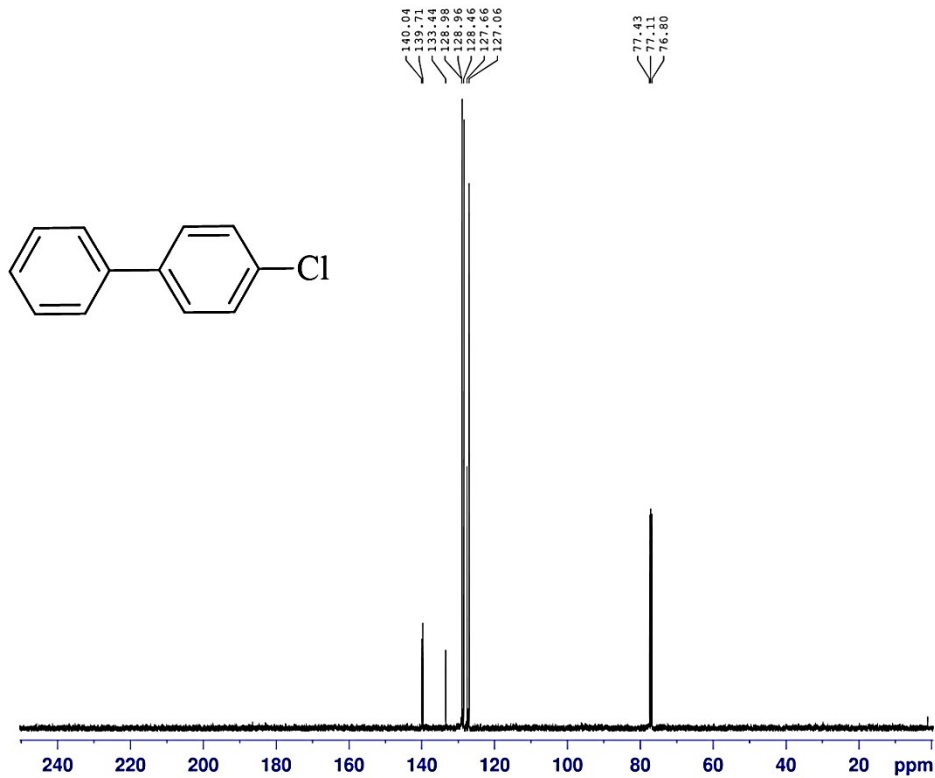
```

===== CHANNEL f2 =====
CPDPRG2   waltz16
NUC2      1H
PCPD2     90.00 usec
PL2        -2.00 dB
PL12      14.48 dB
PL2W      11.86359406 W
PL12W     0.26581873 W
SFO2      400.2216009 MHz
SI         65536
SF         376.5830510 MHz
WDW        EM
SEB         0
LB         0.30 Hz
GB         0
PC         1.00
  
```

¹⁹F NMR of 2-fluoro-2'-methyl-1,1'-biphenyl



¹H NMR of 4-chloro-1,1'-biphenyl

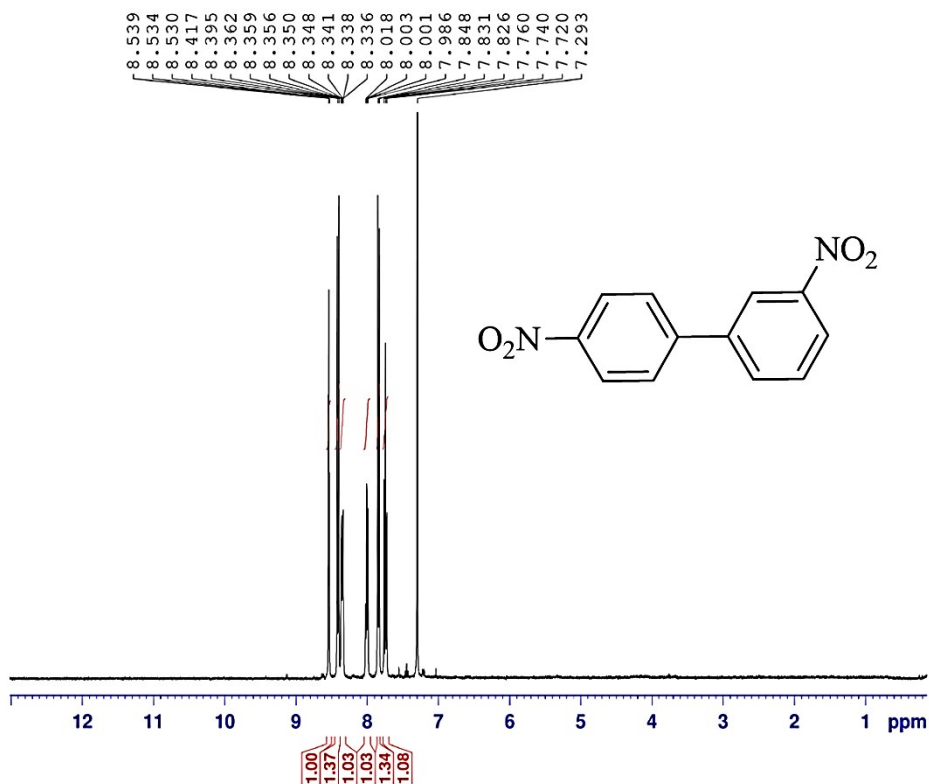


NAME Dr.Gholi nejad(razeghi)
 EXPNO 117
 PROCNO 1
 Date_ 20150513
 Time 15.22
 INSTRUM spect
 PROBHD 5 mm PABBO BB-
 PULPROG zgpg30
 TD 65536
 SOLVENT CDCl3
 NS 68
 DS 0
 SWH 25252.525 Hz
 FIDRES 0.385323 Hz
 AQ 1.2976629 sec
 RG 2050
 DW 19.800 usec
 DE 6.50 usec
 TE 294.6 K
 D1 2.0000000 sec
 D11 0.0300000 sec
 TDO 1

===== CHANNEL f1 =====
 NUC1 13C
 P1 9.00 usec
 PL1 -0.90 dB
 PL1W 42.02801895 W
 SF01 100.6479784 MHz

===== CHANNEL f2 =====
 CPDPRG2 waltz16
 NUC2 1H
 PCPD2 90.00 usec
 PL2 -2.00 dB
 PL12 14.16 dB
 PL13 17.90 dB
 PL2W 11.86359406 W
 PL12W 0.28722104 W
 PL13W 0.12139934 W
 SFO2 400.2216009 MHz
 S1 32768
 SF 100.6353990 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 4.00

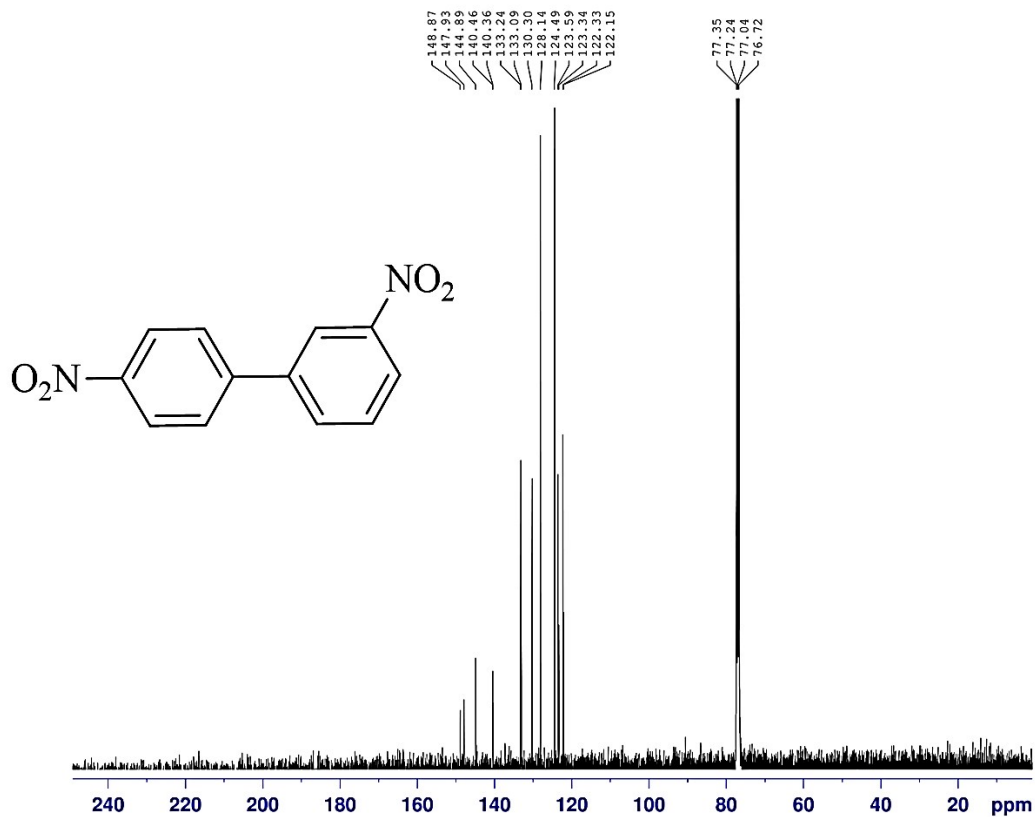
¹³C NMR of 4-chloro-1,1'-biphenyl



NAME Dr.Gholi nejad(razeghi)
EXPNO 95
PROCNO 1
Date_ 20150418
Time_ 10.27
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDC13
NS 12
DS 0
SWH 8012.820 Hz
FIDRES 0.122266 Hz
AQ 4.0894966 sec
RG 322
DW 62.400 usec
DE 6.50 usec
TE 294.4 K
D1 6.0000000 sec
TD0 1

===== CHANNEL f1 =====
NUC1 1H
P1 14.00 usec
PL1 -2.00 dB
PLW 11.86359406 W
SF01 400.2236020 MHz
SI 32768
SF 400.2200000 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00

¹H NMR of 3,4'-dinitro-1,1'-biphenyl



```

NAME      Dr.Gholi nejad(razeghi)
EXPNO     1
PROCNO    1
Date_     20150418
Time      12.42
INSTRUM   spect
PROBHD    5 mm PABBO BB-
PULPROG   zgpg30
TD         65536
SOLVENT   CDCl3
NS         4260
DS         0
SWH        25252.525 Hz
FIDRES     0.385323 Hz
AQ         1.2976629 sec
RG         2050
DW         19.800 usec
DE         6.50 usec
TE         295.2 K
D1         2.0000000 sec
D11        0.0300000 sec
TDO        1

```

```

===== CHANNEL f1 =====
NUC1      13C
P1        9.00 usec
PL1       -0.90 dB
PL1W      42.02801895 W
SFO1      100.6479784 MHz

```

```

===== CHANNEL f2 =====
CPDPRG2   waltz16
NUC2      1H
PCPD2     90.00 usec
PL2        -2.00 dB
PL12       14.16 dB
PL13       17.90 dB
PL12W     11.86359406 W
PL12W     0.28722104 W
PL13W     0.12139934 W
SFO2      400.2216009 MHz
SI         32768
SF         100.6353990 MHz
WDW        EM
SSB         0
LB         1.00 Hz
GB          0
PC          4.00

```

¹³C NMR of 3,4'-dinitro-1,1'-biphenyl

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