

**A mechanistic insight into the chemoselectivity of the reaction between 3-phenyl-2-propynenitrile, secondary phosphine oxides and pyridinoids**

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All reactions were carried out under an argon atmosphere. Pyridine, isoquinoline, 3-phenyl-2-propynenitrile **1** and diphenylphosphine oxide **2a** are commercial reagents (Aldrich, Acros Organics). Bis(2-phenylethyl)phosphine oxide **2b** was prepared from styrene and elemental phosphorus as previously described [S1]. The reaction was monitored using  $^{31}\text{P}$  NMR spectra by the disappearance of peaks of the initial secondary phosphine chalcogenides.

The  $^1\text{H}$ ,  $^{13}\text{C}$ ,  $^{15}\text{N}$  and  $^{31}\text{P}$  NMR spectra were recorded on a Bruker DPX 400 and Bruker AV-400 spectrometers (400.13, 100.62, 40.56 and 161.98 MHz, respectively) in  $\text{CDCl}_3$  solutions and referenced to HMDS ( $^1\text{H}$ ,  $^{13}\text{C}$ ),  $\text{MeNO}_2$  ( $^{15}\text{N}$ ) and  $\text{H}_3\text{PO}_4$  ( $^{31}\text{P}$ ). The assignment of signals in  $^1\text{H}$  spectra was performed using 2D homonuclear correlation method COSY. Resonance signals of  $^{13}\text{C}$  were assigned with application of 2D heteronuclear correlation methods HSQC and HMBC. The values of the  $\delta$   $^{15}\text{N}$  were measured through the 2D  $^1\text{H}$ – $^{15}\text{N}$  HMBC experiment. FT-IR spectra were obtained with a Varian 3100 FT-IR spectrometer. The C, H, N microanalyses were performed on a Flash EA 1112 Series elemental analyzer. The P content was determined by combustion method.

**The reaction of secondary phosphine oxides 2a,b with pyridine and 3-phenyl-2-propynenitrile 1.** To a solution of secondary phosphine oxide **2a,b** (1.0 mmol) in MeCN (3 ml), pyridine (79 mg, 1.0 mmol) and 3-phenyl-2-propynenitrile **1** (127 mg, 1.0 mmol) were added, and the mixture was stirred under argon atmosphere at 20–25 °C for 20 h (in the case of diphenylphosphine oxide **2a**) or 72 h (in the case of bis(2-phenylethyl)phosphine oxide **2b**). After the reaction completion ( $^{31}\text{P}$  NMR monitoring), the solvent was removed under reduced pressure. In the case of diphenylphosphine oxide **2a**, the residue was reprecipitated from  $\text{CHCl}_3$  into hexane to give 1,4-dihydropyridine **3a**. For bis(2-phenylethyl)phosphine oxide **2b**, the residue was purified by column chromatography on  $\text{SiO}_2$  (ethyl acetate was used as an eluent) to give the corresponding phosphorylated 1,2- and 1,4-dihydropyridines **4** and **3b**.

**(Z)-3-[4-(Diphenylphosphoryl)pyridin-1(4H)-yl]-3-phenylacrylonitrile (3a).** Yield 355 mg (87%), waxy substance.  $^1\text{H}$  NMR (400.13 MHz,  $\text{CDCl}_3$ ):  $\delta$  4.26 (dt, 1H, H-4, Py,  $^2J_{\text{PH}} =$

20.8 Hz,  $^3J_{4-3(5)} = 4.2$  Hz); 4.53 (s, 1H, =CHCN); 4.84 (m, 2H, H-3,5, Py); 6.30 (m, 2H, H-2,6, Py); 7.21 (m, 2H, H<sub>o</sub>, PhC=); 7.36 (m, 2H, H<sub>m</sub>, PhC=); 7.43 (m, 1H, H<sub>p</sub>, PhC=); 7.50–7.61 (m, 6H, H<sub>m,p</sub>, PhP); 7.89 (m, 4H, H<sub>o</sub>, PhP).  $^{13}\text{C}$  NMR (100.62 MHz, CDCl<sub>3</sub>):  $\delta_{\text{C}}$  38.7 (d, C-4, Py,  $^1J_{\text{CP}} = 71.6$  Hz); 75.7 (=CHCN); 99.7 (d, C-3,5, Py,  $^2J_{\text{CP}} = 5.9$  Hz); 117.2 (CN); 128.4 (d, C<sub>m</sub>, PhP,  $^3J_{\text{CP}} = 11.2$  Hz); 128.6 (C<sub>o</sub>, PhC=); 128.7 (C<sub>m</sub>, PhC=); 130.21 (d, C<sub>ipso</sub>, PhP,  $^1J_{\text{CP}} = 94.1$  Hz); 130.24 (d, C-2,6, Py,  $^3J_{\text{CP}} = 8.1$  Hz); 131.0 (C<sub>p</sub>, PhP); 131.7 (d, C<sub>o</sub>, PhP,  $^2J_{\text{CP}} = 8.4$  Hz); 131.8 (C<sub>p</sub>, PhC=); 133.9 (C<sub>ipso</sub>, PhC=); 157.8 (PhC=).  $^{15}\text{N}$  NMR (40.56 MHz, CDCl<sub>3</sub>):  $\delta_{\text{N}}$  -253.2 (Py).  $^{31}\text{P}$  NMR (161.98 MHz, CDCl<sub>3</sub>):  $\delta_{\text{P}}$  28.1. IR (film):  $\nu = 3060, 2925, 2851, 2203, 1969, 1900, 1824, 1680, 1586, 1570, 1489, 1430, 1423, 1381, 1313, 1287, 1259, 1192, 1163, 1116, 1074, 1028, 989, 914, 852, 739, 702, 649, 589, 535$  cm<sup>-1</sup>. Anal. Calcd for C<sub>26</sub>H<sub>21</sub>N<sub>2</sub>OP: C, 76.46; H, 5.18; N, 6.86; P, 7.58. Found: C, 76.21; H, 5.11; N, 6.80; P, 7.56.

**(Z)-3-{4-[Bis(2-phenylethyl)phosphoryl]pyridin-1(4H)-yl}-3-phenyl-acrylonitrile**

**(3b).** Yield 241 mg (52%), waxy substance.  $^1\text{H}$  NMR (400.13 MHz, CDCl<sub>3</sub>):  $\delta$  2.20 (m, 4H, CH<sub>2</sub>P); 3.01 (m, 4H, CH<sub>2</sub>Ph); 3.68 (dt, 1H, H-4, Py,  $^2J_{\text{PH}} = 22.2$  Hz,  $^3J_{4-3(5)} = 4.4$  Hz); 4.62 (s, 1H, =CHCN); 4.89 (ddd, 2H, H-3,5, Py,  $^3J_{3(5)-2(6)} = 7.3$  Hz,  $^3J_{3(5)-4} = 4.4$  Hz,  $^3J_{\text{PH}} = 3.1$  Hz); 6.35 (dd, 2H, H-2,6, Py,  $^3J_{2(6)-3(5)} = 7.3$  Hz,  $^4J_{\text{PH}} = 3.8$  Hz); 7.20–7.50 (m, 15H, Ph).  $^{13}\text{C}$  NMR (100.62 MHz, CDCl<sub>3</sub>):  $\delta_{\text{C}}$  27.2 (d, CH<sub>2</sub>P,  $^1J_{\text{CP}} = 56.5$  Hz); 27.5 (CH<sub>2</sub>Ph); 37.0 (d, C-4, Py,  $^1J_{\text{CP}} = 65.8$  Hz); 77.6 (d, =CHCN,  $^6J_{\text{CP}} = 1.9$  Hz); 100.4 (d, C-3,5, Py,  $^2J_{\text{CP}} = 5.2$  Hz); 117.2 (CN); 126.6 (C<sub>p</sub>, CH<sub>2</sub>Ph); 128.3 (C<sub>m</sub>, CH<sub>2</sub>Ph); 128.8 (C<sub>o</sub>, CH<sub>2</sub>Ph); 128.9 (C<sub>o</sub>, PhC=); 129.2 (C<sub>m</sub>, PhC=); 130.5 (d, C-2,6, Py,  $^3J_{\text{CP}} = 7.2$  Hz); 131.6 (C<sub>p</sub>, PhC=); 134.0 (C<sub>ipso</sub>, PhC=); 141.2 (d, C<sub>ipso</sub>, CH<sub>2</sub>Ph,  $^3J_{\text{CP}} = 12.3$  Hz); 158.7 (PhC=).  $^{15}\text{N}$  NMR (40.56 MHz, CDCl<sub>3</sub>):  $\delta_{\text{N}}$  -256.1 (Py); -117.0 (CN).  $^{31}\text{P}$  NMR (161.98 MHz, CDCl<sub>3</sub>):  $\delta_{\text{P}}$  47.7. IR (film):  $\nu = 3062, 3029, 2950, 2925, 2857, 2204, 1679, 1589, 1494, 1449, 1417, 1379, 1312, 1256, 1204, 1158, 1065, 1034, 990, 912, 845, 737, 703, 649, 584, 490, 472, 437$  cm<sup>-1</sup>. Anal. Calcd for C<sub>30</sub>H<sub>29</sub>N<sub>2</sub>OP: C, 77.57; H, 6.29; N, 6.03; P, 6.67. Found: C, 77.45; H, 6.35; N, 5.98; P, 6.48.

**(Z)-3-{2-[Bis(2-phenylethyl)phosphoryl]pyridin-1(2H)-yl}-3-phenyl-acrylonitrile (4).**

Yield 46 mg (10%), waxy substance.  $^1\text{H}$  NMR (400.13 MHz, CDCl<sub>3</sub>):  $\delta$  2.19 (m, 4H, CH<sub>2</sub>P); 2.91 (m, 4H, CH<sub>2</sub>Ph); 4.87 (s, 1H, =CHCN); 5.06 (dd, 1H, H-2, Py,  $^2J_{\text{PH}} = 12.7$  Hz,  $^3J_{2-3} = 6.5$  Hz); 5.35 (ddd, 1H, H-5, Py,  $^3J_{5-6} = 7.6$  Hz,  $^3J_{5-4} = 5.1$  Hz,  $^5J_{\text{PH}} = 0.7$  Hz); 5.45 (m, 1H, H-3, Py); 6.21 (ddd, 1H, H-4, Py,  $^4J_{\text{PH}} = 9.4$  Hz,  $^3J_{4-5} \sim ^3J_{4-3} = 5.1$  Hz); 6.84 (d, 1H, H-6, Py,  $^3J_{6-5} = 7.6$  Hz); 7.18 (m, 4H, H<sub>m</sub>, CH<sub>2</sub>Ph); 7.22 (m, 2H, H<sub>p</sub>, CH<sub>2</sub>Ph); 7.26 (m, 4H, H<sub>o</sub>, CH<sub>2</sub>Ph); 7.43 (m, 2H, H<sub>o</sub>, PhC=); 7.49 (m, 1H, H<sub>p</sub>, PhC=); 7.53 (m, 2H, H<sub>m</sub>, PhC=).  $^{13}\text{C}$  NMR (100.62 MHz, CDCl<sub>3</sub>):  $\delta_{\text{C}}$  27.6, 27.7 (CH<sub>2</sub>Ph); 27.8, 28.1 (2d, CH<sub>2</sub>P,  $^1J_{\text{CP}} = 59.0$  Hz,  $^1J_{\text{CP}} = 51.9$  Hz); 59.3 (d, C-2, Py,  $^1J_{\text{CP}} = 68.6$  Hz); 82.2 (=CHCN); 105.2 (C-5, Py); 113.4 (C-3, Py); 117.9 (CN); 126.2 (d, C-4, Py,  $^3J_{\text{CP}} = 6.9$  Hz); 126.57, 126.59 (C<sub>p</sub>, CH<sub>2</sub>Ph); 128.1, 128.3 (C<sub>m</sub>, CH<sub>2</sub>Ph); 128.82, 128.84 (C<sub>o</sub>,

CH<sub>2</sub>Ph); 129.0 (C<sub>m</sub>, PhC=); 129.5 (C<sub>o</sub>, PhC=); 131.8 (C<sub>p</sub>, PhC=); 133.9 (C-6, Py); 134.4 (d, C<sub>ipso</sub>, PhC=, <sup>4</sup>J<sub>CP</sub> = 1.4 Hz); 141.1 (d, C<sub>ipso</sub>, CH<sub>2</sub>Ph, <sup>3</sup>J<sub>CP</sub> = 12.8 Hz); 164.6 (PhC=). <sup>15</sup>N NMR (40.56 MHz, CDCl<sub>3</sub>): δ<sub>N</sub> -292.1 (Py); -113.7 (CN). <sup>31</sup>P NMR (161.98 MHz, CDCl<sub>3</sub>): δ<sub>P</sub> 51.2. IR (film): ν = 3030, 2923, 2855, 2204, 1674, 1635, 1590, 1565, 1494, 1451, 1387, 1261, 1211, 1158, 1066, 1003, 912, 846, 735, 702, 651, 577, 530, 495 cm<sup>-1</sup>. Anal. Calcd for C<sub>30</sub>H<sub>29</sub>N<sub>2</sub>OP: C, 77.57; H, 6.29; N, 6.03; P, 6.67. Found: C, 77.36; H, 6.20; N, 6.09; P, 6.40.

**Synthesis of 4-phosphorylpyridines 8a,b.** A solution of pyridine (79 mg, 1.0 mmol), secondary phosphine oxide **2a,b** (1.0 mmol) and 3-phenyl-2-propynenitrile **1** (127 mg, 1.0 mmol) in MeCN (3 ml) was stirred under an argon atmosphere at 80–85 °C for 96 h. After the reaction completion (<sup>31</sup>P NMR monitoring), the solvent was removed under the reduced pressure. The obtained residue was purified by column chromatography on SiO<sub>2</sub> (ethyl acetate was used as an eluent) to yield the target 4-phosphorylpyridines **8a,b**.

**4-(Diphenylphosphoryl)pyridine (8a)** [S2]. Yield: 97 mg (35%); beige powder, mp 151–153 °C (published [S2] data: 153–155 °C) (hexane). <sup>31</sup>P NMR (161.98 MHz, CDCl<sub>3</sub>): δ 27.9 (published [S3] data: 27.6). The <sup>1</sup>H and <sup>13</sup>C NMR spectra are in accordance with the published [S3] data. Anal. Calcd for C<sub>17</sub>H<sub>14</sub>NOP: C, 73.11; H, 5.05; N, 5.02; P, 11.09. Found: C, 73.35; H, 5.15; N, 5.73; P, 10.88.

**4-[Bis(2-phenylethyl)phosphoryl]pyridine (8b)** [S3]. Yield: 101 mg (30%); beige powder, mp 83–84 °C (published [S3] data: 81–82 °C) (reprecipitated from CCl<sub>4</sub> to hexane). <sup>31</sup>P NMR (161.98 MHz, CDCl<sub>3</sub>): δ 37.9 (published<sup>3</sup> data: 37.2). The <sup>1</sup>H and <sup>13</sup>C NMR spectra are in accordance with the published [S3] data. Anal. Calcd for C<sub>21</sub>H<sub>22</sub>NOP: C, 75.21; H, 6.61; N, 4.18; P, 9.24. Found: C, 75.43; H, 6.52; N, 4.05; P, 9.02.

**Reaction of secondary phosphine oxides 2a,b with isoquinoline and 3-phenyl-2-propynenitrile 1.** To a solution of secondary phosphine oxide **2a,b** (1.0 mmol) in MeCN (3 ml), isoquinoline (129 mg, 1.0 mmol) and 3-phenyl-2-propynenitrile **1** (127 mg, 1.0 mmol) were added, and the mixture was stirred under argon atmosphere at 20–25 °C for 16–20 h. After the reaction completion (<sup>31</sup>P NMR monitoring), the solvent was removed under reduced pressure, and the residue was reprecipitated from CHCl<sub>3</sub> into hexane to give 1,2-dihydroisoquinolines **10a,b**.

**(Z)-3-[1-(Diphenylphosphoryl)isoquinoline-2(1H)-yl]-3-phenylacrylonitrile (10a).** Yield 425 mg (93%), waxy substance. <sup>1</sup>H NMR (400.13 MHz, CDCl<sub>3</sub>): δ 4.41 (s, 1H, =CHCN); 5.47 (d, 1H, H-4, isoquinoline, <sup>3</sup>J<sub>4-3</sub> = 7.7 Hz); 6.42 (d, 1H, H-1, isoquinoline, <sup>3</sup>J<sub>PH</sub> = 9.0 Hz); 6.62 (d, 1H, H-3, isoquinoline, <sup>3</sup>J<sub>3-4</sub> = 7.7 Hz); 6.64 (d, 1H, H-8, isoquinoline, <sup>3</sup>J<sub>8-7</sub> = 6.8 Hz); 6.88 (d, 1H, H-5, isoquinoline, <sup>3</sup>J<sub>5-6</sub> = 6.8 Hz); 6.99 (t, 1H, H-7, isoquinoline, <sup>3</sup>J<sub>7-6(8)}</sub> = 6.8 Hz); 7.18 (t, 1H, H-6, isoquinoline, <sup>3</sup>J<sub>6-7(5)}</sub> = 6.8 Hz); 7.29–7.57 (m, 11H, Ph); 7.79 (m, 4H, H<sub>o</sub>, PhP).

$^{13}\text{C}$  NMR (100.62 MHz,  $\text{CDCl}_3$ ):  $\delta_{\text{C}}$  63.1 (d, C-1, isoquinoline,  $^1J_{\text{CP}} = 70.0$  Hz); 74.8 (=CHCN); 109.6 (C-4, isoquinoline); 118.4 (CN); 124.3 (C-4a, isoquinoline); 124.6 (C-5, isoquinoline); 126.7 (C-7, isoquinoline); 126.8 (d, C-3, isoquinoline,  $^3J_{\text{CP}} = 4.4$  Hz); 127.8, 128.4 (2d,  $C_m$ , PhP,  $^3J_{\text{CP}} = 11.2$  Hz,  $^3J_{\text{CP}} = 11.4$  Hz); 128.6 (C-6, isoquinoline); 128.5, 130.40 (2d,  $C_{\text{ipso}}$ , PhP,  $^1J_{\text{CP}} = 91.8$  Hz,  $^1J_{\text{CP}} = 92.2$  Hz); 128.6 ( $C_o$ , PhC=); 128.9 ( $C_m$ , PhC=); 129.6 (C-8, isoquinoline); 130.43 ( $C_p$ , PhC=); 131.8, 132.2 (2d,  $C_o$ , PhP,  $^2J_{\text{CP}} = 9.2$  Hz,  $^2J_{\text{CP}} = 8.6$  Hz); 131.9, 132.1 (2d,  $C_p$ , PhP,  $^4J_{\text{CP}} = 2.8$  Hz); 132.4 (d, C-8a, isoquinoline,  $^2J_{\text{CP}} = 3.1$  Hz); 135.3 ( $C_{\text{ipso}}$ , PhC=); 162.2 (PhC=).  $^{15}\text{N}$  NMR (40.56 MHz,  $\text{CDCl}_3$ ):  $\delta_{\text{N}}$  -281.9 (isoquinoline).  $^{31}\text{P}$  NMR (161.98 MHz,  $\text{CDCl}_3$ ):  $\delta_{\text{P}}$  29.2. Anal. Calcd for  $\text{C}_{30}\text{H}_{23}\text{N}_2\text{OP}$ : C, 78.59; H, 5.06; N, 6.11; P, 6.76. Found: C, 76.21; H, 5.11; N, 6.80; P, 7.56.

**(Z)-3-{1-[Bis(2-phenylethyl)phosphoryl]isoquinolin-2(1H)-yl}-3-phenylacrylonitrile**

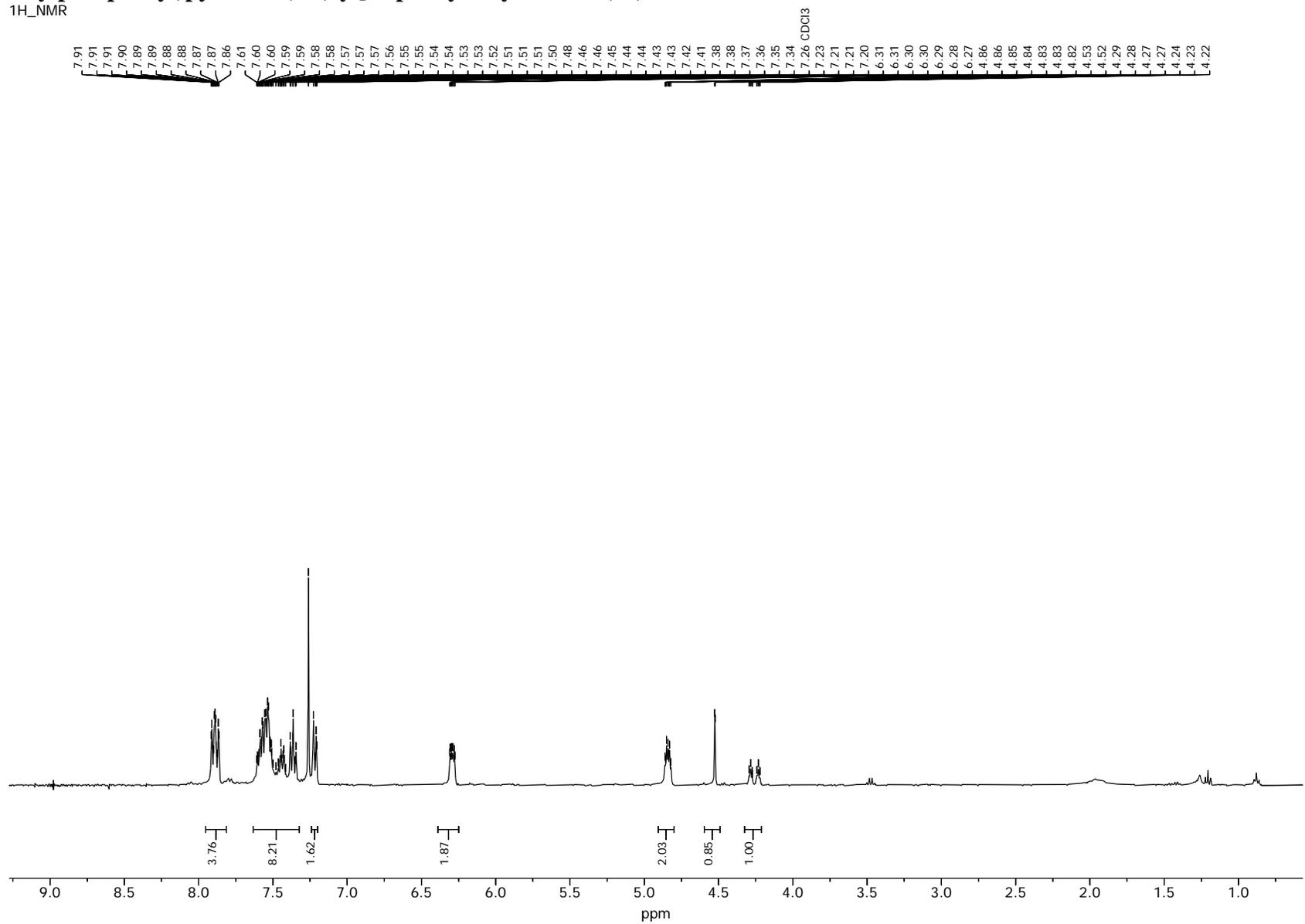
**(10b)**. Yield 457 mg (89%), waxy product.  $^1\text{H}$  NMR (400.13 MHz,  $\text{CDCl}_3$ ):  $\delta$  1.72–2.20 (m, 4H,  $\text{CH}_2\text{P}$ ); 2.60–2.99 (m, 4H,  $\text{CH}_2\text{Ph}$ ); 5.31 (s, 1H, =CHCN); 5.51 (d, 1H, H-1, isoquinoline,  $^1J_{\text{PH}} = 10.3$  Hz); 5.88 (d, 1H, H-4, isoquinoline,  $^3J_{4-3} = 7.7$  Hz); 6.23 (d, 1H, H-3, isoquinoline,  $^3J_{3-4} = 7.7$  Hz); 7.05–7.47 (m, 19H, Ph; H-5,6,7,8, isoquinoline).  $^{13}\text{C}$  NMR (100.62 MHz,  $\text{CDCl}_3$ ):  $\delta_{\text{C}}$  27.1, 27.7 (d,  $\text{CH}_2\text{Ph}$ ,  $^2J_{\text{CP}} = 3.8$  Hz); 28.6, 29.5 (2d,  $\text{CH}_2\text{P}$ ,  $^1J_{\text{CP}} = 71.0$  Hz,  $^1J_{\text{CP}} = 69.4$  Hz); 62.2 (d, C-1, isoquinoline,  $^1J_{\text{CP}} = 62.3$  Hz); 74.5 (=CHCN); 109.8 (C-4, isoquinoline); 119.4 (CN); 124.6 (C-4a, isoquinoline); 125.0 (C-5, isoquinoline); 126.3 (C-7, isoquinoline); 126.46, 126.50 (C-3, isoquinoline); 127.8, 127.9 ( $C_m$ ,  $\text{CH}_2\text{Ph}$ ); 128.6 (C-6, isoquinoline); 128.5, 128.6 ( $C_o$ ,  $\text{CH}_2\text{Ph}$ ); 128.8 ( $C_o$ , PhC=); 129.2 (C-8, isoquinoline); 129.77 ( $C_m$ , PhC=); 129.79 ( $C_p$ ,  $\text{CH}_2\text{Ph}$ ); 130.6 ( $C_p$ , PhC=); 130.8 (d, C-8a, isoquinoline,  $^2J_{\text{CP}} = 2.7$  Hz); 132.5 ( $C_{\text{ipso}}$ , PhC=); 140.4, 140.5 (2d,  $C_{\text{ipso}}$ ,  $\text{CH}_2\text{Ph}$ ,  $^3J_{\text{CP}} = 12.7$  Hz,  $^3J_{\text{CP}} = 13.5$  Hz); 161.5 (PhC=).  $^{15}\text{N}$  NMR (40.56 MHz,  $\text{CDCl}_3$ ):  $\delta_{\text{N}}$  -277.6 (isoquinoline); -124.3 (CN).  $^{31}\text{P}$  NMR (161.98 MHz,  $\text{CDCl}_3$ ):  $\delta_{\text{P}}$  50.1. Anal. Calcd for  $\text{C}_{34}\text{H}_{31}\text{N}_2\text{OP}$ : C, 79.36; H, 6.07; N, 5.44; P, 6.02. Found: C, 79.15; H, 6.13; N, 5.34; P, 5.81.

**References**

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- [S2]. M. A. Weiner and P. Schwartz, *Inorg. Chem.*, 1975, **14**, 1714.
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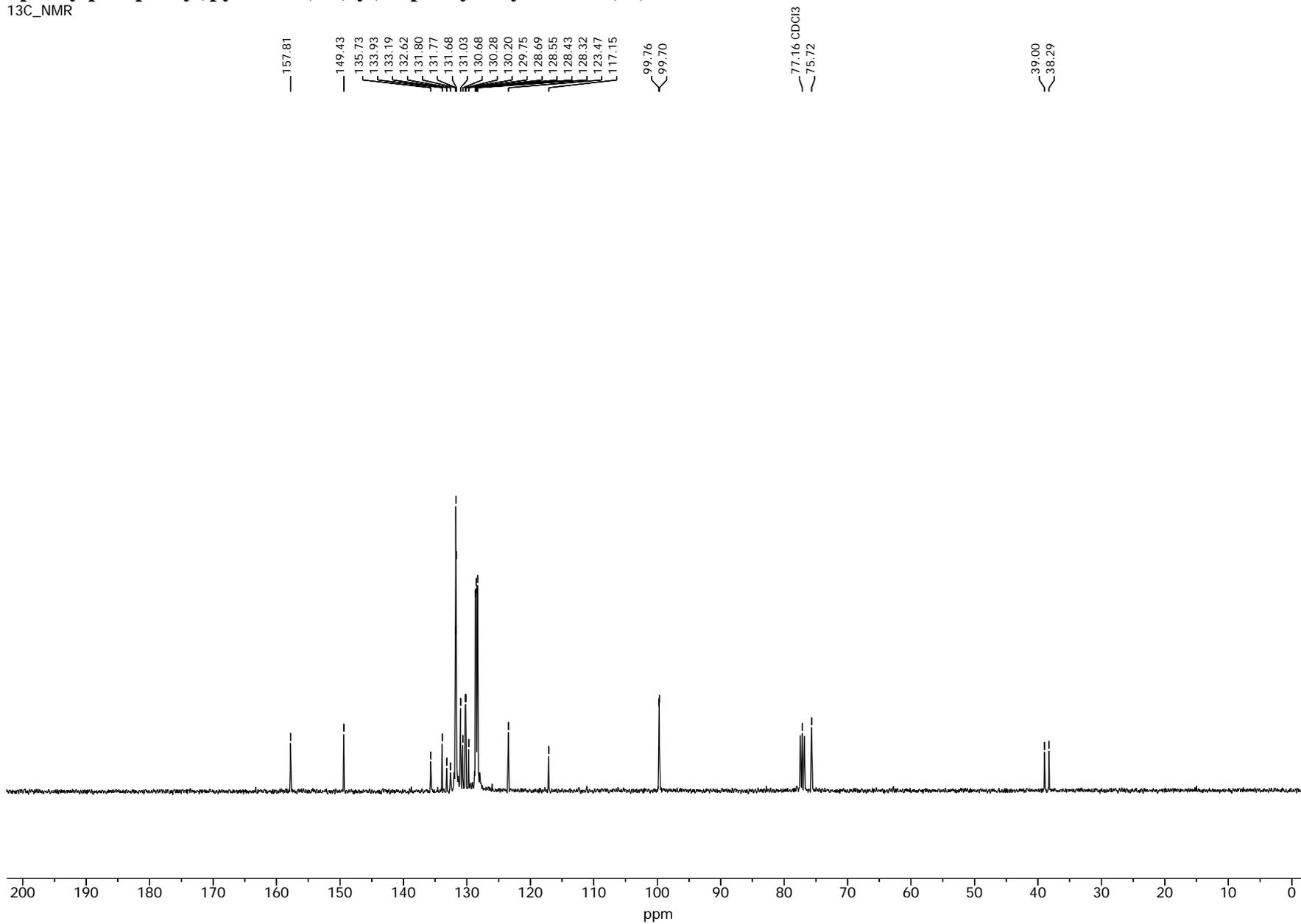
**(Z)-3-[4-(Diphenylphosphoryl)pyridin-1(4H)-yl]-3-phenylacrylonitrile (3a)**

<sup>1</sup>H\_NMR



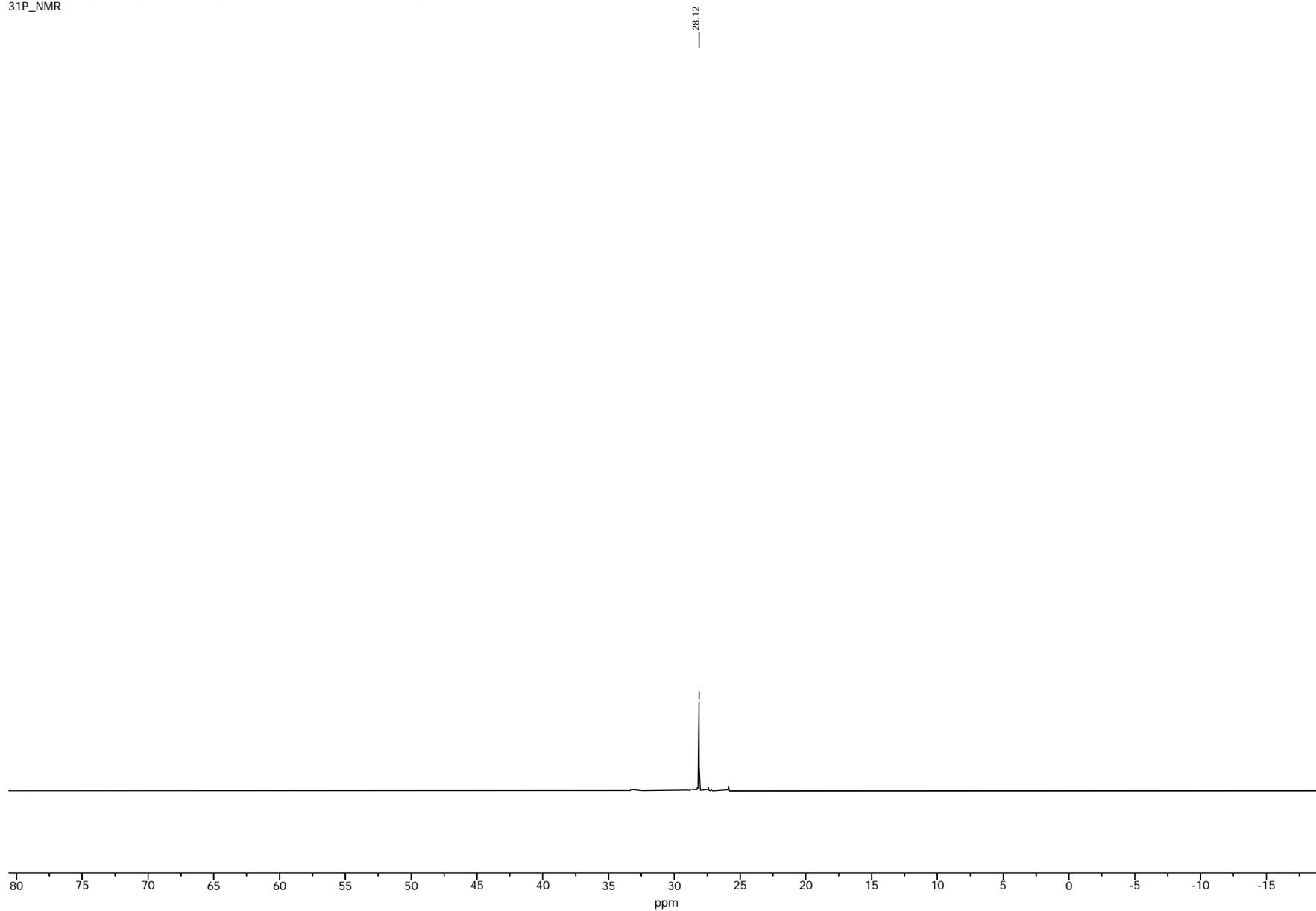
**(Z)-3-(4-(Diphenylphosphoryl)pyridin-1(4H)-yl)-3-phenylacrylonitrile (3a)**

<sup>13</sup>C\_NMR



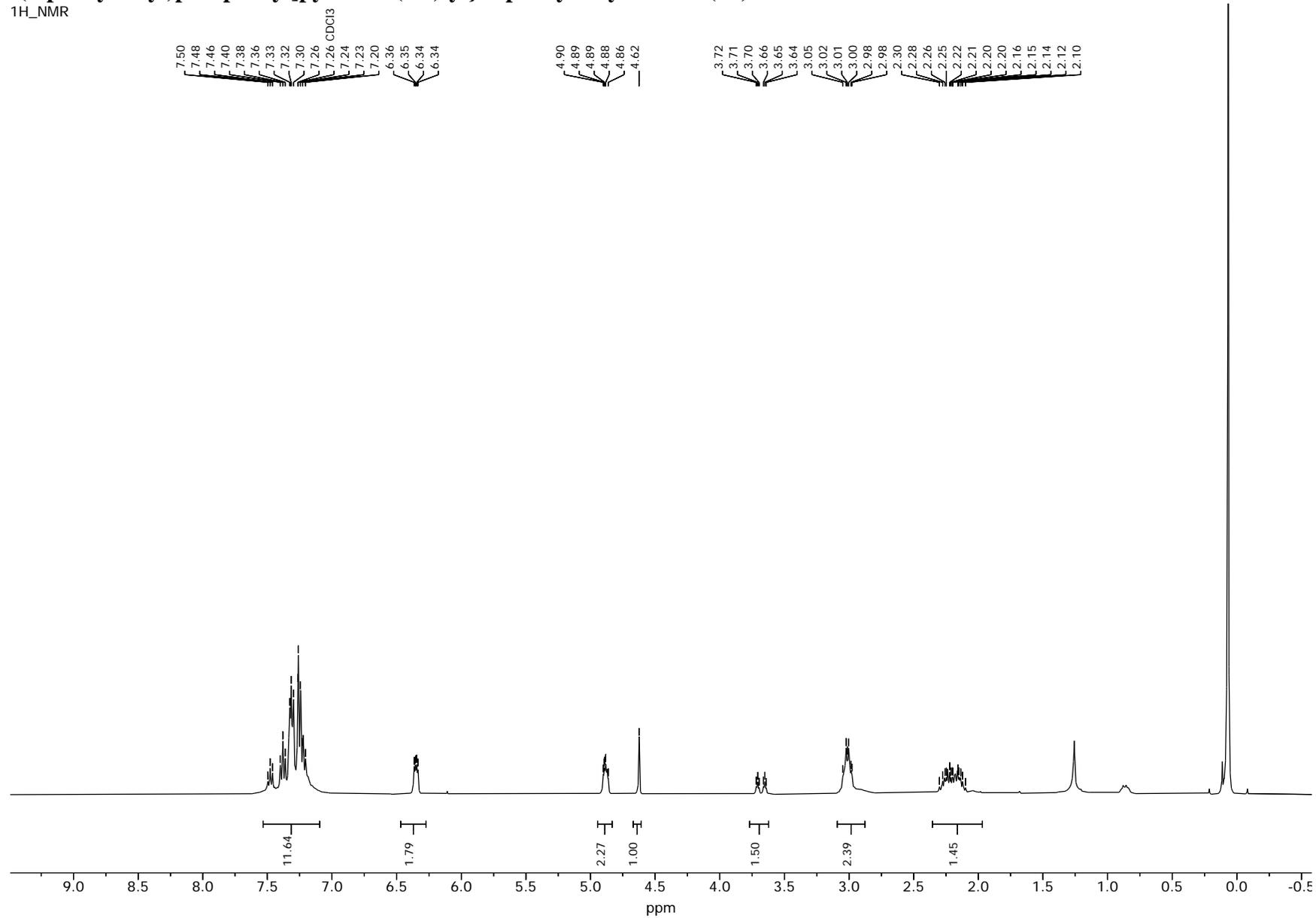
**(Z)-3-[4-(Diphenylphosphoryl)pyridin-1(4H)-yl]-3-phenylacrylonitrile (3a)**

<sup>31</sup>P\_NMR



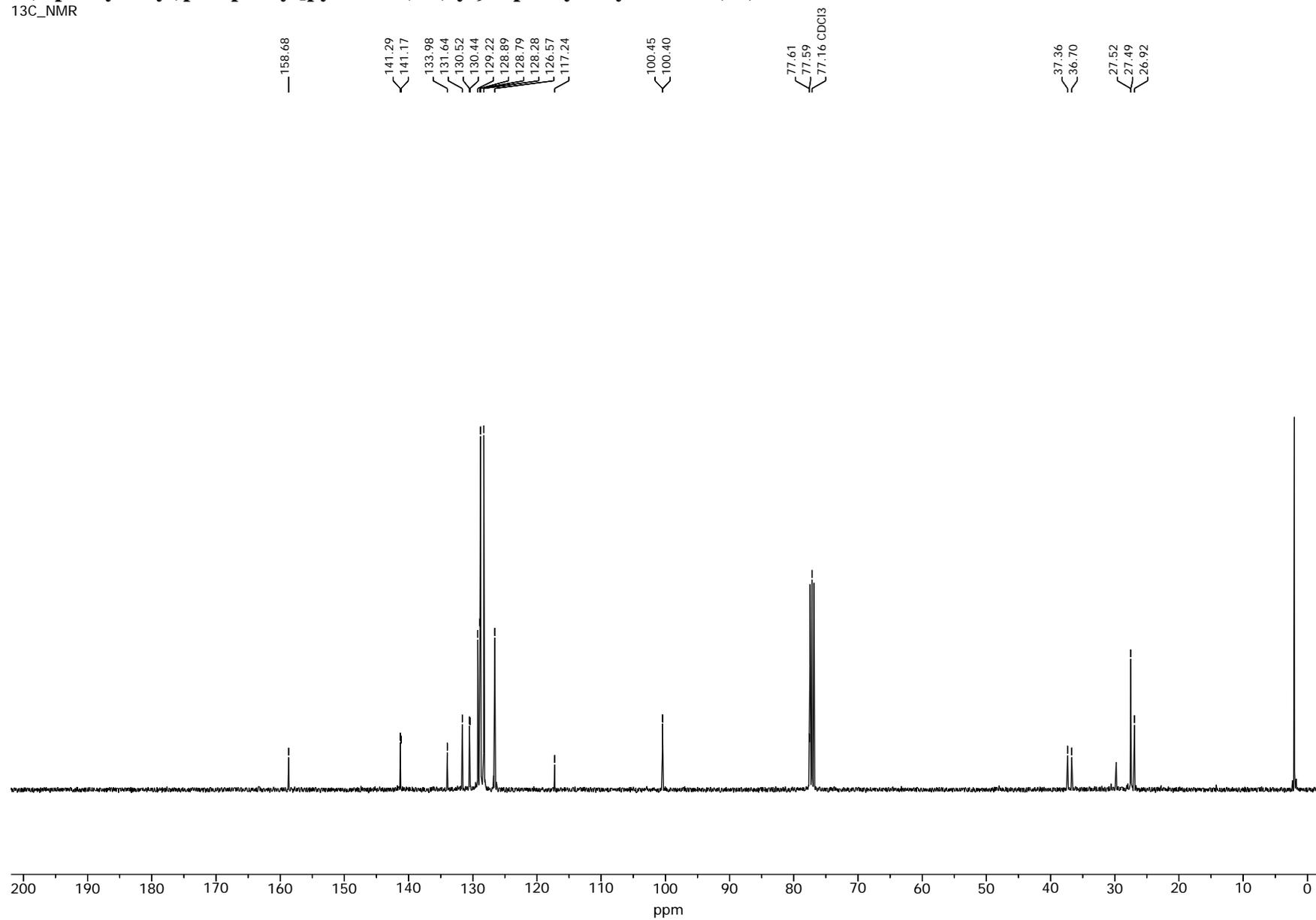
**(Z)-3-{4-[Bis(2-phenylethyl)phosphoryl]pyridin-1(4H)-yl}-3-phenylacrylonitrile (3b)**

<sup>1</sup>H\_NMR



**(Z)-3-{4-[Bis(2-phenylethyl)phosphoryl]pyridin-1(4H)-yl}-3-phenylacrylonitrile (3b)**

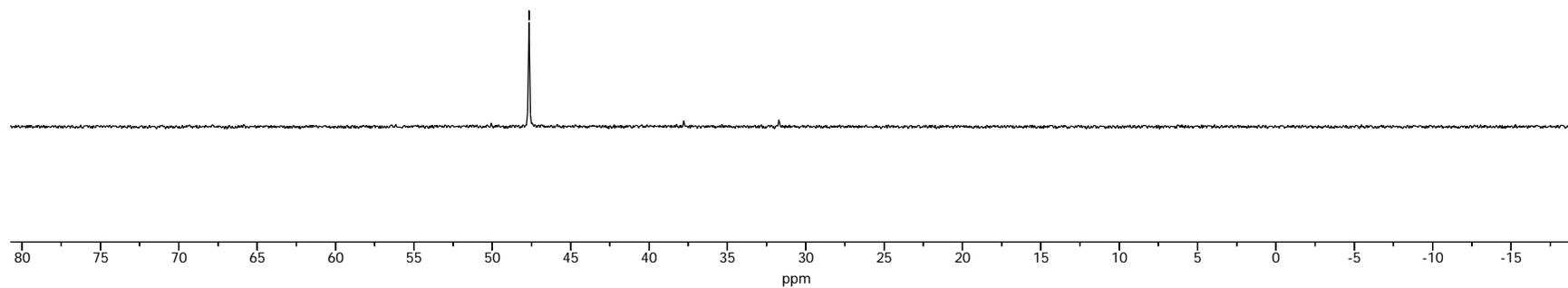
<sup>13</sup>C\_NMR



**(Z)-3-{4-[Bis(2-phenylethyl)phosphoryl]pyridin-1(4H)-yl}-3-phenylacrylonitrile (3b)**

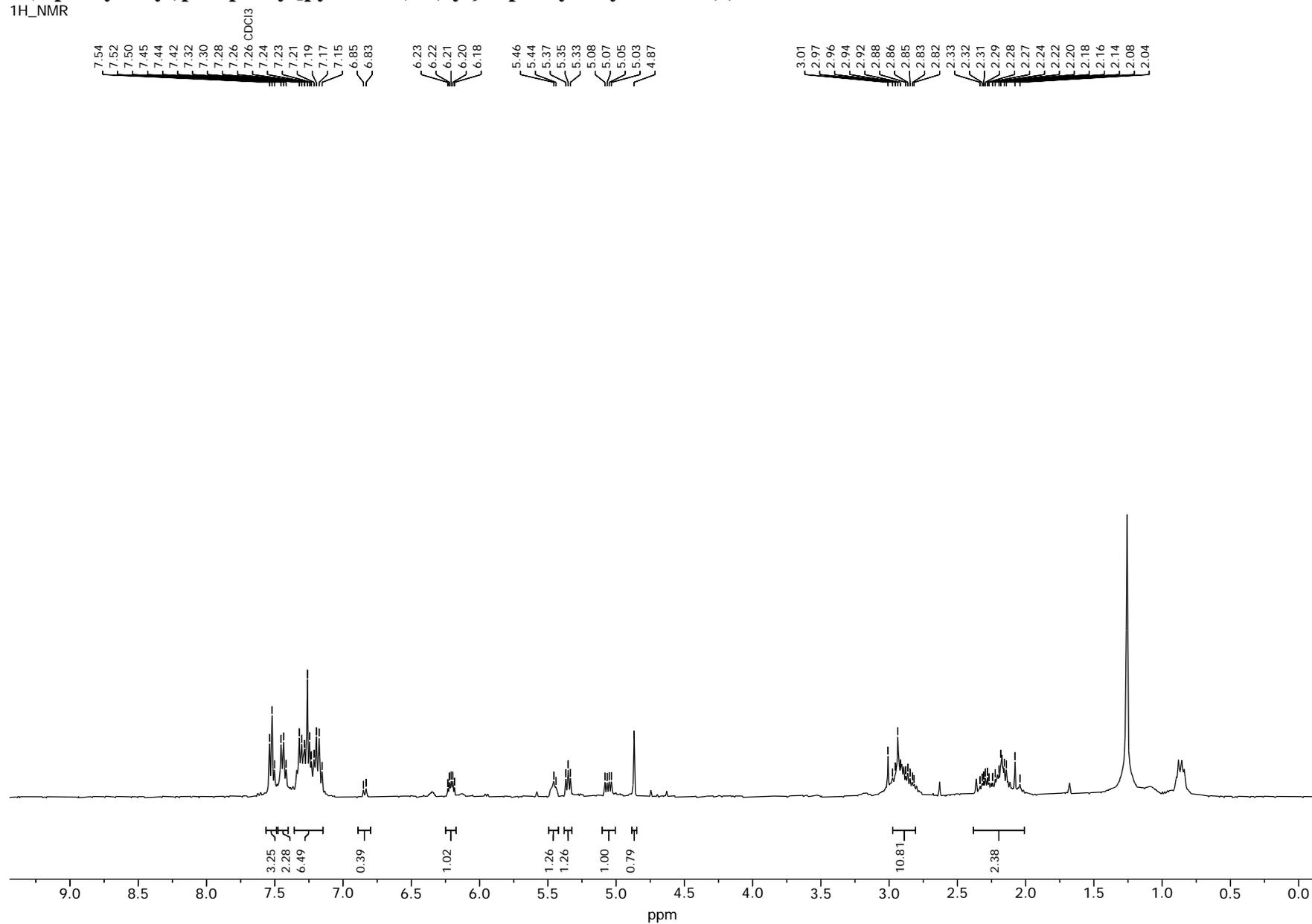
<sup>31</sup>P\_NMR

47.65



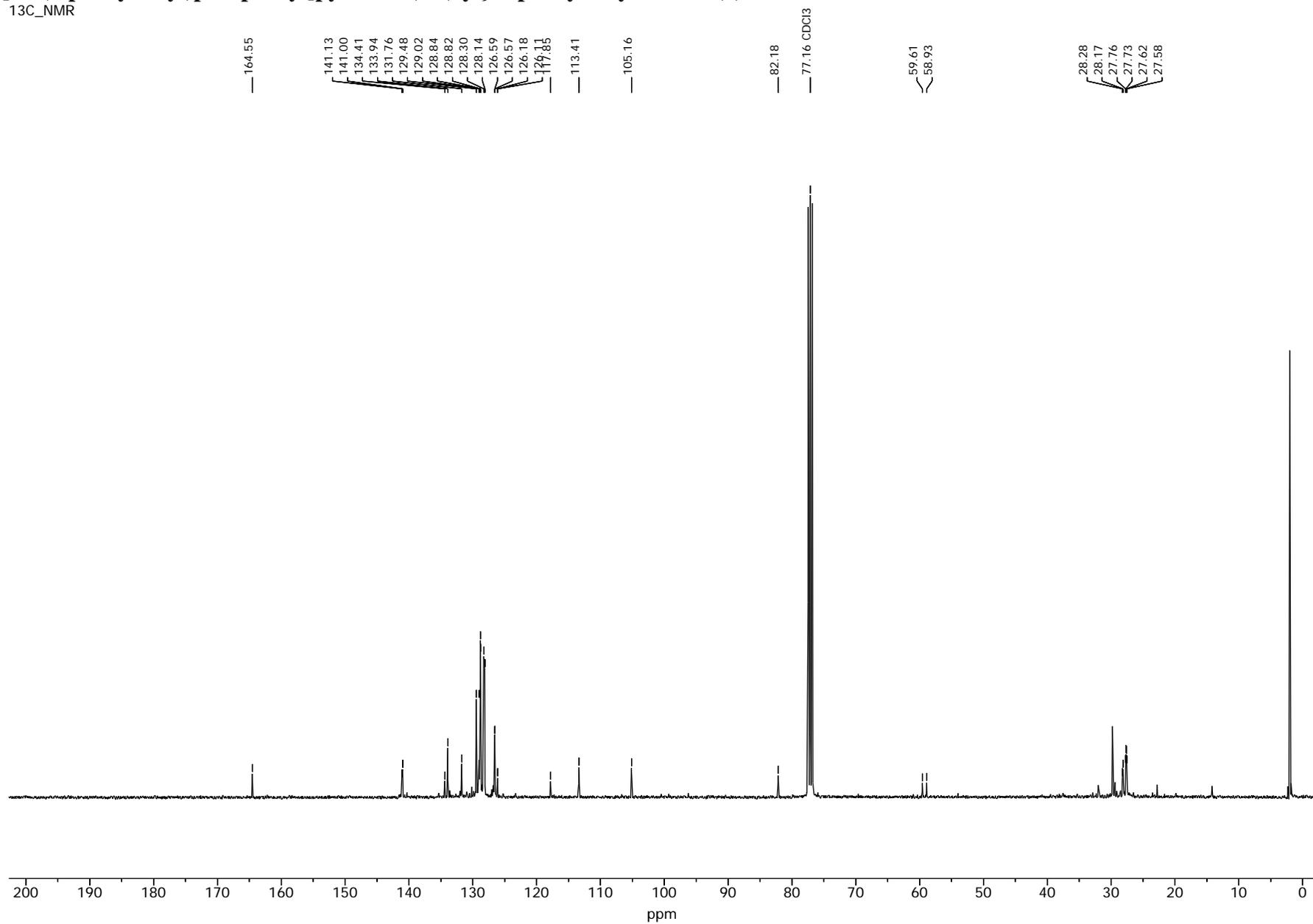
**(Z)-3-{2-[Bis(2-phenylethyl)phosphoryl]pyridin-1(2H)-yl}-3-phenylacrylonitrile (4)**

<sup>1</sup>H\_NMR



**((Z)-3-{2-[Bis(2-phenylethyl)phosphoryl]pyridin-1(2H)-yl}-3-phenylacrylonitrile (4)**

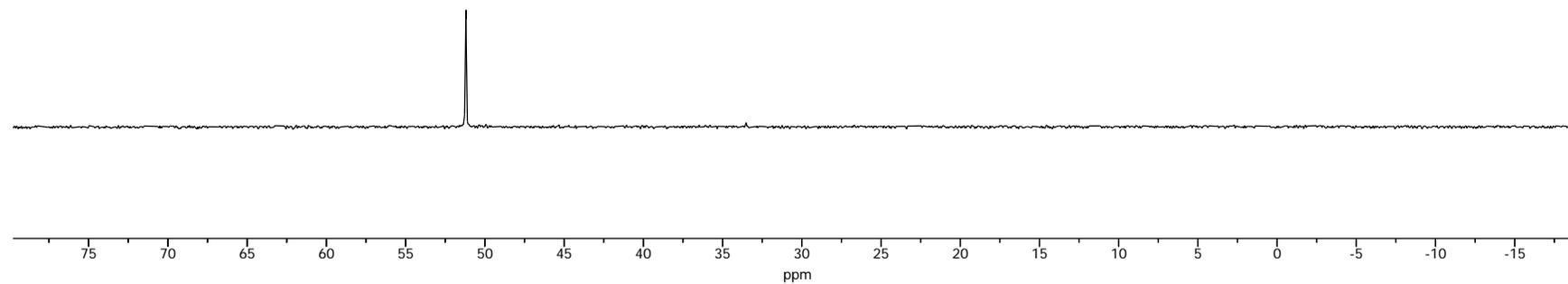
<sup>13</sup>C\_NMR



**(Z)-3-{2-[Bis(2-phenylethyl)phosphoryl]pyridin-1(2H)-yl}-3-phenylacrylonitrile (4)**

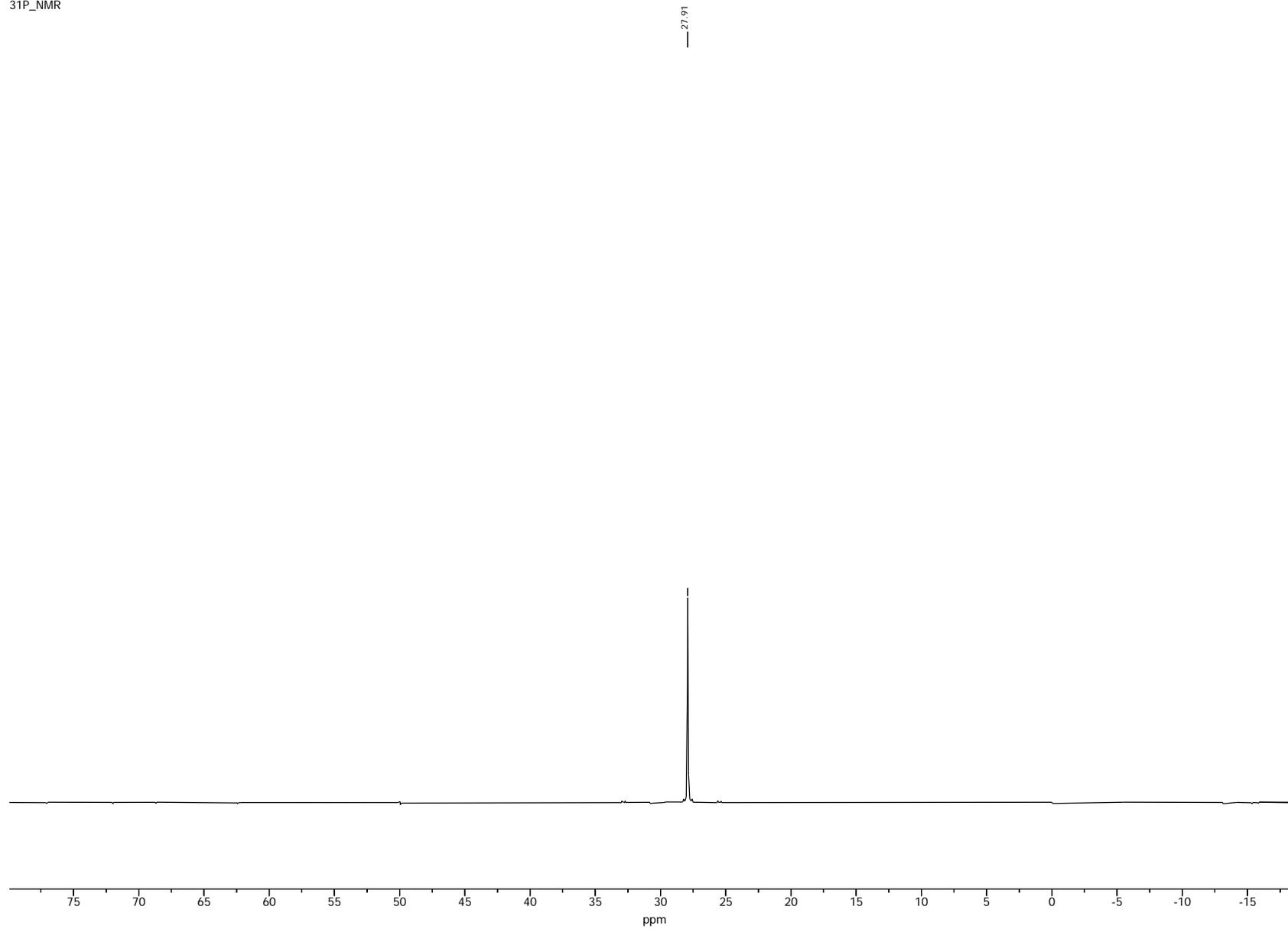
<sup>31</sup>P\_NMR

51.21



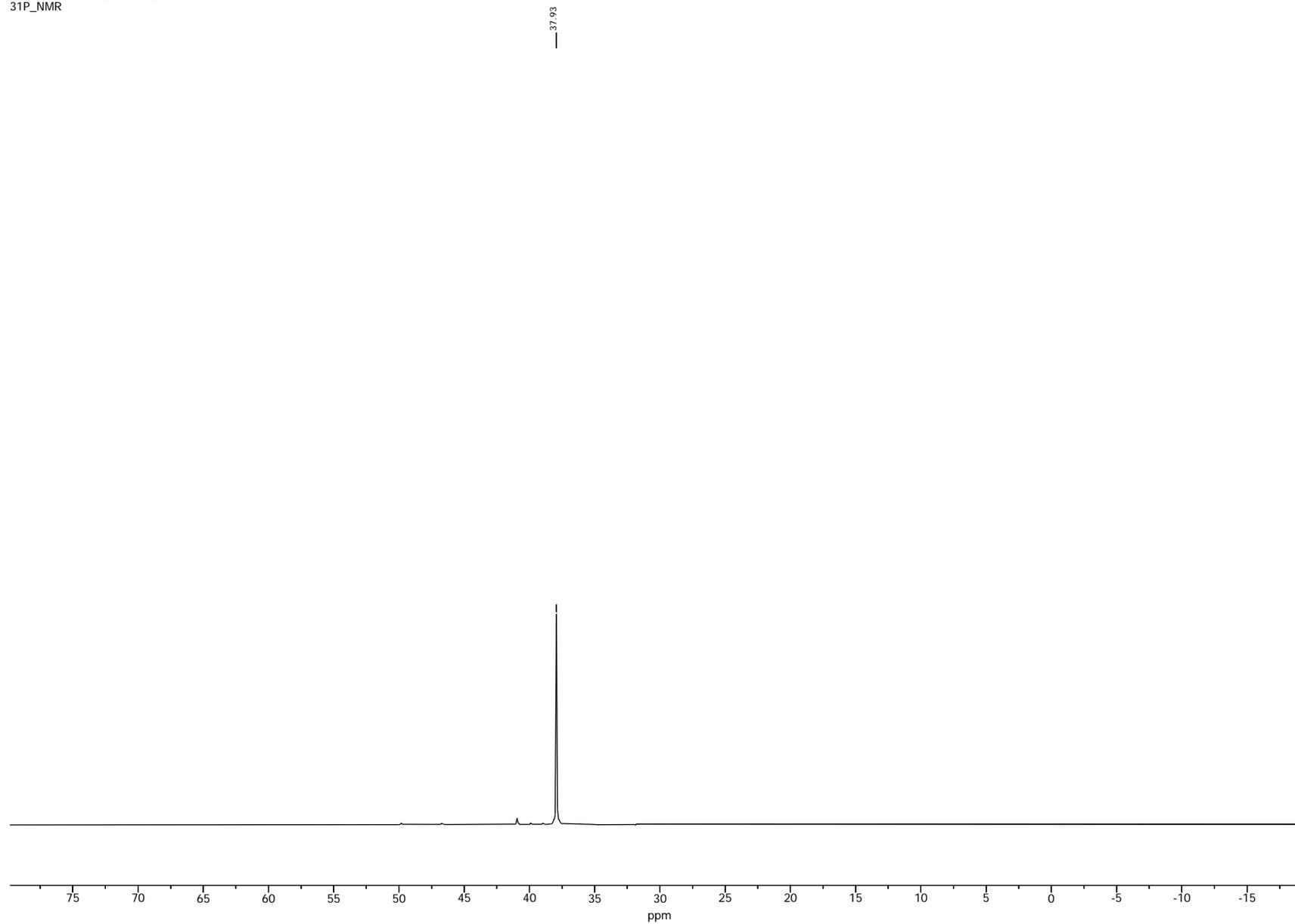
**4-(Diphenylphosphoryl)pyridine (8a)**

<sup>31</sup>P\_NMR



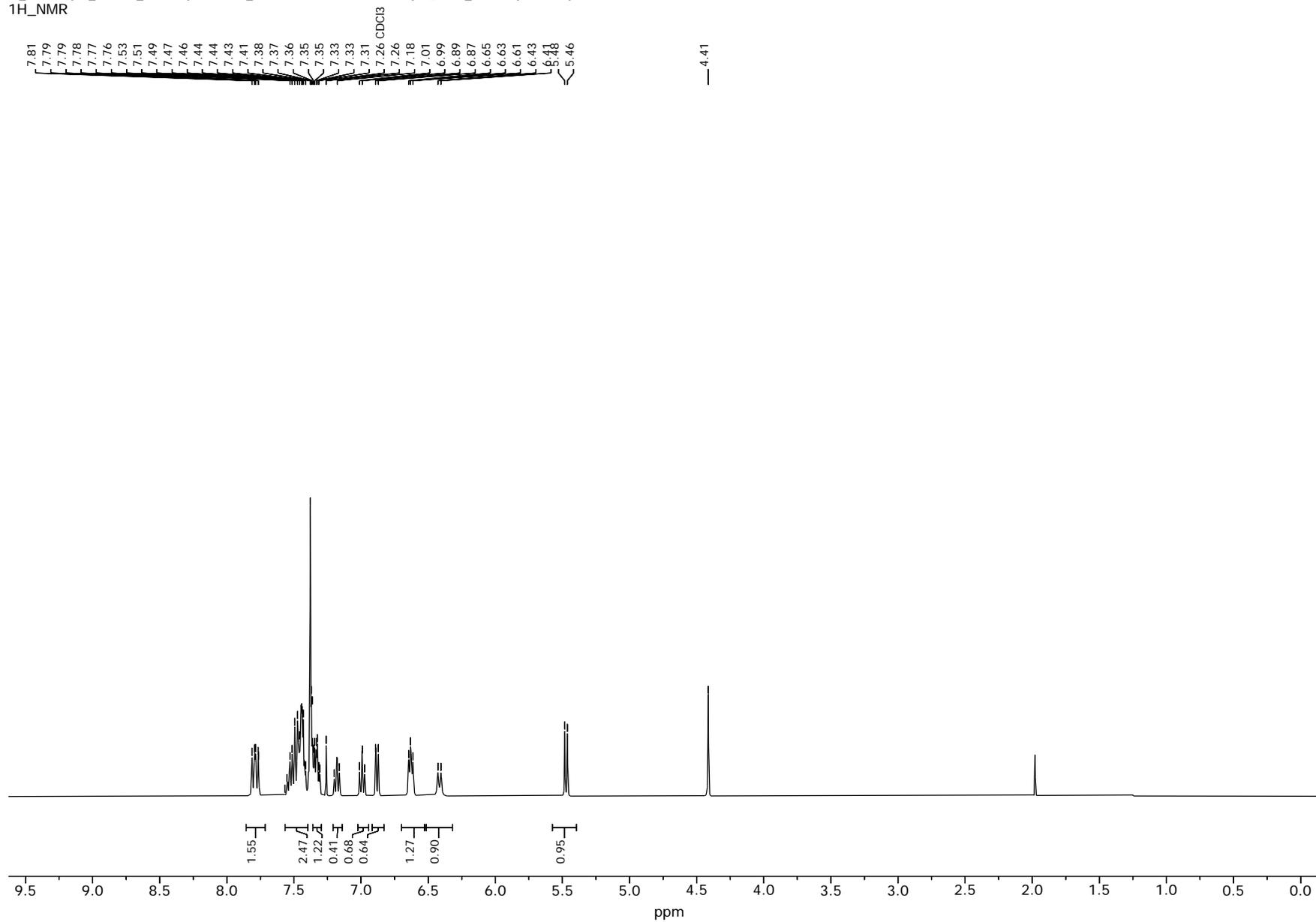
4-[Bis(2-phenylethyl)phosphoryl]pyridine (8b)

<sup>31</sup>P\_NMR



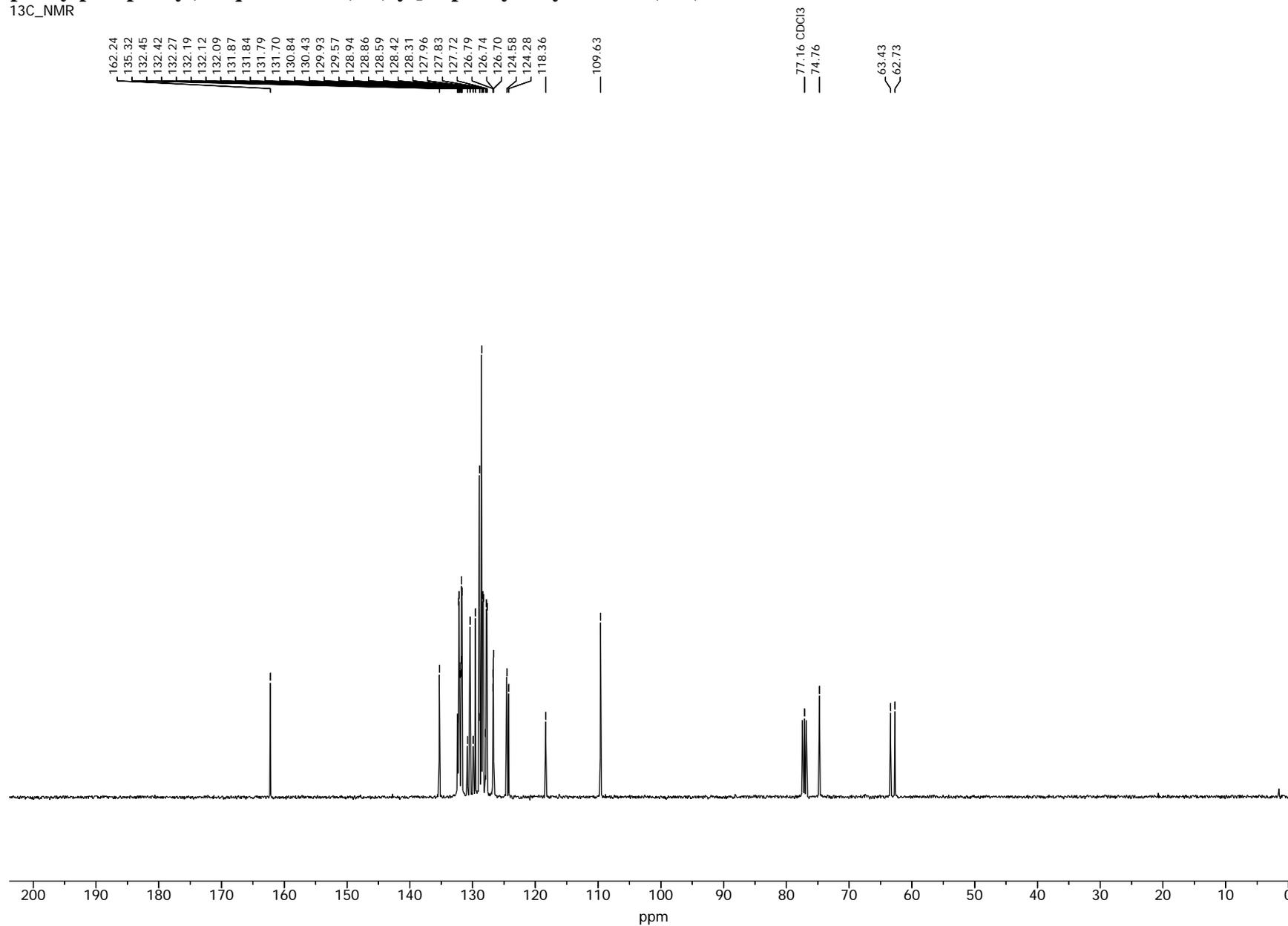
**(Z)-3-[1-(Diphenylphosphoryl)isoquinoline-2(1H)-yl]-3-phenylacrylonitrile (10a)**

<sup>1</sup>H\_NMR



**(Z)-3-[1-(Diphenylphosphoryl)isoquinoline-2(1H)-yl]-3-phenylacrylonitrile (10a)**

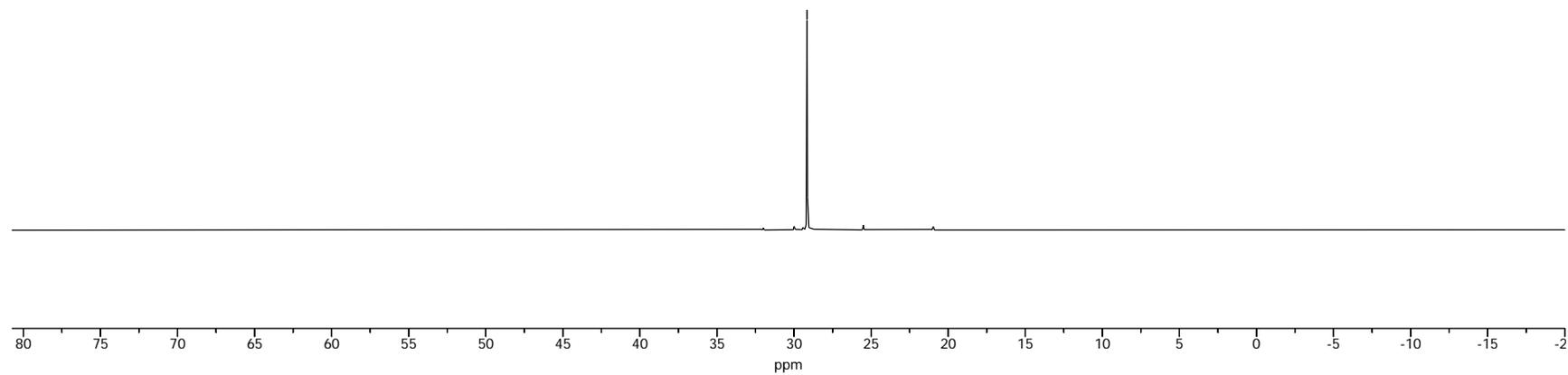
<sup>13</sup>C\_NMR



**(Z)-3-[1-(Diphenylphosphoryl)isoquinoline-2(1H)-yl]-3-phenylacrylonitrile (10a)**

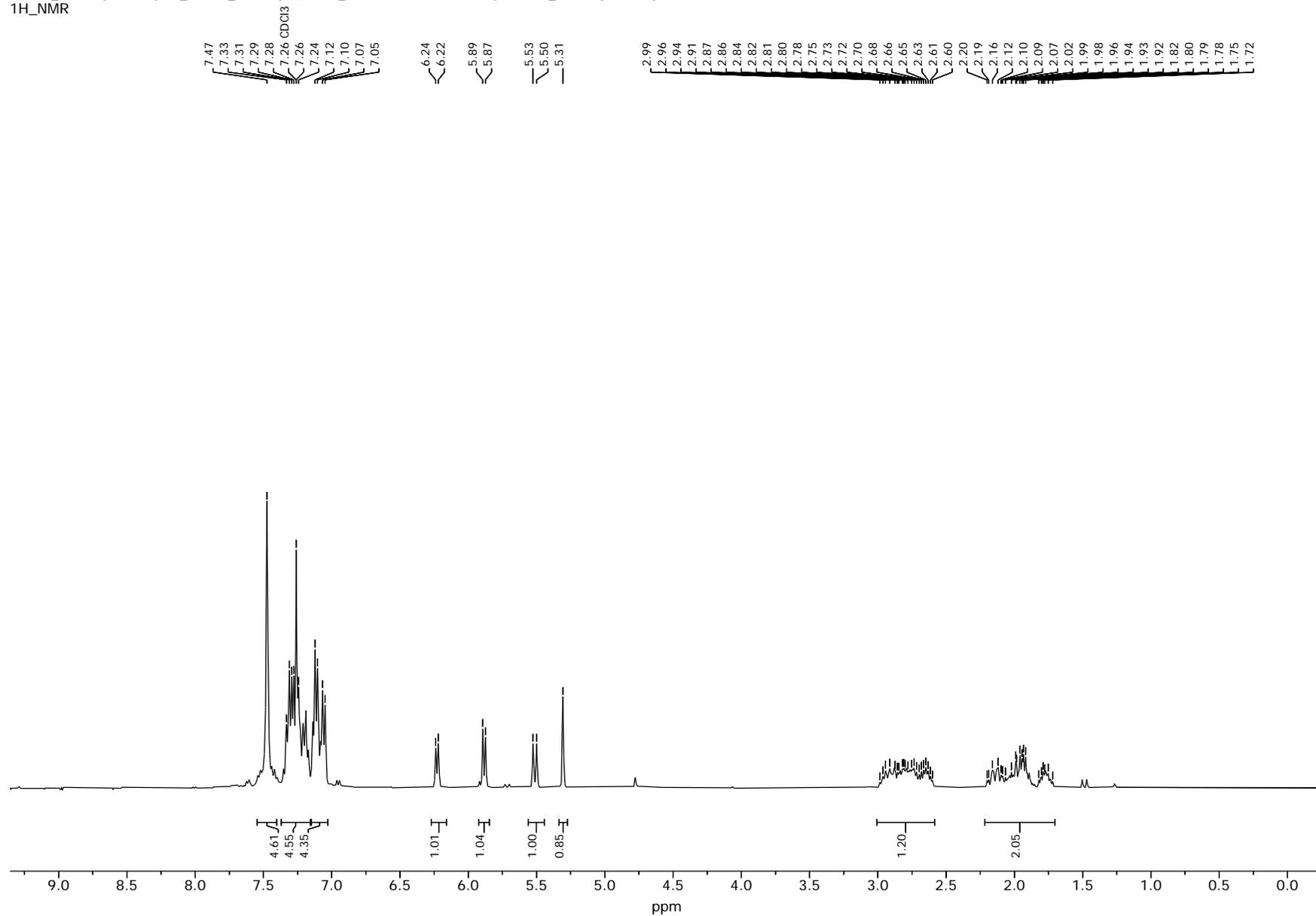
<sup>31</sup>P\_NMR

29.16



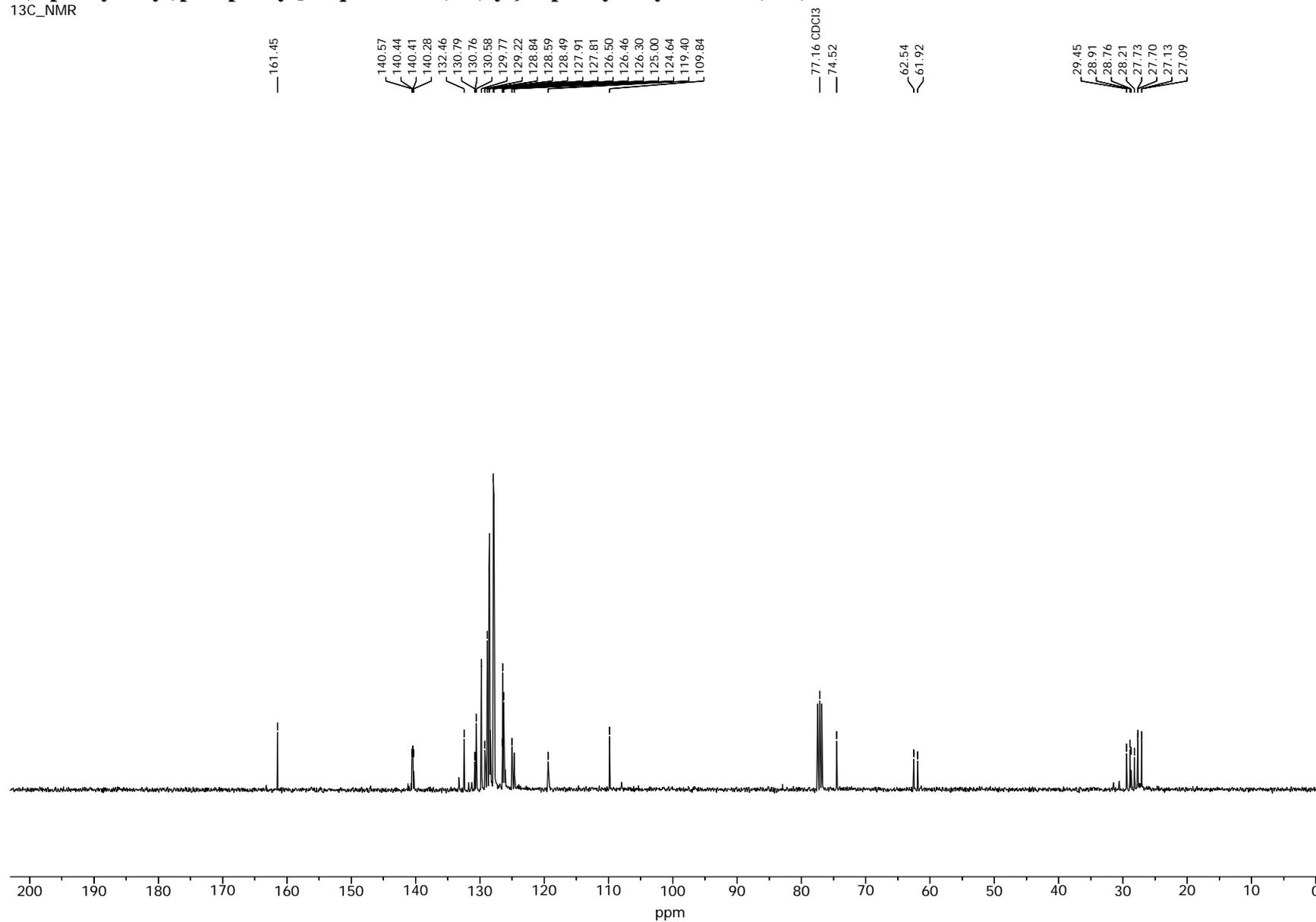
**(Z)-3-{1-[Bis(2-phenylethyl)phosphoryl]isoquinolin-2(1H)-yl}-3-phenylacrylonitrile (10b)**

<sup>1</sup>H-NMR



**(Z)-3-{1-[Bis(2-phenylethyl)phosphoryl]isoquinolin-2(1H)-yl}-3-phenylacrylonitrile (10b)**

<sup>13</sup>C\_NMR



**(Z)-3-{1-[Bis(2-phenylethyl)phosphoryl]isoquinolin-2(1H)-yl}-3-phenylacrylonitrile (10b)**

<sup>31</sup>P\_NMR

