**Supporting Information**

# Light-induced splitting of P-C bonds in a lanthanum(III) hemiphosphinal complex

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# 1. Experimental Section

**General Remarks.** If not otherwise mentioned, all transformations were carried out under inert conditions using an argon filled glovebox. All glassware (including glass-fibre filters) was stored in an oven at 150 °C for at least 12 h prior to use. Solvents were dried by a MBraun SPS system, degassed and stored over activated molecular sieves (3 Å) for at least 24 h prior to use. $C_6D_6$ was degassed by three freeze-pump-thaw cycles and then dried by storage over activated molecular sieves (3 Å) for at least 24 h. IR spectra were recorded at room temperature under inert conditions using a Bruker Vertex 70 with ATR equipment. If not otherwise stated, the NMR spectra were collected at 303 K on a Bruker AV-500 or an Ascent 700 spectrometer using a J-Young NMR tube. All chemical shifts ($\delta$) are reported in ppm and coupling constants are given in Hz. $^{1}$H and $^{13}$C chemical shifts were calibrated to residual solvent peaks. $^{31}$P chemical shifts were calibrated externally to phosphoric acid ($H_3PO_4$, 85% in water). EPR spectra were recorded on a Bruker Magnettech ESR5000 X-band EPR spectrometer using a temperature control unit and 3 mm o.d. J-Young fused silica tubes. For in-situ irradiation experiments a Hamamatsu LightningCure lamp (L9566-06A, 200W Mercury Xenon 365 nm wide band) was used. Analysis was performed using the EasySpin package for MatLab®. Values were obtained by least-squares fitting to the experimental spectra using the garlic function. Elemental analyses were performed using an Elementar vario microcube instrument at the University of Innsbruck. **KPH$^t$Bu** was synthesize by adding KHMDS to commercially available $PH_2{}^t$Bu (10 weight% in hexane) and filtering off the faint yellow solid. Starting materials **(PN)$_2$LaCl** and **1a** were synthesized following literature known procedures.[1] 9H-Fluoren-9-one and $PPh_3$ was used as received.

**Synthetic Procedures**

***Preparation of (PN)$_2$LaPHPh (1b).***

Solid **(PN)$_2$LaCl** (342 mg, 400 µmol, 1 eq.) and **KPHPh** (71 mg, 480 µmol, 1.2 eq.) were combined and toluene (6 mL) was added to this mixture. The resulting yellow suspension was stirred for 12 h at room temperature. After centrifugation the supernatant was filtered through a glass-fibre filter and all volatiles were removed *in vacuo* to yield the crude product. This solid was resuspended in *n*-pentane (4 mL) and stirred for 3 h at room temperature. The suspension was then centrifuged and the supernatant was separated from the solid with a pipette. The yellow solid was washed with additional *n*-pentane (3 x 2 mL) and dried *in vacuo*. *(Caution: The product complex and the phosphanide starting material are very malodorous as well as potentially pyrophoric and should therefore be quenched carefully and only in small quantities with sodium hypochlorite solution before disposal.)* Single crystals suitable for X-ray structure determination were obtained as thin, pale yellow plates by storing a concentrated *n*-hexane solution of **1b** at –40 °C for five weeks. Yield: 224 mg (240 µmol, 60%). $^{1}$H NMR ($C_6D_6$, 700 MHz, in ppm) $\delta$ = 7.44–7.39 (m, C$H_{Ar}$, 2 H), 7.00–6.96 (m, C$H_{Ar}$, 2 H), 6.89–6.86 (m, C$H_{Ar}$, 2 H), 6.85–6.79 (s at 6.85 & m, C$H_{Ar}$, 7 H), 5.69–5.64 (m, C$H_{Ar}$, 2 H), 4.06 (d, $^{1}J_{PH}$ = 194.8 Hz, P$H$Ph, 1 H), 2.27–2.22 (br. s, C$H_{3Ar}$, 12 H), 2.16 (s, C$H_{3Ar}$, 6 H), 2.11 (s, C$H_{3Ar}$, 6 H), 1.80–1.67 (br. s, C$H_{i\mathrm{Pr}}$, 4 H), 1.21–1.15 (br. m, C$H_{3i\mathrm{Pr}}$, 12 H), 0.94–0.85 (br. m, C$H_{3i\mathrm{Pr}}$, 12 H); $^{13}$C{$^{1}$H} NMR ($C_6D_6$, 176 MHz, in ppm) $\delta$ = 160.3 (*pseudo*-t, $J_{CP}$ = 11.7 Hz, $C_{qAr}$), 148.6 (s, $J_{CP}$ = 26.8 Hz, $C_{qAr}$), 138.3 (br. s, $C_{qAr}$), 138.0 (s, $C_{qAr}$), 135.3 (s, $C_{qAr}$), 133.8 (s, $C$H$_{Ar}$), 133.5 (s, $C$H$_{Ar}$), 131.8 (s, $C$H$_{Ar}$), 130.54 (s, $C_{qAr}$), 130.47 (s, $C$H$_{Ar}$), 127.9 (resonance obscured by $C_6D_6$ peak, only identifiable by $^{1}$H–$^{13}$C HSQC NMR spectroscopy, s, $C$H$_{Ar}$), 123.5 (s, $C_{qAr}$), 121.9 (s, $C$H$_{Ar}$), 113.9 (d, $J_{CP}$ = 6.8 Hz, $C_{qAr}$), 113.8 (d, $J_{CP}$ = 6.4 Hz, $C_{qAr}$), 112.7 (*pseudo*-t, $J_{CP}$ = 3.8 Hz, $C$H$_{Ar}$), 22.4 (s, $C$H$_{i\mathrm{Pr}}$), 20.9 (s, $C$H$_{3Ar}$), 20.6 (s, $C$H$_{3Ar}$), 19.9 (*pseudo*-t, $J_{CP}$ = 5.4 Hz, $C$H$_{3i\mathrm{Pr}}$), 19.7 (d, $J_{CP}$ = 3.6 Hz, $C$H$_{3Ar}$), 17.7 (br. s, $C$H$_{3i\mathrm{Pr}}$); $^{31}$P{$^{1}$H} NMR ($C_6D_6$, 283 MHz, in ppm): $\delta$ = 10.3 (s, $P$N$^-$, 2 P), –10.2 (s, P$H$Ph, 1 P); $^{31}$P NMR ($C_6D_6$, 283 MHz, in ppm): $\delta$ = 10.3 (s, $P$N$^-$, 2 P), –10.2 (d, $^{1}J_{PH}$ = 194.8 Hz, P$H$Ph, 1 P). Elemental analysis *calc'd* for $C_{50}H_{68}N_2P_3La_1$ (%) C 64.65 H 7.38 N 3.02 found C 63.35 H 7.43 N 2.84. (Despite numerous attempts, this was the best elemental analysis that could be obtained for the complex). UV/VIS/NIR: $\lambda_{max}$ = 327 (ε = 47370 L mol$^{-1}$ cm$^{-1}$), 339 (ε = 44560 L mol$^{-1}$ cm$^{-1}$), 388 (ε = 36360 L mol$^{-1}$ cm$^{-1}$). IR (cm$^{-1}$): 2957, 2918, 2865, 1599, 1576, 1464, 1394, 1382, 1303, 1280, 1268, 1249, 1215, 1194, 1156, 1098, 1076, 1025, 996, 931, 882, 861, 817, 733, 708, 696, 663, 616, 584, 545, 488, 467, 433.

***Preparation of (PN)$_2$LaPH$^t$Bu (1c).***

In a 20 mL scintillation vial, **(PN)$_2$LaCl** (500 mg, 0.59 mmol, 1 eq.) dissolved in toluene (12 mL) and cooled down to – 40 °C. A suspension of **potassium tert-butylhydrophosphanide (KPH$^t$Bu)** (89.9 mg, 0.70 mmol, 1.2 eq.) in toluene (2 mL) was added slowly. After complete addition, the reaction mixture was allowed to warm up to room

temperature and stirred overnight. The resulting orange solution was centrifuged and the supernatant was filtered through a glass-fibre filter. Afterwards the filtrate dried *in vacuo* and the solid was redissolved in *n*-hexane, filtered again and concentrated to 2 mL under reduced pressure. The concentrated solution stored at – 40 °C for crystallization. The crystals were washed with a small amount of – 40 °C cold *n*-hexane to observe a yellow powder. Single crystals suitable for X-ray structure determination were obtained of a concentrated solution of **$(PN)_2LaPH^tBu$** in *n*-pentane at room temperature. Yield: 435 mg (0.48 mmol, 82 %). $^1$H NMR ($C_6D_6$, 400 MHz, in ppm) $\delta$ = 6.89 (m, C$H_{Ar}$, 6 H), 6.81 (m, C$H_{Ar}$, 2 H), 5.78 – 5.55 (m, C$H_{Ar}$, 2 H), 3.47 (d, $^1J_{PH}$ = 200.7 Hz, P$H^t$Bu, 1 H), 2.31 (s, C$H_{3Ar}$, 12 H), 2.17 (s, C$H_{3Ar}$, 6 H), 2.15 (s, C$H_{3Ar}$, 6 H), 1.72 (br. s, 4 H), 1.53 (d, *J* = 12.0 Hz, PHC(C$H_3$)$_3$, 9 H), 1.26 (s, C$H_{3iPr}$, 12 H), 1.03 (s, C$H_{3iPr}$, 12 H); $^{13}$C{$^1$H} NMR ($C_6D_6$, 101 MHz, in ppm) $\delta$ = 160.7 (*pseudo*-t, *J* = 11.5 Hz, $C_{qAr}$), 139.4 (s, $C_{qAr}$), 138.4 (br. s, $C$H$_{qAr}$), 134.5 (s, $C$H$_{Ar}$), 133.7 (s, $C$H$_{Ar}$), 133.4 (s, $C_{qAr}$), 131.5 (s, $C$H$_{Ar}$), 122.8 (s, $C_{qAr}$), 113.8 (t, *J* = 6.6 Hz, (s, $C$H$_{Ar}$), 112.6 (t, *J* = 4.0 Hz, ($C$H$_{Ar}$), 36.7 (d, *J* = 6.8 Hz, PH$C$(CH$_3$)$_3$), 32.0 (d, *J* = 6.8 Hz, PHC($C$H$_3$)$_3$), 22.0 (br. s, $C$H(CH$_3$)$_{2iPr}$), 20.9 (s, CH($C$H$_2$)$_{3iPr}$), 20.6 (br. s, CH($C$H$_2$)$_{3iPr}$), 20.2 (br. s, $C$H$_{3Ar}$), 19.2 (s, CH($C$H$_3$)$_{2iPr}$), 17.9 (br. s, CH($C$H$_3$)$_{2iPr}$); $^{31}$P NMR ($C_6D_6$, 162 MHz, in ppm) $\delta$ = 97.45 (d, $^1J_{PH}$ = 199.3 Hz, P$H^t$Bu, 1 P), 12.30 (s, P$N^-$, 2 P); $^{31}$P{$^1$H} NMR ($C_6D_6$, 162 MHz, in ppm) $\delta$ = 97.44 (s, P$H^t$Bu, 1 P), 12.30 (s, P$N^-$, 2 P). Elemental analysis *calc'd* for $C_{48}H_{72}N_2P_3La_1$ · 0.25 KCl (%) C 62.15 H 7.82 N 3.02 found C 61.74 H 8.08 N 3.00. UV/VIS/NIR: $\lambda_{max}$ = 327 (ε = 41220 L mol$^{-1}$ cm$^{-1}$), 368 (ε = 45130 L mol$^{-1}$ cm$^{-1}$), 397 (ε = 46070 L mol$^{-1}$ cm$^{-1}$). IR (cm$^{-1}$): 2959, 2920, 2865, 1599, 1537, 1464, 1390, 1303, 1278, 1266, 1249, 1215, 1192, 1156, 1098, 1033, 929, 882, 857, 821, 810, 731, 710, 690, 661, 616, 543, 490, 467, 433.

***Preparation of $(PN)_2La${OFluoren(PHMes)} (2a).***

*(Note: The product is light-sensitive, therefore the reaction is performed in a brown glass vial)* In a 20 mL scintillation vial, **$(PN)_2LaPHMes$** (200 mg, 0.2 mmol, 1.0 eq.) was dissolved in toluene (8 mL) and cooled down to – 40 °C. A solution of **9H-fluoren-9-one** (37.1 mg, 0.2 mmol, 1.0 eq.) in toluene (2 mL) was added to the reaction mixture. After complete addition, the reaction mixture was allowed to warm to room temperature and stirred overnight. On the next day the red solution was filtered through a glass-fibre filter and dried *in vacuo*. Afterwards the solid was washed twice with – 40 °C *n*-hexane (2 mL). The solid was dried under reduced pressure to give a grey solid. Single crystals suitable for X-ray structure determination were obtained from a concentrated solution of **$(PN)_2La${OFluoren(PHMes)}** in *n*-hexane at – 40 °C. Yield: 162 mg (0.14 mmol, 68 %). $^1$H NMR ($C_6D_6$, 400 MHz, in ppm) $\delta$ = 7.74 (dd, *J* = 11.3, 7.8 Hz, C$H_{Fl}$, 2 H), 7.09 – 6.98 (m, C$H_{Ar}$, 6 H), 6.92 – 6.81 (m, C$H_{Ar}$, 8 H), 6.43 (s, C$H_{Fl}$, 2 H), 5.91 – 5.74 (m, C$H_{Ar}$, 2 H), 5.17 (d, $^1J_{PH}$ = 210.6 Hz, P$H$Mes, 1 H), 2.40 (br. s, C$H_{3Ar}$, 6 H), 2.19 (s, C$H_{3Ar}$, 12 H), 2.11 (s, C$H_{3Ar}$, 6 H), 1.99 (s, C$H_{3Ar}$, 6 H), 1.83 (s, C$H_{3Ar}$, 3 H), 1.29 – 1.17 (m, C$H_{iPr}$, 4 H), 1.04 – 0.91 (m, C$H_{3iPr}$, 24 H); $^{13}$C{$^1$H} NMR ($C_6D_6$, 101 MHz, in ppm) $\delta$ = 161.3 (m, $C_{qAr}$), 143.1 (s, $C_{qAr}$), 143.0 (s, $C_{qAr}$), 141.6 (s, $C$H$_{Ar}$), 137.7 (s, $C_{qFl}$), 137.5 (s, $C_{qAr}$), 133.7 (s, $C$H$_{Ar}$), 133.5 (s, $C$H$_{Ar}$), 133.3 (s, $C$H$_{Ar}$), 131.5 (s, $C$H$_{Ar}$), 129.3 ($C_{qAr}$), 128.8 (s, $C$H$_{Ar}$), 126.9 (s, $C_{qFl}$), 122.0 (s, $C_{qAr}$), 113.1 (s, $C_{qAr}$), 95.3 (s, $C_{qFl}$), 23.1 (s, $C$H$_{3Ar}$), 20.9 (s, $C_{qAr}$), 20.7 (s, $C$H$_{3Ar}$), 20.6 (s, $C$H$_{3Ar}$); $^{31}$P NMR ($C_6D_6$, 162 MHz, in ppm) $\delta$ = 9.78 (s, P$N^-$, 2 P), -32,02 (br. s, $P$HMes, 1 P); $^{31}$P{$^1$H} NMR ($C_6D_6$, 162 MHz, in ppm) $\delta$ = 9.78 (s, P$N^-$, 2 P), - 32.09 (br. s, $P$HMes, 1 P). Elemental analysis *calc'd* for $C_{66}H_{82}N_2O_1P_3La_1$ (%) C 68.86 H 7.18 N 2.43 found C 68.37 H 7.26 N 2.18. UV/VIS/NIR: $\lambda_{max}$ = 326 (ε = 60890 L mol$^{-1}$ cm$^{-1}$), 366 (ε = 53740 L mol$^{-1}$ cm$^{-1}$), 379 (ε = 44950 L mol$^{-1}$ cm$^{-1}$), 441 (ε = 5710 L mol$^{-1}$ cm$^{-1}$). IR (cm$^{-1}$): 2952, 2918, 2865, 2336, 1691, 1599, 1537, 1497, 1462, 1392, 1303, 1280, 1268, 1196, 1156, 1135, 1109, 1080, 1045, 923, 880, 859, 821, 810, 782, 759, 733, 712, 692, 661, 606, 584, 541, 490, 463, 431.

***Preparation of $(PN)_2La${OFluoren(PHPh)} (2b).***

*(Note: The product is light-sensitive, therefore the reaction is performed in a brown glass vial)* In a 20 mL scintillation vial, **$(PN)_2LaPHPh$** (136 mg, 0.15 mmol, 1.0 eq.) was dissolved in toluene (5 mL) and cooled down to – 40 °C. A solution of **9H-fluoren-9-one** (26.4 mg, 0.15 mmol, 1.0 eq.) in toluene (1 mL) was added dropwise. After complete addition, the reaction mixture was allowed to warm up to room temperature and stirred overnight. On the next day the red solution was filtered and dried under reduced pressure. The solid was washed twice with *n*-hexane (2 mL) and dried *in vacuo* to give a grey powder. Yield: 139 mg (0.13 mmol, 86 %). $^1$H NMR ($C_6D_6$, 400 MHz, in ppm) $\delta$ = 7.84 (d, *J* = 8.0 Hz, C$H_{Fl}$, 1 H), 7.65 (d, *J* = 8.4 Hz, C$H_{Fl}$, 1 H), 7.11 – 6.92 (m, C$H_{Ar}$, 4 H), 6.92 – 6.80 (m, C$H_{Ar}$, 8 H), 6.72 (m, C$H_{Ar}$, 1 H), 5.81 (dd, *J* = 8.3, 5.1 Hz, CH$_{Ar}$, 1 H), 4.85 (d, $^1J_{PH}$ = 196.7 Hz, P$H$Ph, 1 H), 2.39 (s, C$H_{3Ar}$, 12 H), 2.17 (br. s, C$H_{3Ar}$, 12 H), 1.33 – 1.17 (m, C$H_{iPr}$, 4 H), 0.96 (s, C$H_{3iPr}$, 24 H); $^{13}$C{$^1$H} NMR ($C_6D_6$, 101 MHz, in ppm) $\delta$ = 161.4

(*pseudo*-t, *J* = 11.1 Hz, $C_{qAr}$), 141.5 (s, $C_{qAr}$), 138.8 (s, $C_{qFl}$), 138.0 (s, $C_{qFl}$), 134.6 (s, $CH_{Ar}$), 134.1 (s, $CH_{Ar}$), 133.9 (s, $C_{qAr}$), 133.7 (s, $CH_{Ar}$), 133.5 (s, $C_{qAr}$), 133.4 (s, $CH_{Ar}$), 131.4 (s, $CH_{Ar}$), 127.2 (s, $CH_{Ar}$), 127.2 (s, $CH_{Ar}$), 126.7 (s, $CH_{Ar}$), 125.4 (s, $CH_{Fl}$), 124.3 (s, $CH_{Fl}$), 122.0 (s, $CH_{3Ar}$), 119.2 (s, $C_{qAr}$), 119.1 (s, $CH_{Ar}$), 113.2 (s, $C_{qAr}$), 113.0 (s, $CH_{Ar}$), 93.7 (d, *J* = 6.8 Hz, $C_{qFl}$), 22.7 (s, $CH_{3Ar}$), 20.9 (s, $CH_{3Ar}$), 20.7 (s, $CH_{Ar}$), 20.4 (br. s, $CH_{iPr}$); $^{31}$P NMR ($C_6D_6$, 162 MHz, in ppm) $\delta$ = 9.99 (s, $PN^-$, 2 P), 5.46 (d, *J* = 196.9 Hz, *P*HPh, 1 P); $^{31}$P{H} NMR ($C_6D_6$, 162 MHz, in ppm) $\delta$ = 9.98 (s, $PN^-$, 2 P), 5.46 (s, *P*HPh, 1 P). Elemental analysis *calc'd* for $C_{63}H_{76}N_2O_1P_3La_1$ 0.20 KCl (%) C 67.32 H 6.82 N 2.49 found C 66.99 H 6.86 N 2.53. UV/VIS/NIR: $\lambda_{max}$ = 330 (ε = 55620 L mol$^{-1}$ cm$^{-1}$), 367 (ε = 57870 L mol$^{-1}$ cm$^{-1}$), 379 (ε = 55760 L mol$^{-1}$ cm$^{-1}$), 392 (ε = 57580 L mol$^{-1}$ cm$^{-1}$). IR (cm$^{-1}$): 2957, 2918, 2865, 2291, 1597, 1537, 1462, 1392, 1303, 1280, 1268, 1217, 1196, 1153, 1111, 1051, 927, 880, 857, 815, 794, 782, 739, 729, 710, 694, 663, 621, 543, 486, 467, 433, 414.

***Preparation of (PN)$_2$La{OFluoren(PH$^t$Bu)} (2c).***

*(Note: The product is light-sensitive, therefore the reaction is performed in a brown glass vial)* In a 20 mL scintillation vial, **(PN)$_2$LaPH$^t$Bu** (200 mg, 220 µmol, 1 eq.) was dissolved in toluene (8 mL) and cooled down to – 40 °C. A solution of **9H-fluoren-9-one** (39.7 mg, 220 µmol, 1 eq.) in toluene (1 mL) was added and the reaction mixture was allowed to warm up to room temperature and stirred overnight. On the next day the red solution was filtered and all volatile components were removed under reduced pressure. The residue solid was solved in *n*-hexane and filtered again. The solution was concentrated and cooled down to – 40°C for crystallization. Afterwards the solution was removed and the residue was washed with – 40°C cold *n*-hexane to observe a green/grey powder. Single crystals for X-ray determination was obtained from a concentrated solution of **(PN)$_2$La{OFluoren(PH$^t$Bu)}** in *n*-hexane. Yield: 162 mg (0.15 mmol, 68 %). $^1$H NMR NMR ($C_6D_6$, 400 MHz, in ppm) $\delta$ = 7.74 (d, *J* = 7.5 Hz, $CH_{Fl}$, 1 H), 7.57 (d, *J* = 7.6 Hz, $CH_{Fl}$, 1 H), 7.44 (dd, *J* = 7.5, 3.5 Hz, $CH_{Fl}$, 2 H), 7.08 (t, *J* = 7.4 Hz, $CH_{Fl}$, 2 H), 6.92 – 6.83 (m, $CH_{3Ar}$, 6 H), 6.81 (s, $CH_{Ar}$ , 2 H), 5.78 (m, $CH_{Ar}$, 2 H), 4.12 (d, $^1J_{PH}$ = 190.9 Hz, P*H*C(CH$_3$)$_3$, 1 H), 2.34 (br. s, $CH_3$, 12 H), 2.17 (s, $CH_3$, 6 H), 2.16 (s, $CH_3$, 6 H), 1.24 (s, C*H*(CH$_3$)$_2$, 4H), 0.98 (s, CH(C*H*$_3$)$_2$, 24 H), 0.53 (d, $^3J_{HP}$ = 10.9 Hz, PHC(C*H*$_3$)$_3$, 9 H); $^{13}$C{$^1$H} NMR ($C_6D_6$, 101 MHz, in ppm) $\delta$ = 161.4 (pseudo-t, *J* = 11.2 Hz, $C_{qAr}$), 141.7 (s, $C_{qAr}$), 138.8 (s, $C_{qFl}$), 138.6 (s, $C_{qFl}$), 133.5 (s, $CH_{Ar}$), 131.3 (s, $CH_{Ar}$), 127.4 (s, $CH_{Fl}$), 125.5 (s, $CH_{Fl}$), 121.9 (s, $C_{qAr}$), 119.7 (s, $CH_{Fl}$), 113.0 (pseudo-t, *J* = 3.9 Hz, $C_{qAr}$), 90.7 (d, *J* = 12.6 Hz, $C_{qFl}$), 30.2 (d, *J* = 2.1 Hz, PHC(*C*H$_3$)$_3$, 30.0 (s, $CH_{3Ar}$), 20.9 (s, $CH_{3Ar}$), 20.6 (s, $CH_{3Ar}$), 20.5 (s, $CH_{3Ar}$); $^{31}$P NMR ($C_6D_6$, 162 MHz, in ppm) $\delta$ = 23.58 (d, $^1J_{PH}$ = 191.6 Hz, *P*H$^t$Bu, 1 P), 9.49 (s, $PN^-$, 2 P); $^{31}$P{$^1$H} NMR ($C_6D_6$, 162 MHz, in ppm) $\delta$ = 23.59 (s, *P*H$^t$Bu, 1 P), 9.49 (s, $PN^-$, 2 P). Elemental analysis *calc'd* for $C_{61}H_{80}N_2O_1P_3La_1 \cdot 0.1$ KCl (%) C 66.81 H 7.35 N 2.55 found C 66.78 H 7.86 N 2.35. UV/VIS/NIR: $\lambda_{max}$ = 326 (ε = 46260 L mol$^{-1}$ cm$^{-1}$), 379 (ε = 41880 L mol$^{-1}$ cm$^{-1}$), 392 (ε = 43660 L mol$^{-1}$ cm$^{-1}$). IR (cm$^{-1}$): 2955, 2920, 2865, 2297, 1691, 1599, 1537, 1462, 1390, 1303, 1280, 1252, 1213, 1194, 1156, 1104, 1031, 929, 886, 859, 812, 780, 747, 733, 710, 688, 661, 621, 584, 541, 488, 433, 414.

***Preparation of (PN)$_2$LaOFluorenyl-radical (3).***

Complex ***(PN)$_2$La{OFluoren(PHMes)}*** *(15.6 mg, 13.6 µmol)* was solved in $C_6D_6$ and was irradiated in a photoreactor (5000k cold white LED) for 2 min, to ensure that the temperature inside the reaction vessel does rise to much (10 °C max). After the NMR cooled to room temperature the irradiation step was repeated. After 36 min almost no educts was left and compound **3** was crystallized from $C_6D_6$ layered with hexane to observe small black crystals. Yield: 3.4 mg (3.4 µmol, 25.1 %). $\mu_{eff}$ (Evans method, 25 °C, Benzene-$d_6$) = 1.42 $\mu_B$. UV/VIS/NIR: $\lambda_{max}$ = 321 (ε = 26460 L mol$^{-1}$ cm$^{-1}$), 366 (ε = 20260 L mol$^{-1}$ cm$^{-1}$), 443 (ε = 9420 L mol$^{-1}$ cm$^{-1}$). IR (cm$^{-1}$): 2950, 2920, 2865, 2272, 1601, 1566, 1494, 1464, 1443, 1401, 1341, 1319, 1305, 1282, 1198, 1153, 1135, 1111, 1080, 1045, 980, 929, 906, 880, 855, 845, 812, 774, 743, 712, 667, 629, 621, 606, 586, 537, 490, 465, 431.

***Preparation of (PN)$_2$LaOFluorenid (4).***

In a 20 mL scintillation vial, **(PN)$_2$LaCl** (120 mg, 0.14 mmol, 1.0 eq.) was dissolved in toluene (10 mL) and stirred at room temperature. A solution of **lithium 9H-fluoren-9-olate** (26.4 mg, 0.14 mmol, 1.0 eq.) in toluene (2 mL) was added to the mixture. After complete addition the reaction mixture was stirred overnight. On the next day the suspension was filtered through a glass-fibre filter and the filtrate dried under reduced pressure. Afterwards all

volatile components were removed *in vacuo*. The residue was washed twice with – 40 °C cold *n*-hexane (1 mL) and dried *in vacuo* to give **$(PN)_2$LaOFluorenid** as white solid. Single crystals suitable for X-ray structure determination were obtained from a concentrated solution of **$(PN)_2$LaOFluorenid** in diethyl ether at – 40 °C. Yield: 107 mg (0.11 mmol, 76 %). $^1$H NMR ($C_6D_6$, 400 MHz, in ppm) $\delta$ = 7.58 (br. s, C$H_{Fl}$, 2 H), 7.50 (d, $J$ = 7.5 Hz, C$H_{Fl}$, 2 H), 7.13 (m, C$H_{Ar}$, 2 H), (t, $^1J_{HH}$ = 7.4 Hz, C$H_{Ar}$, 2 H), 6.91 (s, C$H_{Ar}$, 4 H), 6.82 (m, C$H_{Ar}$, 2 H), 6.10 (s, OC$H_{Fl}$, 1 H), 5.76 (m, C$H_{Ar}$, 2 H), 2.48 (br.s, C$H_{3Ar}$, 6 H), 2.18 (s, C$H_{3Ar}$, 9 H), 2.14 (s, C$H_{3Ar}$, 9 H), 1.50 – 1.20 (m, 4 H), 0.92-0.69 (br. s, 24 H); $^{13}$C{$^1$H} NMR ($C_6D_6$, 101 MHz, in ppm) $\delta$ = 161.3 (t, $J$ = 11.3 Hz, $C_{qAr}$), 140.7 (s, $C_{qAr}$), 140.1 (s, $C_{qAr}$), 133.8 (s, $C$H$_{Ar}$), 133.6 (s, $C_{qAr}$), 133.4 (s, $C_{qAr}$), 131.9 (s, $C$H$_{Ar}$), 131.4 (s, $C$H$_{Ar}$), 125.7 (s, $C$H$_{Ar}$), 121.8 (s, $C_{qAr}$), 119.6 (s, $C_{Ar(Fl)}$), 113.4 – 113.1 (m, $C$H$_{Ar}$), 112.6 (m , $C$H$_{Ar}$), 83.9 (s, O$C$H$_{Fl}$), 23.8 (s, $C$H(CH$_3$)$_2$), 21.0 (s, $C$H$_{3Ar}$), 20.6 (s, $C$H$_{3Ar}$), 20.0 (s, $C$H$_{3Ar}$), 19.5 (s, $C$H$_{3Ar}$), 19.2 (s, $C$H$_{3i/Pr}$); $^{31}$P NMR ($C_6D_6$, 162 MHz, in ppm) $\delta$ = 9.17 (s, $P$N$^-$, 2 P); $^{31}$P{$^1$H} NMR ($C_6D_6$, 162 MHz, in ppm) $\delta$ = 9.17 (s, $P$N$^-$, 2 P). Elemental analysis *calc'd* for $C_{57}H_{71}LaN_2OP_2 \cdot LiCl \cdot Et_2O$ (%) C 65.56, H 7.31, N 2.51; found: C 65.51, H 7.70, N 2.35. UV/VIS/NIR: $\lambda_{max}$ = 311 (ε = 31960 L mol$^{-1}$ cm$^{-1}$), 328 (ε = 22560 L mol$^{-1}$ cm$^{-1}$). IR (cm$^{-1}$): 2950, 2922, 2865, 1605, 1494, 1466, 1452, 1392, 1305, 1266, 1188, 1156, 1100, 1033, 943, 880, 855, 815, 770, 739, 659, 623, 606, 580, 514, 449, 410.

***Irradiation experiments:***

In a J. Young NMR tube, **2a-c** (1 eq.) was dissolved in $C_6D_6$ (600 µL) and triphenylphosphine (1 eq.) was added as an internal standard. The reaction was then irradiated in a photoreactor equipped with 5000 K cold-white LEDs for 2 min followed by measuring $^1$H, $^{31}$P and $^{31}$P{$^1$H} NMR. This step was repeated as long as reactants were still present (time depending on substrate).

**X-ray Crystallography**

Single crystals for X-ray diffraction experiments were measured at the analytical facility of the University of Innsbruck using a Bruker D8 Quest instrument. All crystals were kept at 153(2) K throughout data collection. Data collection was performed using the APEXIV software package. Data refinement and reduction were performed with Bruker Saint (V8.34A). All structures were solved with SHELXT[2,3] and refined using the OLEX 2 software package.[4] All non-hydrogen atoms were refined anisotropically, and hydrogen atoms were included at the geometrically calculated positions and refined using a riding model. All structures have been submitted to the CCDC and can be obtained under the numbers presented in Table S1. For further crystallographic details regarding crystal measurements, please check Tables S1 and S2.

## 2. NMR Spectra

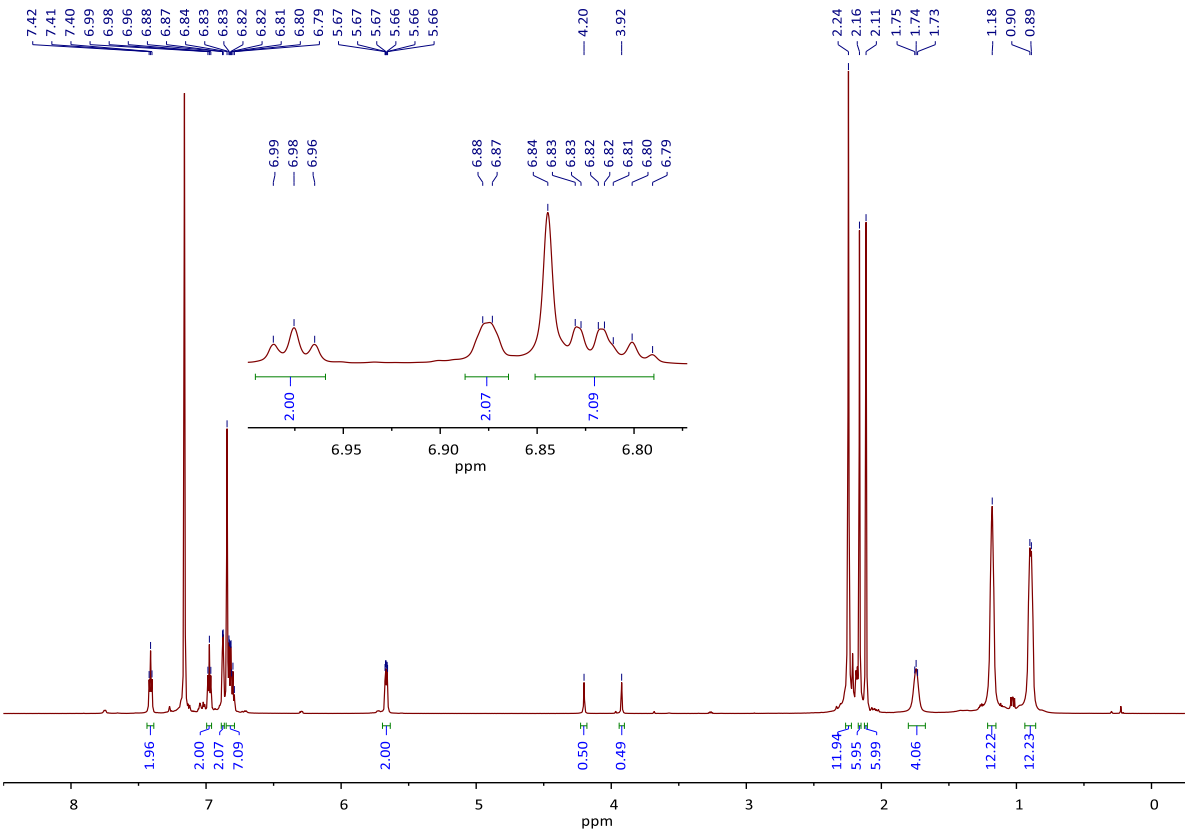


*Figure S 1:* *$^{1}$H NMR spectrum of **1b** in $C_6D_6$ (303 K). The enlargement shows the crowded resonances in the aromatic region. Traces of toluene from work-up are marked by *.*

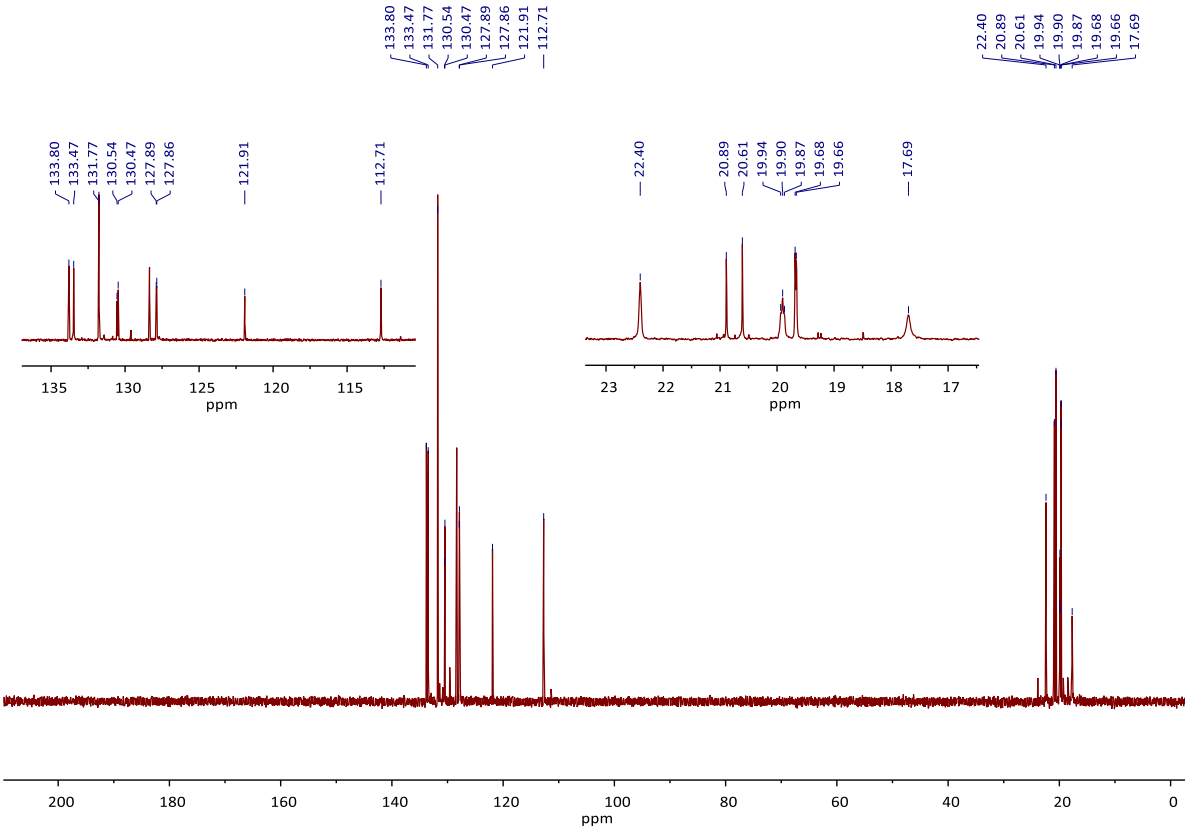


*Figure S 2:* *$^{13}C\{^{1}H\}$ NMR spectrum of **1b** in $C_6D_6$ (303 K). The peak listing is given in the three enlargements of the relevant aromatic and aliphatic regions of the spectrum.*

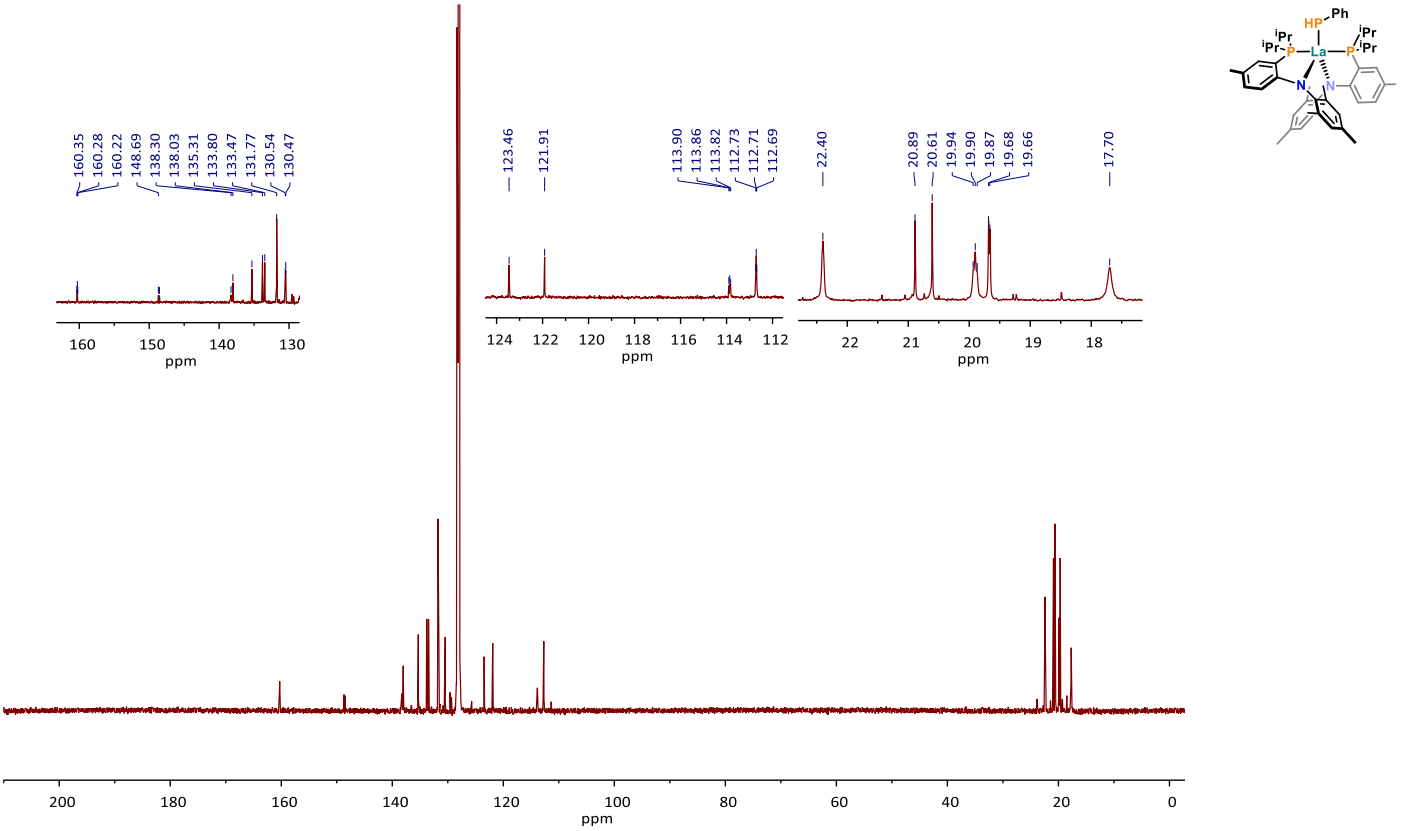



*Figure S 3:* *$^{13}C\{^1H\}$ DEPT135 NMR spectrum of **1b** in $C_6D_6$ (303 K). The two enlargements show the resonances in the aromatic and aliphatic region.*

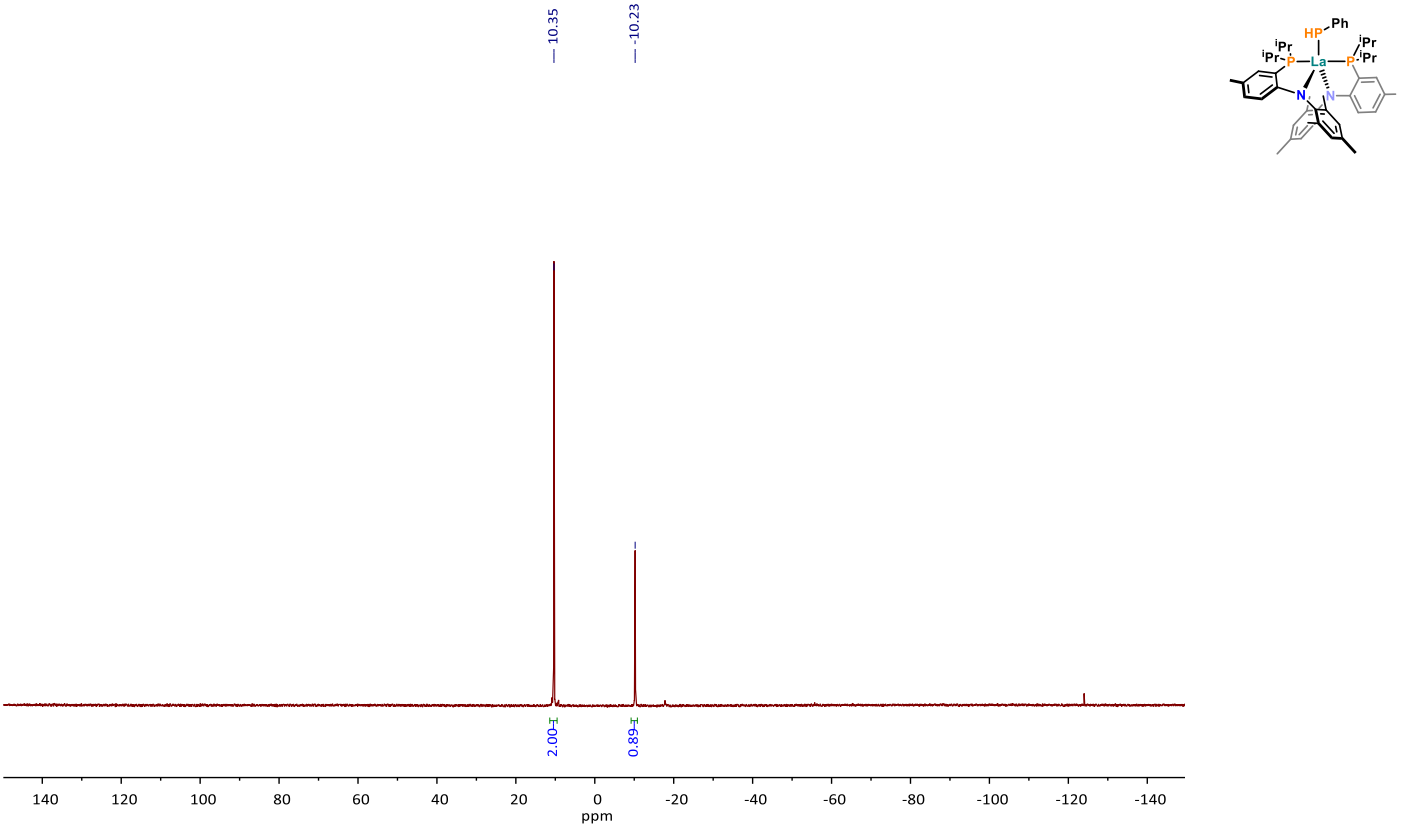



*Figure S 4:* *$^{31}P\{^1H\}$ NMR spectrum of **1b** in $C_6D_6$ (303 K).*

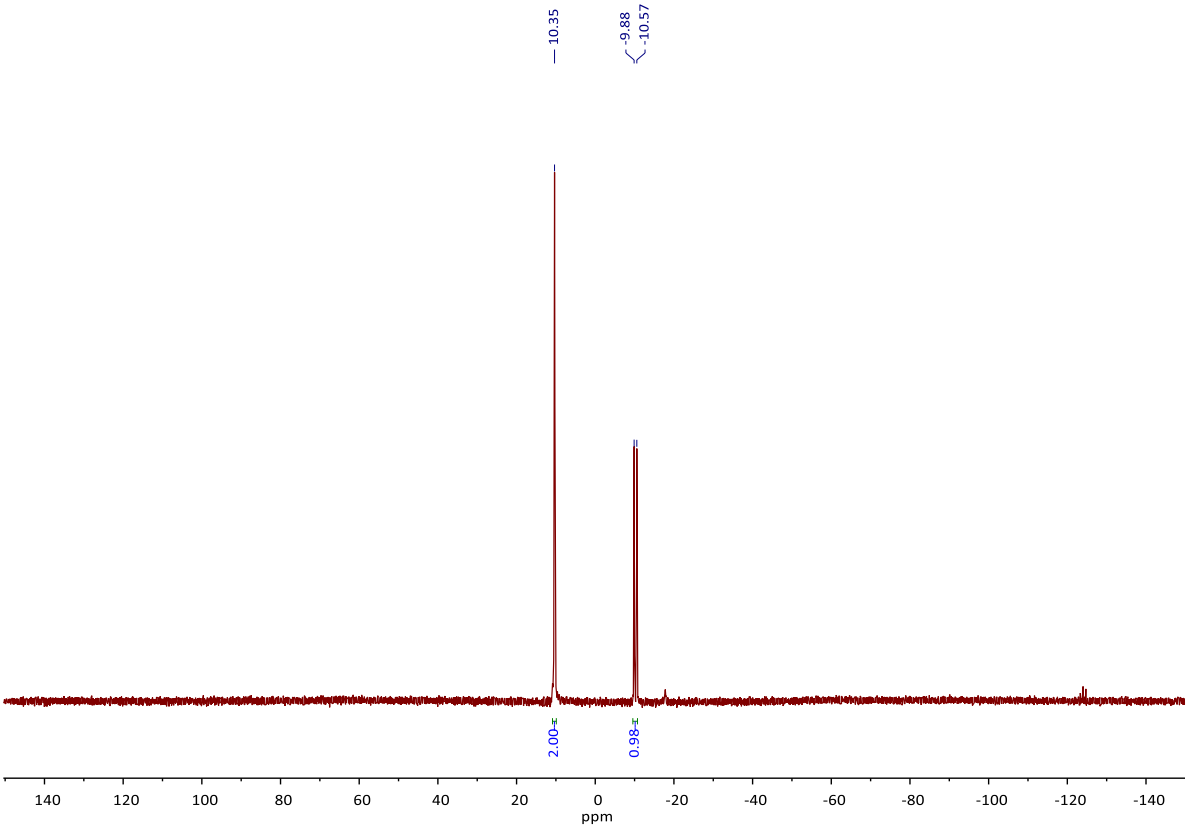



*Figure S 5:* *$^{31}$P NMR spectrum of **1b** in $C_6D_6$ (303 K).*

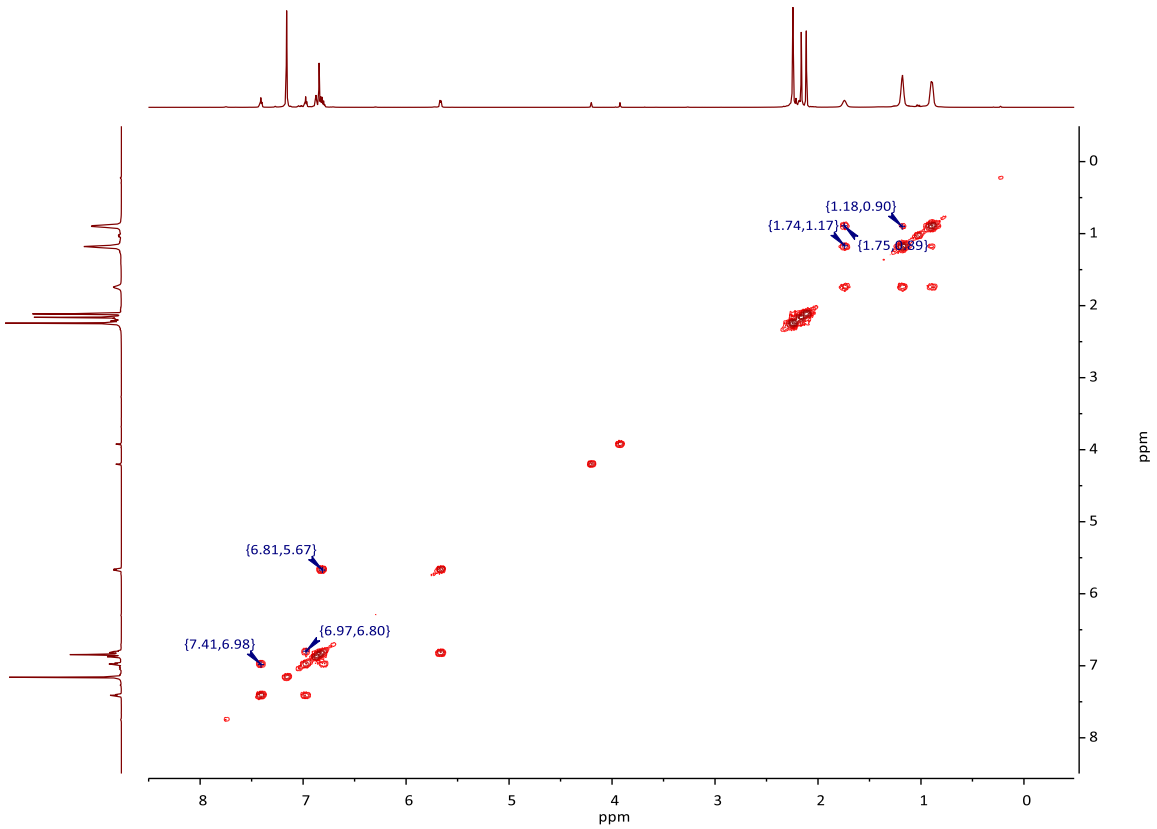



*Figure S 6:* *$^{1}$H–$^{1}$H COSY NMR spectrum of **1b** in $C_6D_6$ (303 K).*

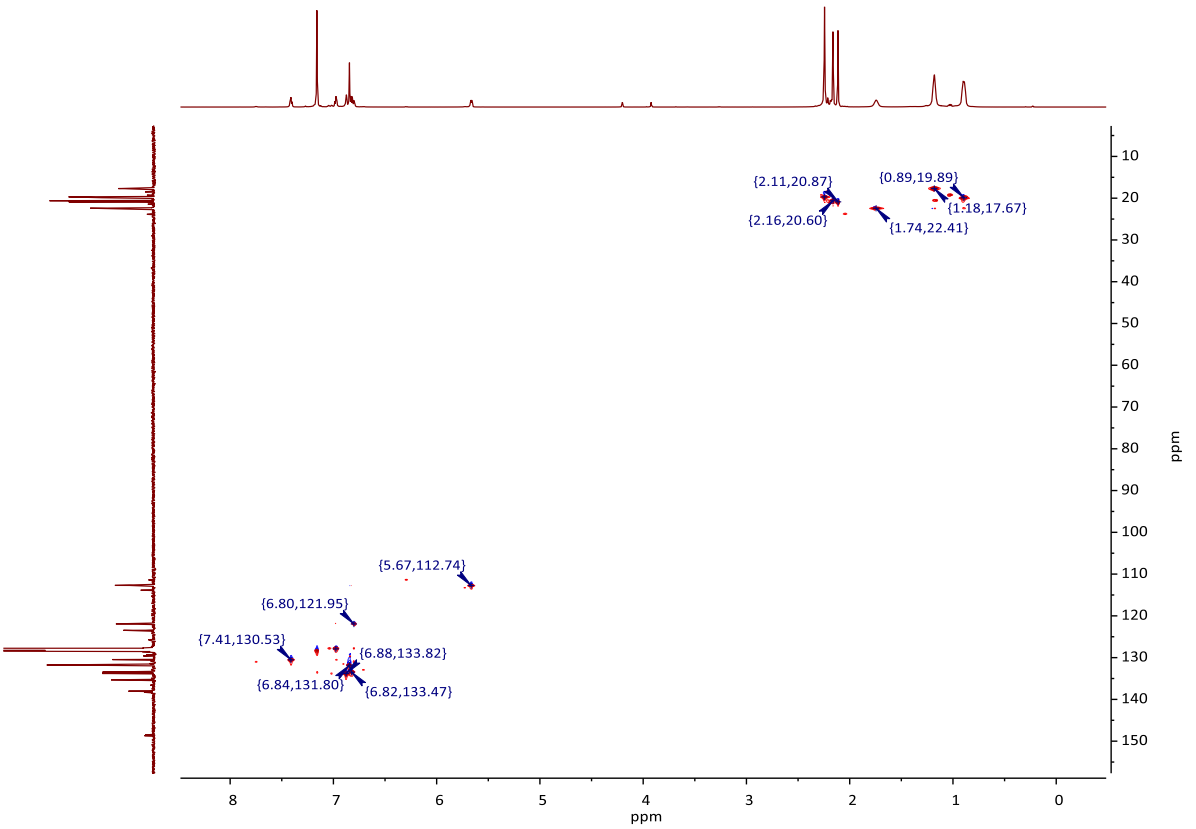



*Figure S 7:* *$^{1}H$–$^{13}C$ HSQC NMR spectrum of **1b** in $C_6D_6$ (303 K).*

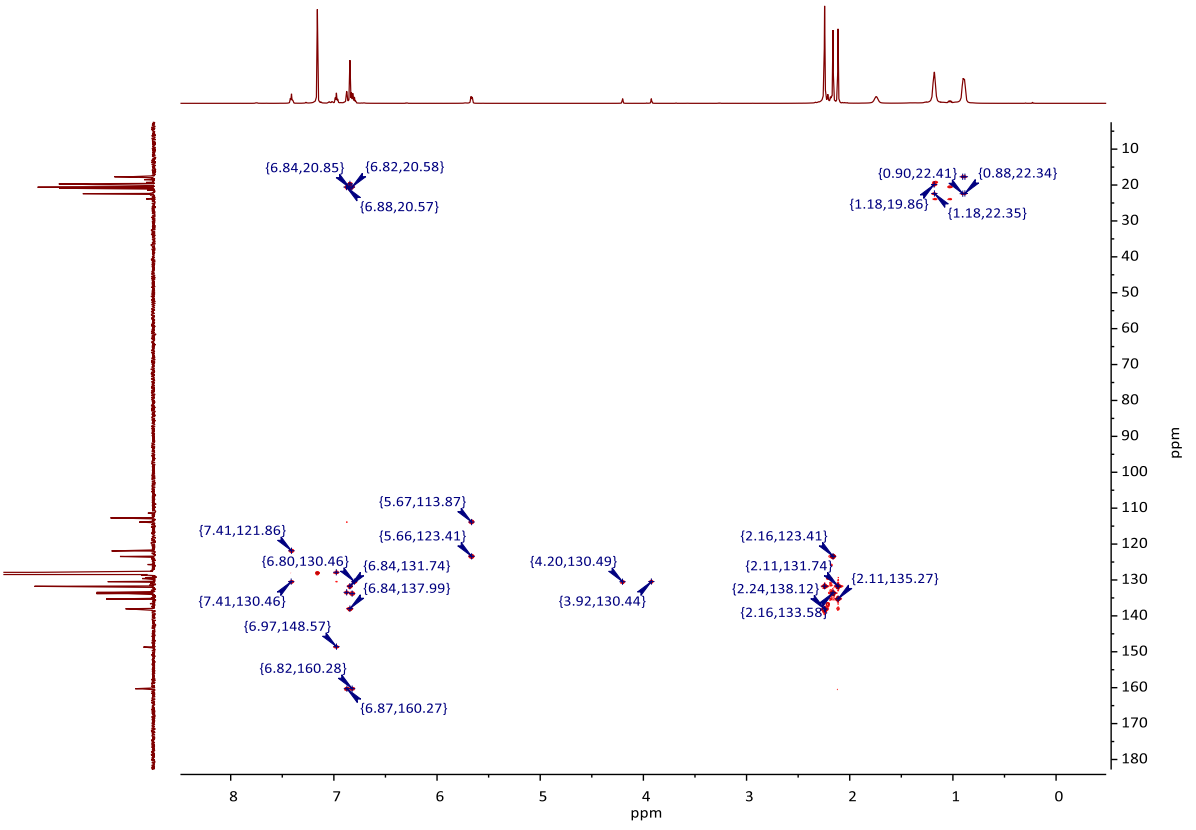
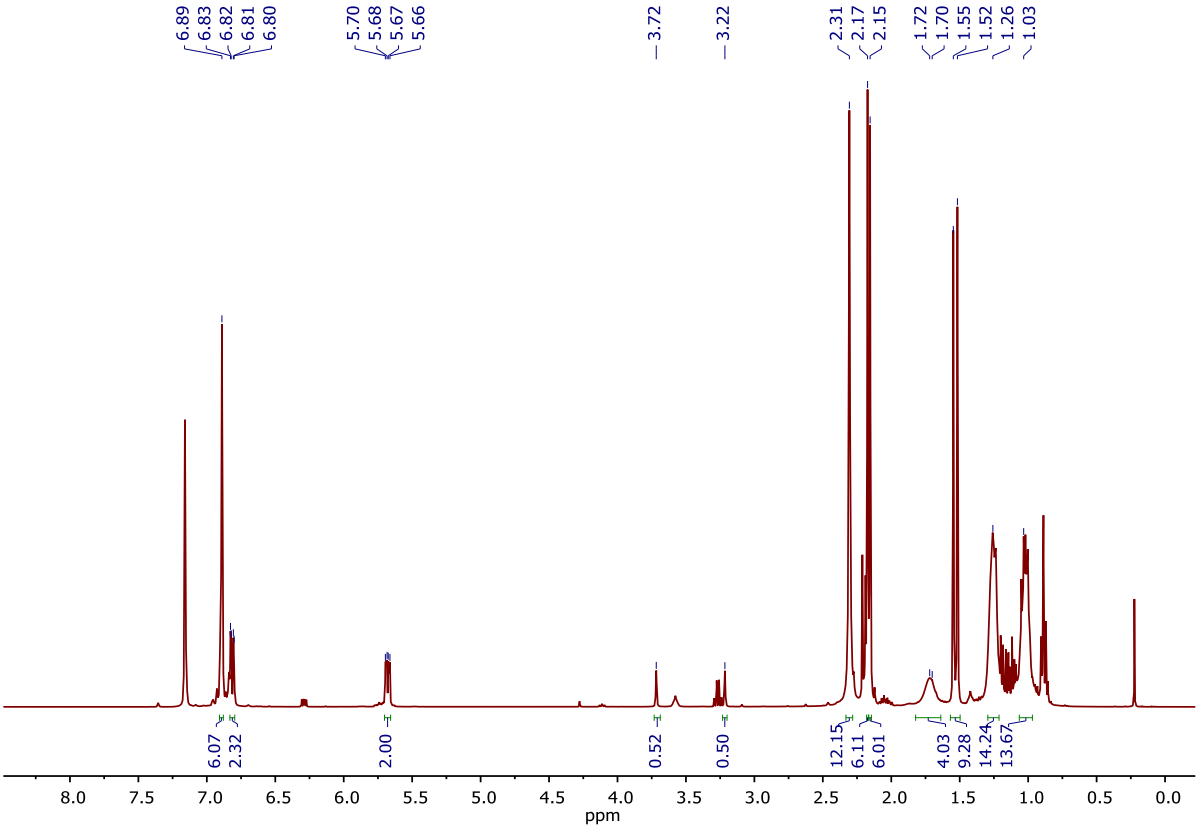



*Figure S 8:* *$^{1}H$–$^{13}C$ HMBC NMR spectrum of **1b** in $C_6D_6$ (303 K).*



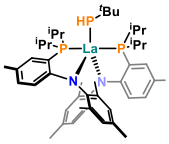
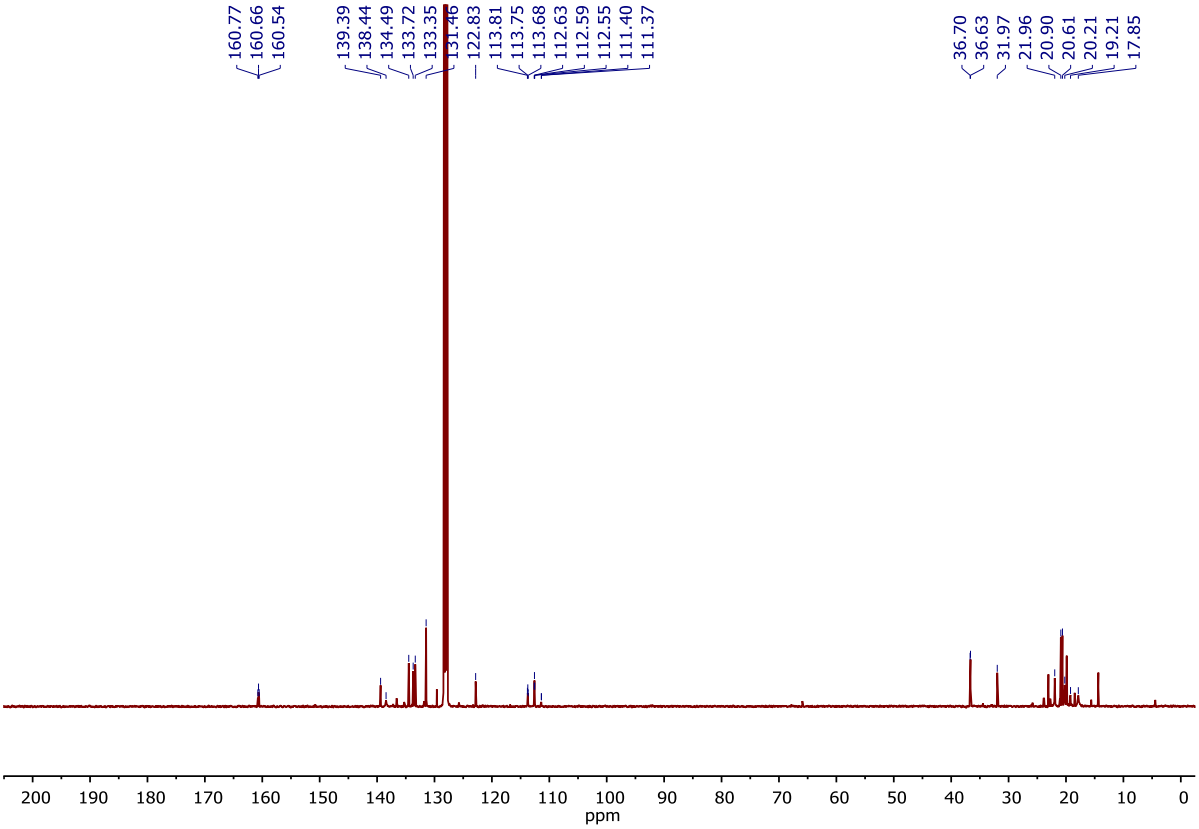



*Figure S 9:* *$^{1}$H NMR spectrum of **1c** in $C_6D_6$ (303 K).*



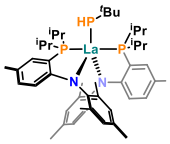
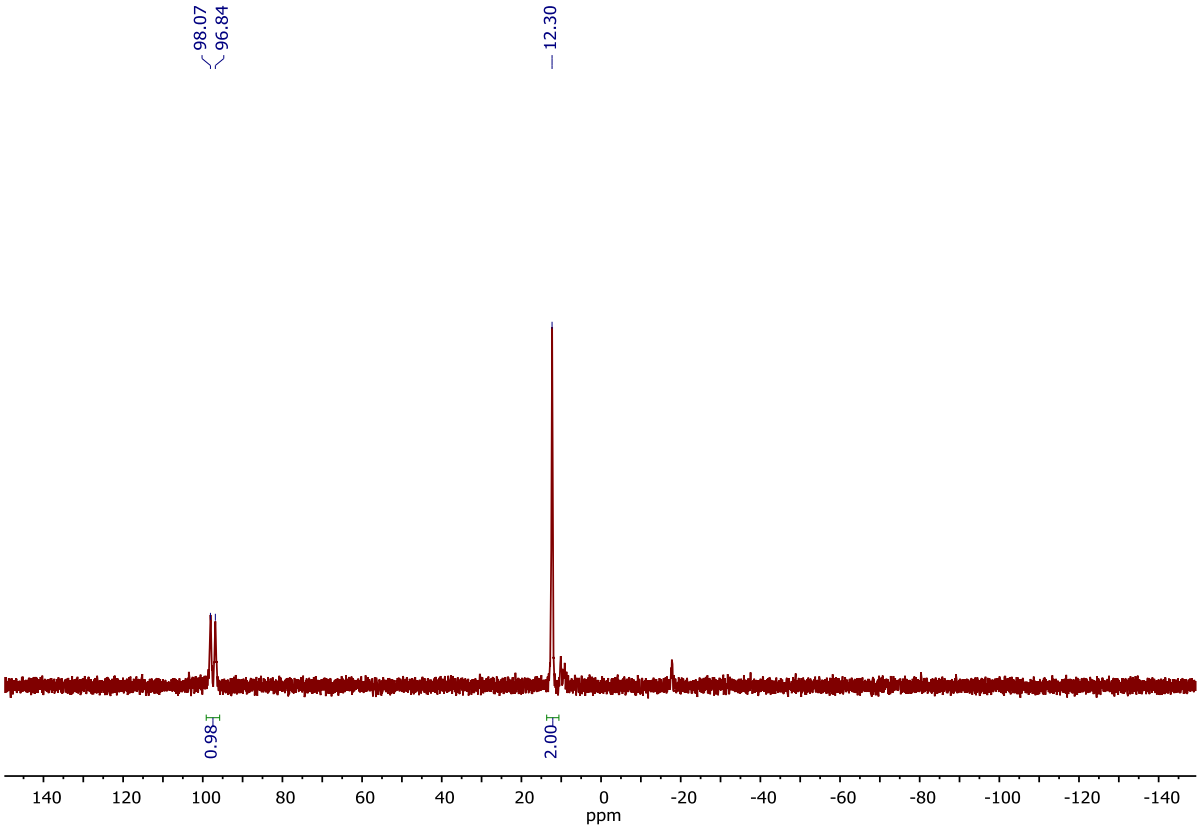



*Figure S 10:* *$^{13}C\{^{1}H\}$ NMR spectrum of **1c** in $C_6D_6$ (303 K).*



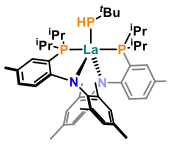
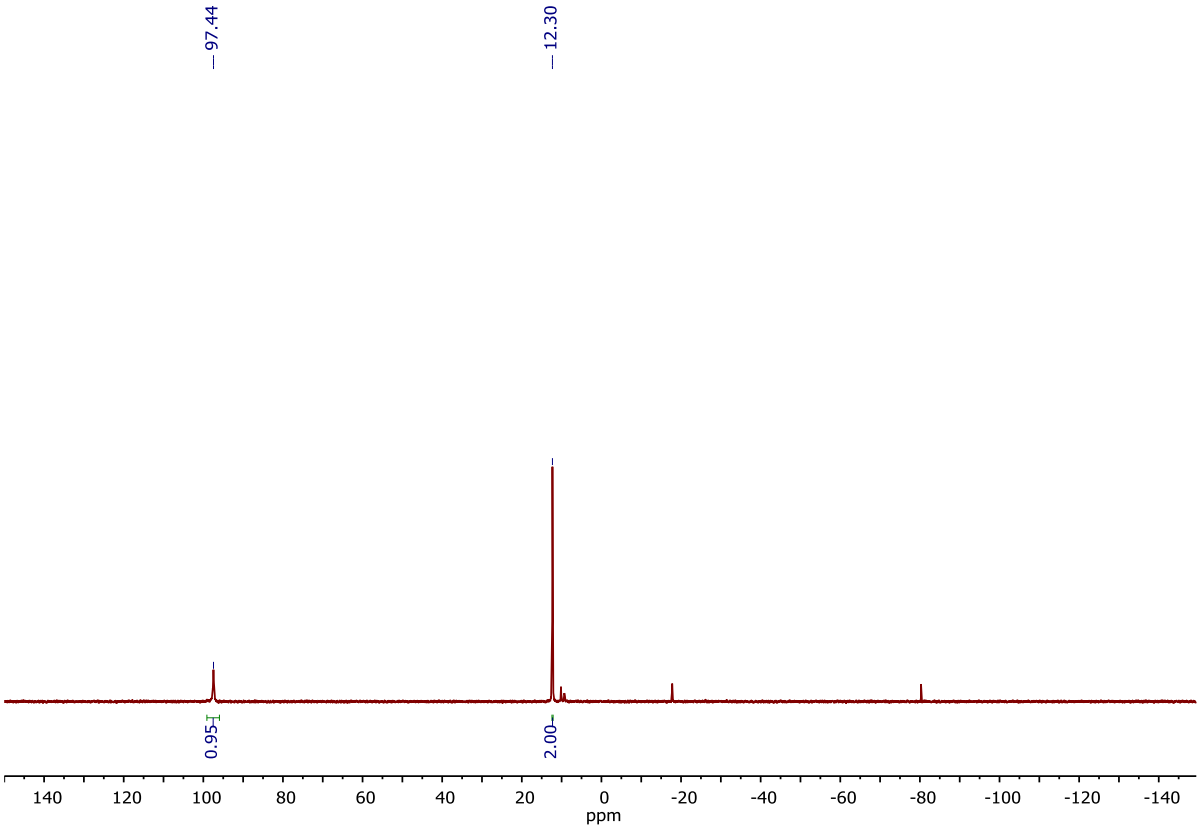



*Figure S 11:* *$^{31}$P NMR of **1c** in $C_6D_6$ (303 K).*



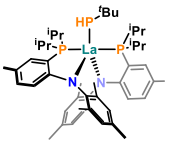



*Figure S 12:* *$^{31}$P{$^1$H} NMR of **1c** in $C_6D_6$ (303 K).*

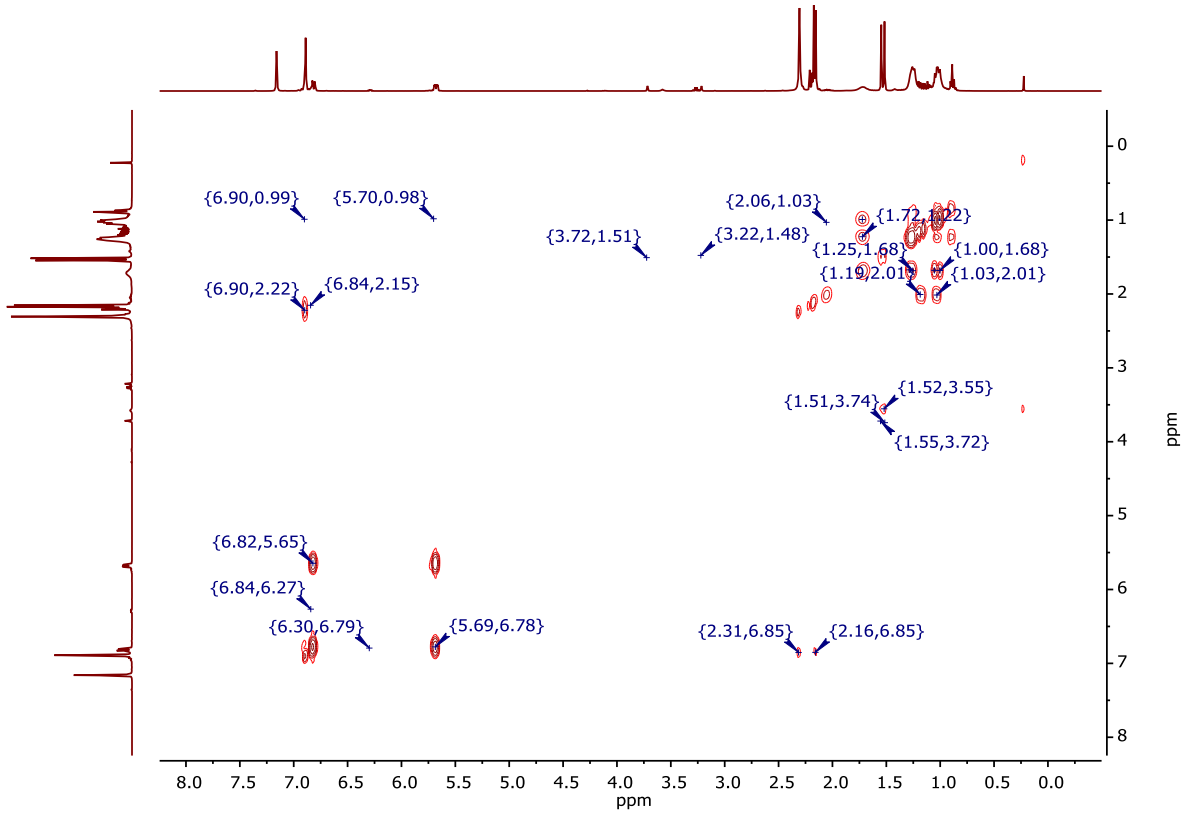



*Figure S 13:* *$^{1}$H–$^{1}$H COSY NMR spectrum of **1c** in $C_6D_6$ (303 K).*

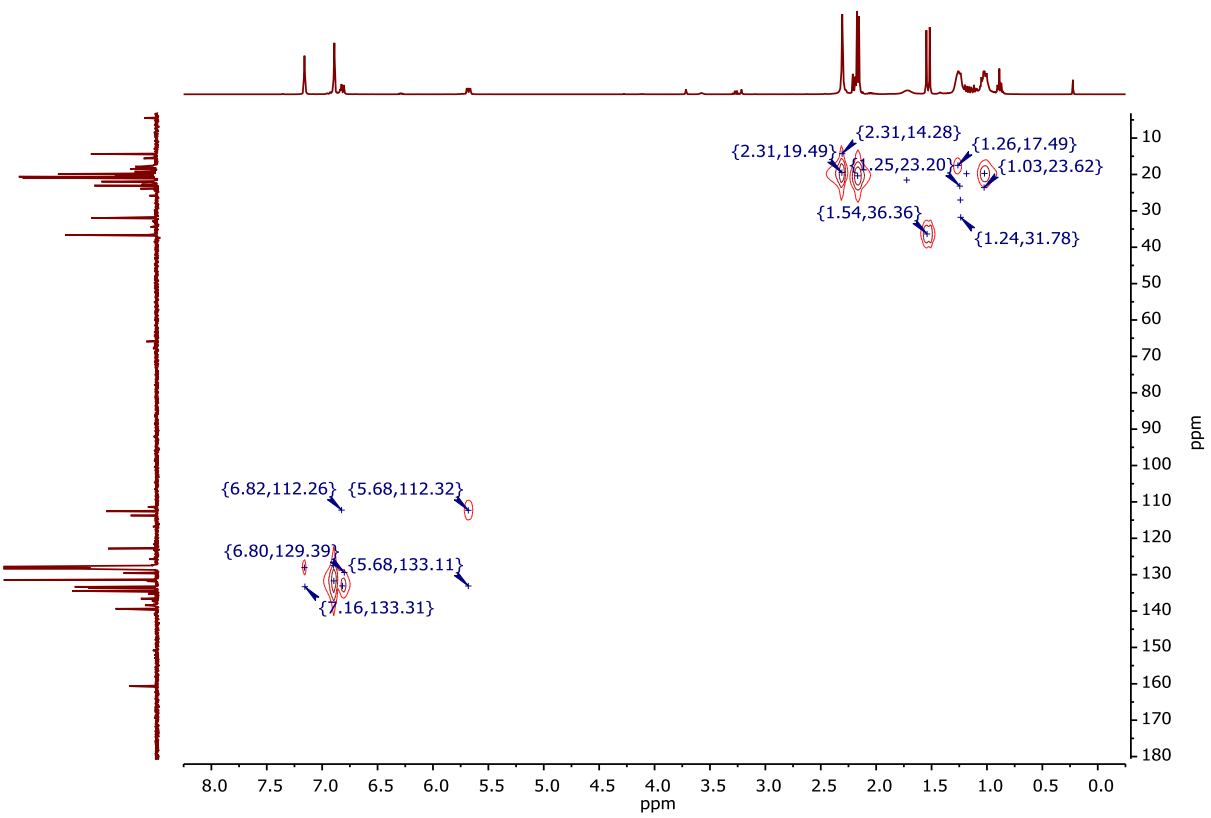



*Figure S 14:* *$^{1}$H–$^{13}$C HMBC NMR spectrum of **1c** in $C_6D_6$ (303 K).*

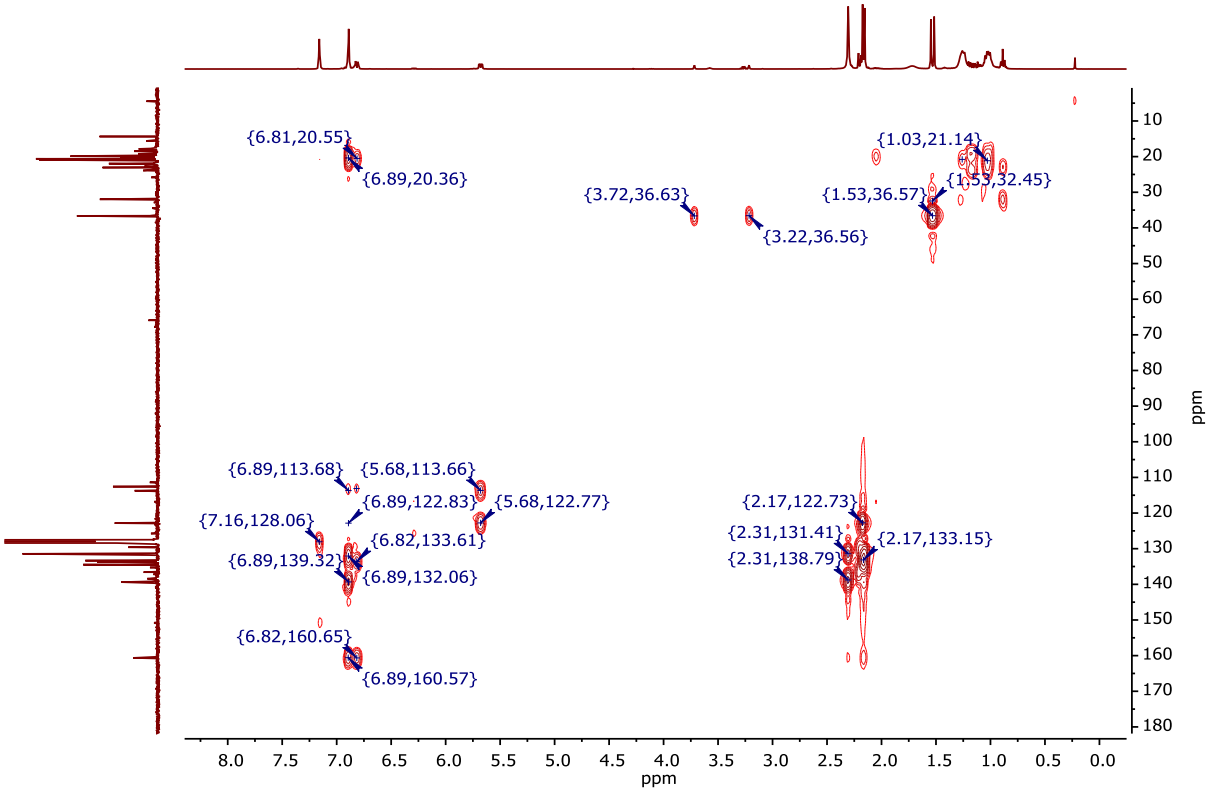



*Figure S 15:* *$^{1}H$–$^{13}C$ HMBC NMR spectrum of **1c** in $C_6D_6$ (303 K).*

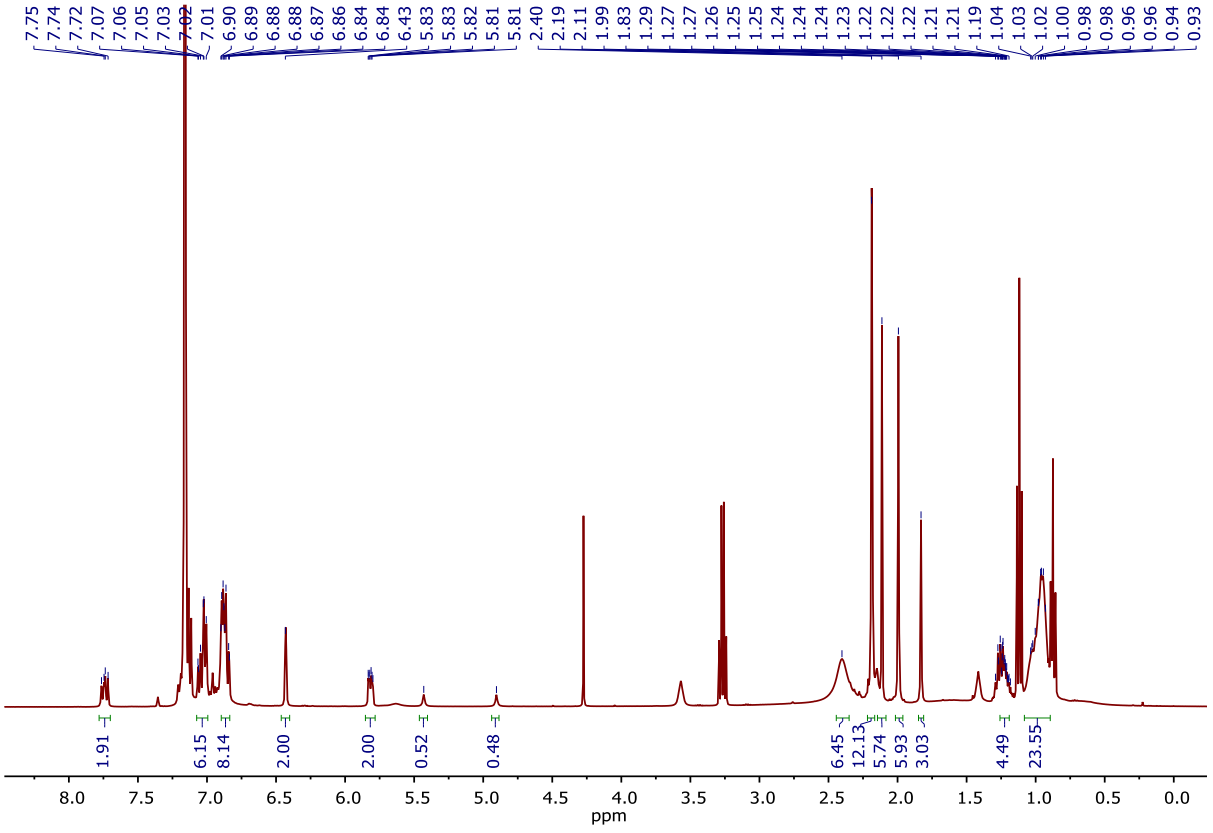



*Figure S 16:* *$^{1}H$ NMR spectrum of **2a** in $C_6D_6$ (303 K).*

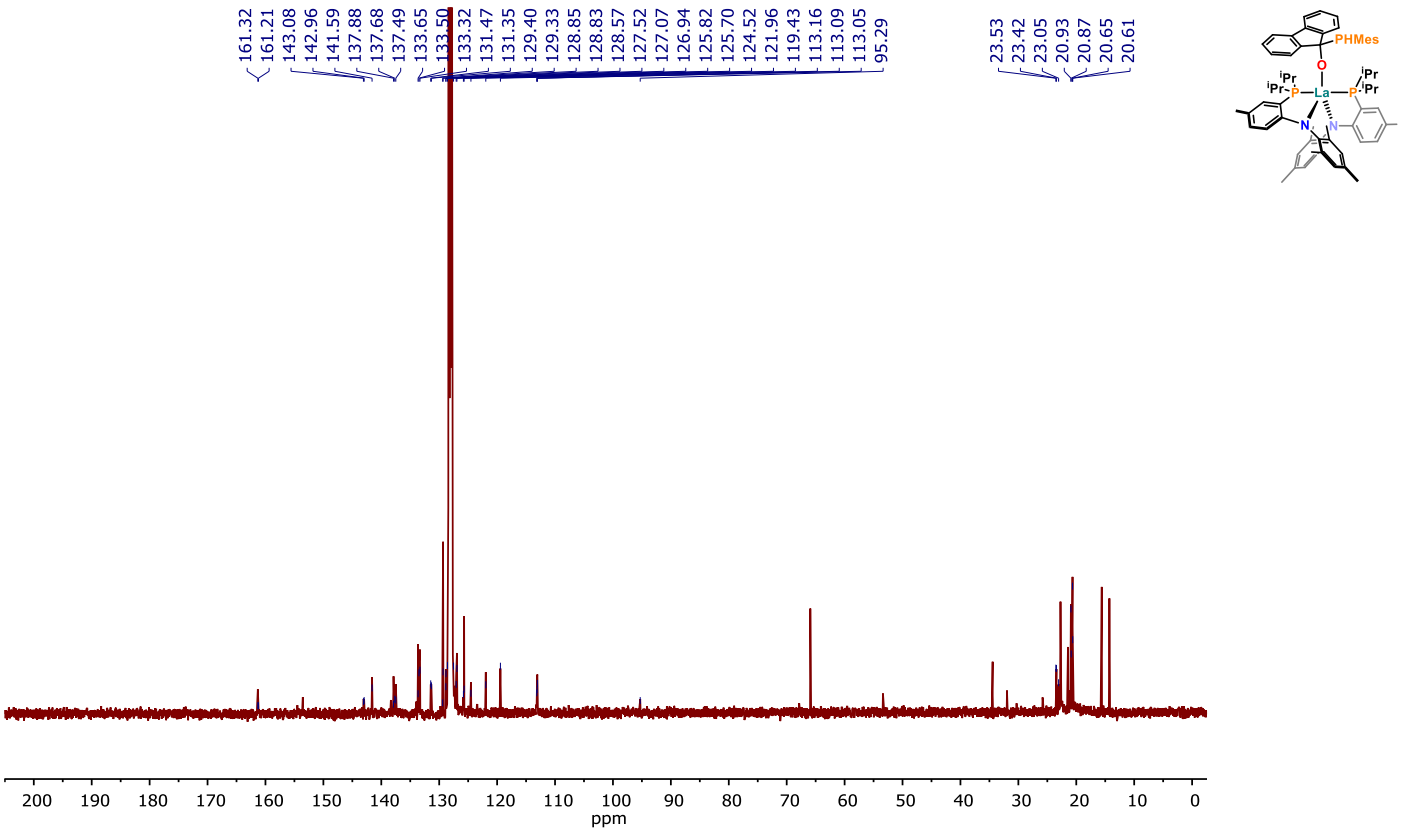
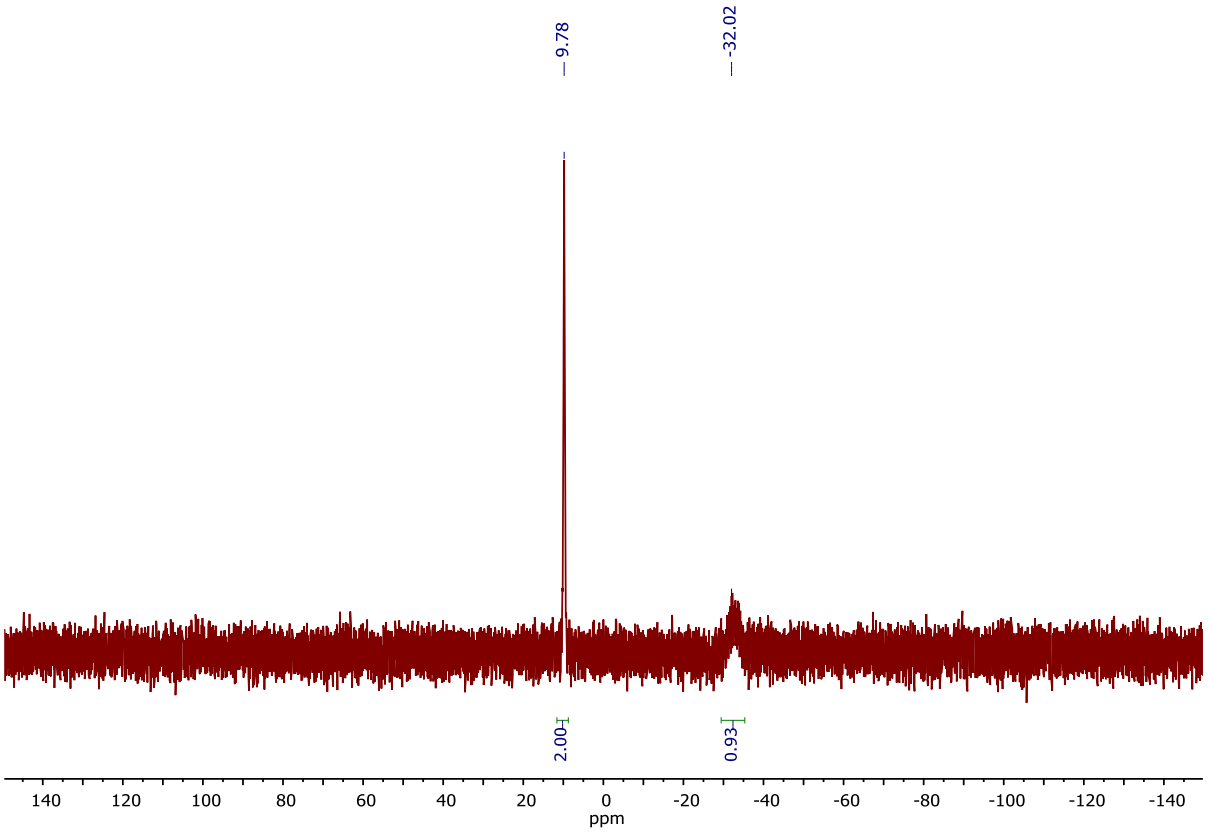






*Figure S 17:* *$^{13}C\{^{1}H\}$ NMR spectrum of **2a** in $C_6D_6$ (303K).*



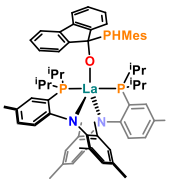
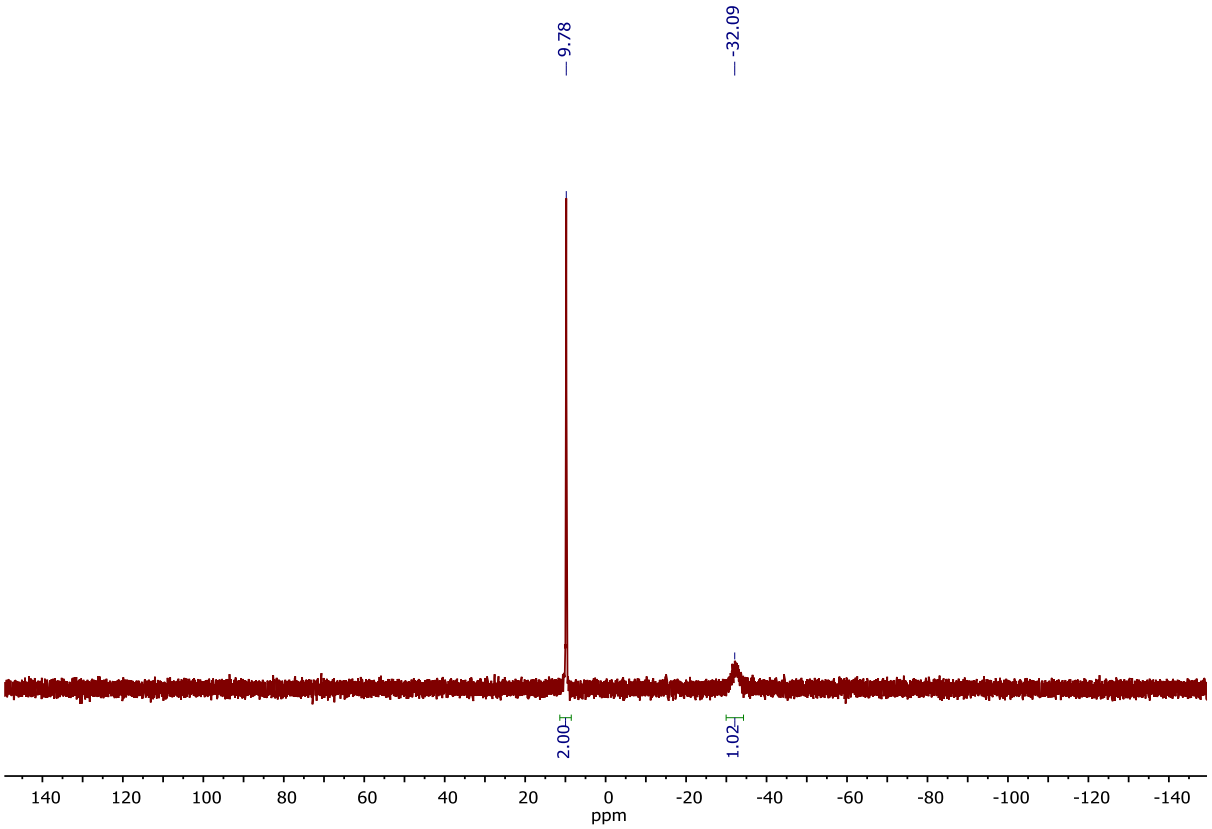




*Figure S 18:* *$^{31}P$ NMR spectrum of **2a** in $C_6D_6$ (303 K).*



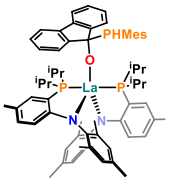
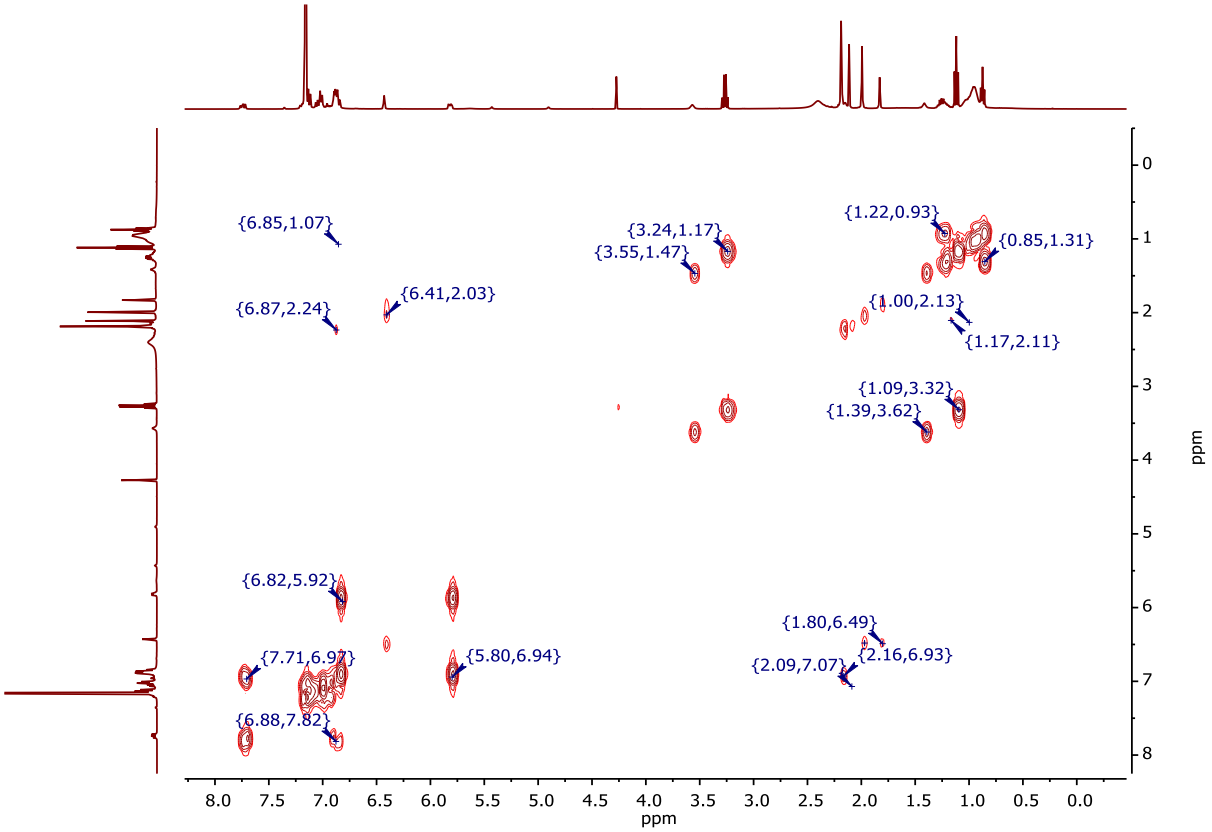




*Figure S 19:* *$^{31}P\{^{1}H\}$ NMR spectrum of **2a** in $C_6D_6$ (303 K).*



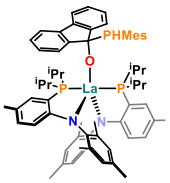
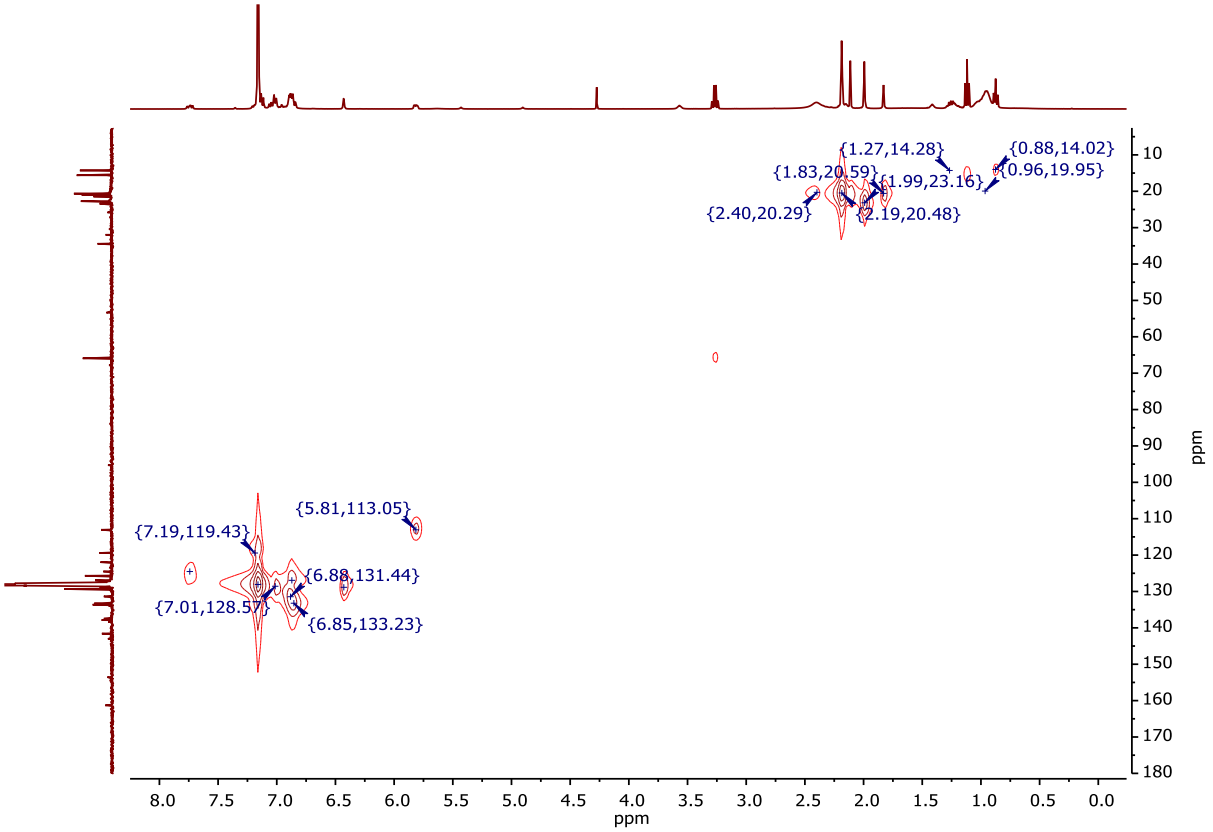




*Figure S 20:* *$^{1}H$–$^{1}H$ COSY NMR spectrum of **2a** in $C_6D_6$ (303 K).*



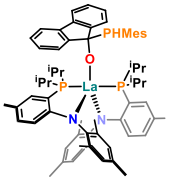
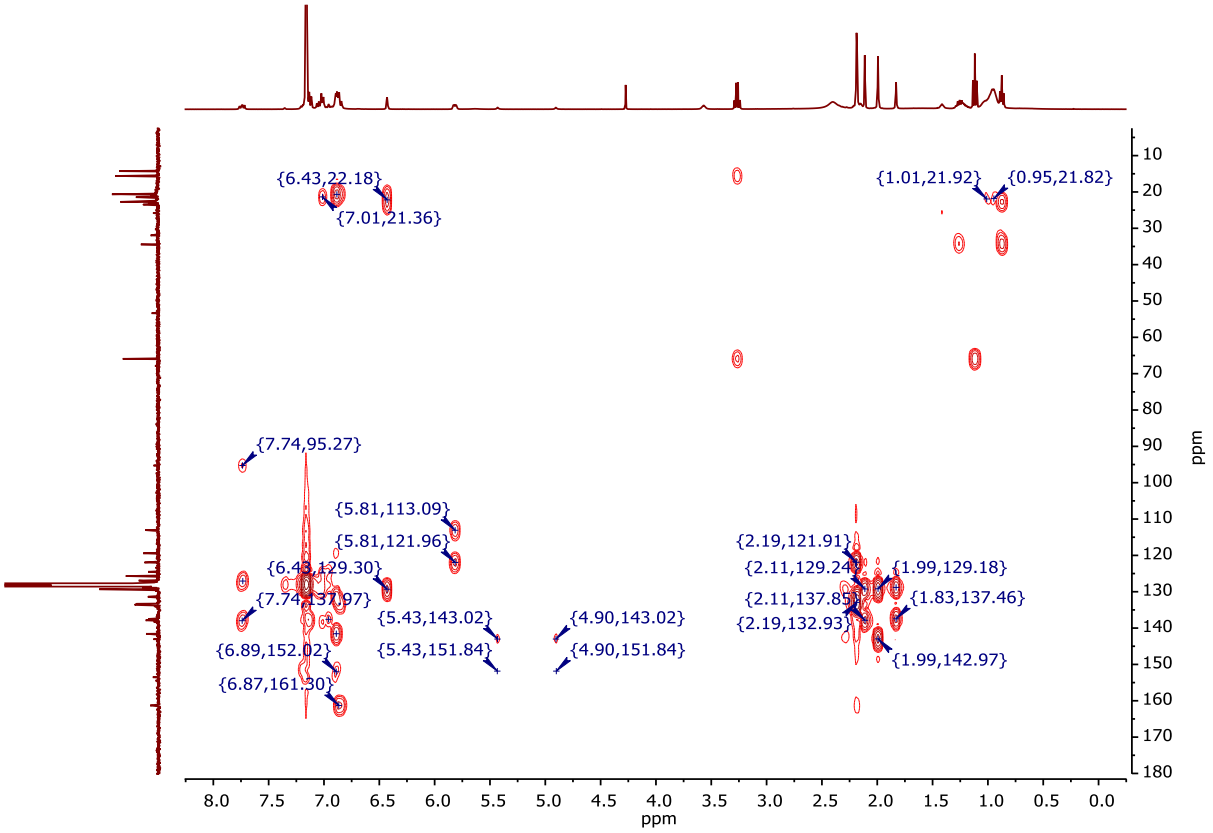




*Figure S 21:* *$^{1}H$–$^{13}C$ HSQC NMR spectrum of **2a** in $C_6D_6$ (303 K).*



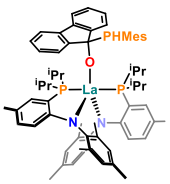
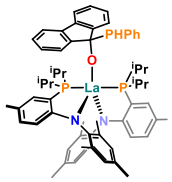




*Figure S 22:* *$^{1}H$–$^{13}C$ HMBC NMR spectrum of **2a** in $C_6D_6$ (303 K).*



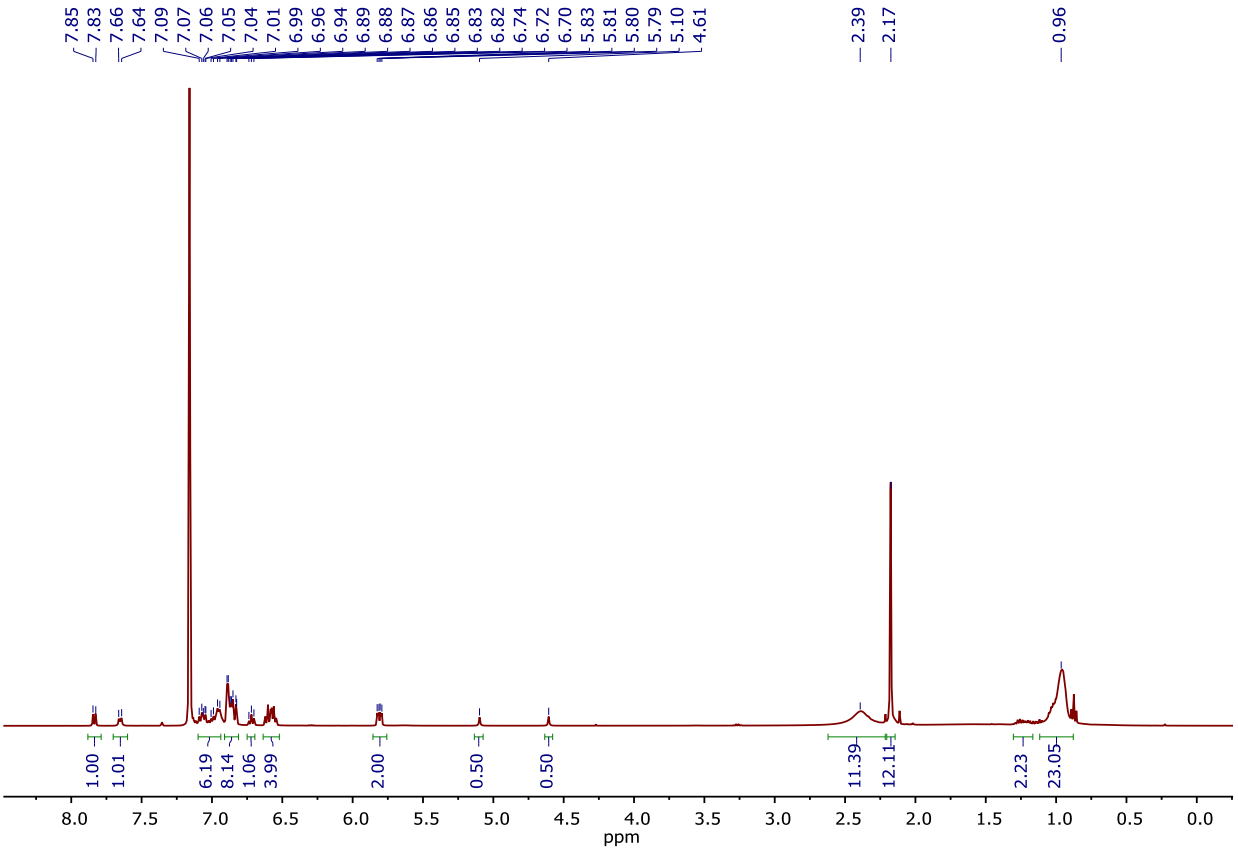
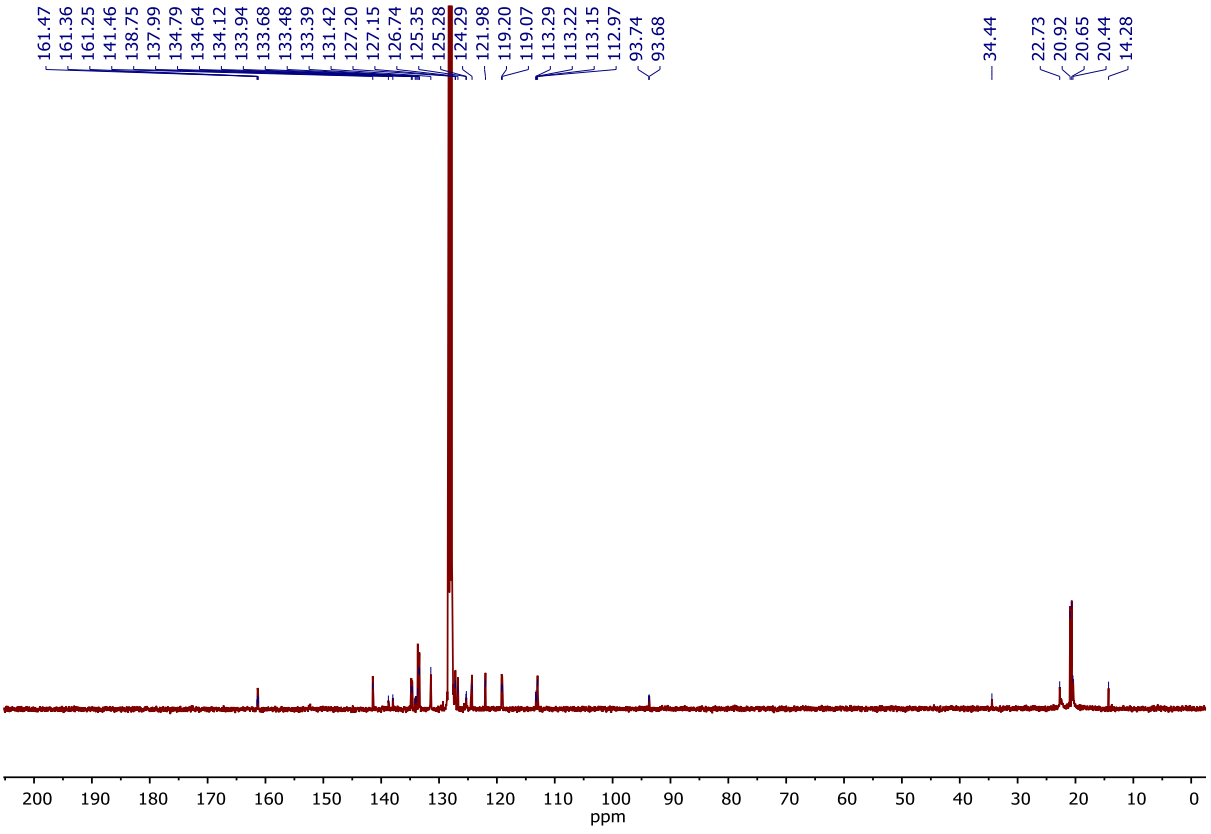




*Figure S 23:* *$^{1}$H NMR of **2b** in $C_6D_6$ (303 K).*



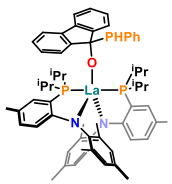
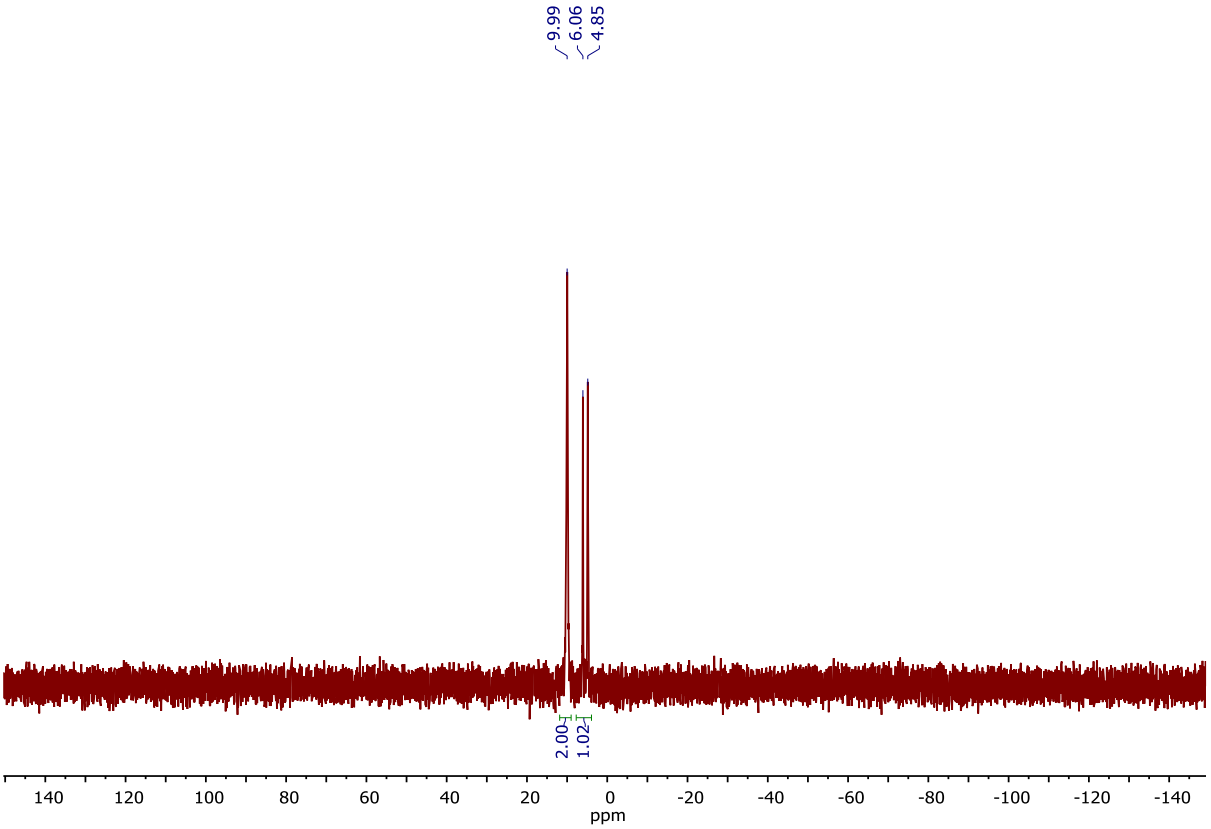




*Figure S 24:* *$^{13}C\{^{1}H\}$ NMR of **2b** in $C_6D_6$ (303 K).*



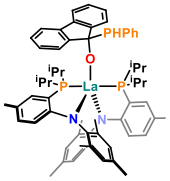
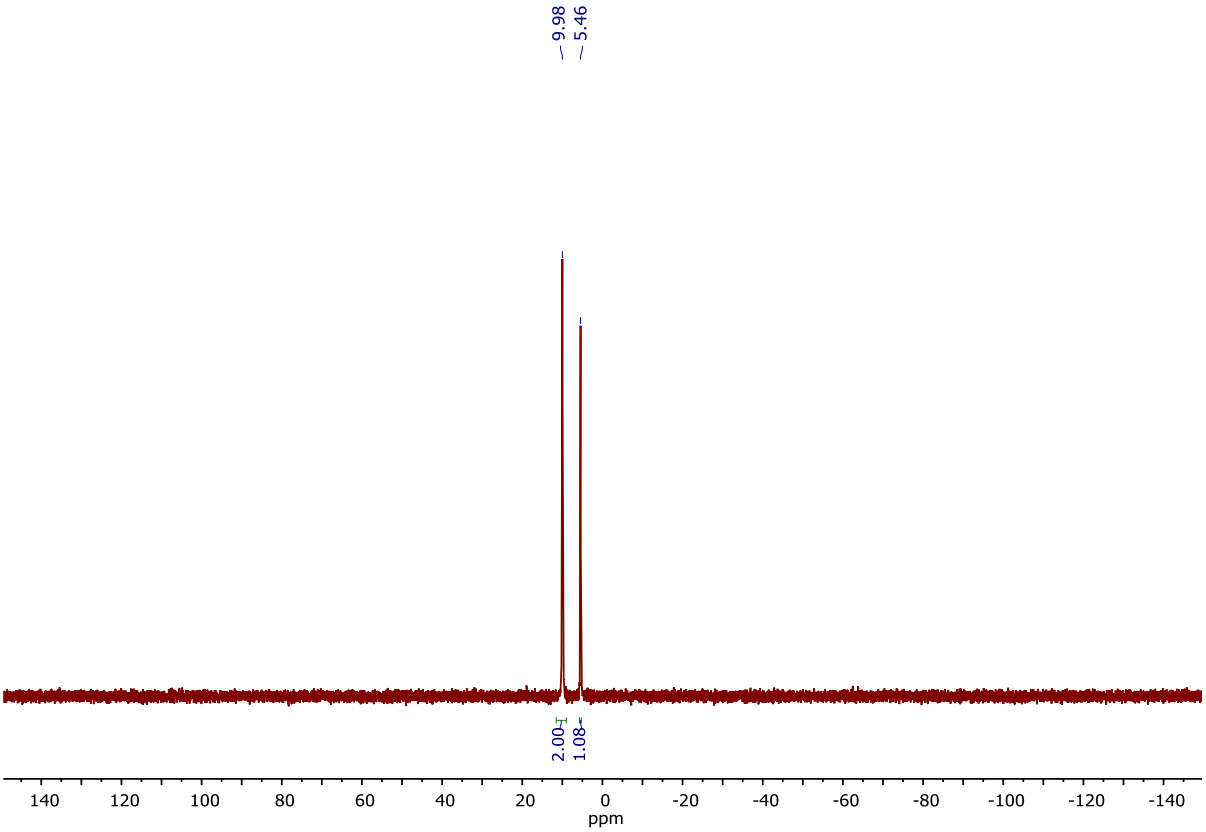




*Figure S 25:* *$^{31}P$ NMR of **2b** in $C_6D_6$ (303 K).*



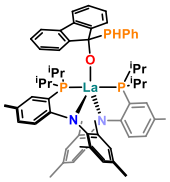




*Figure S 26:* *$^{31}P\{^1H\}$ NMR of **2b** in $C_6D_6$ (303 K).*

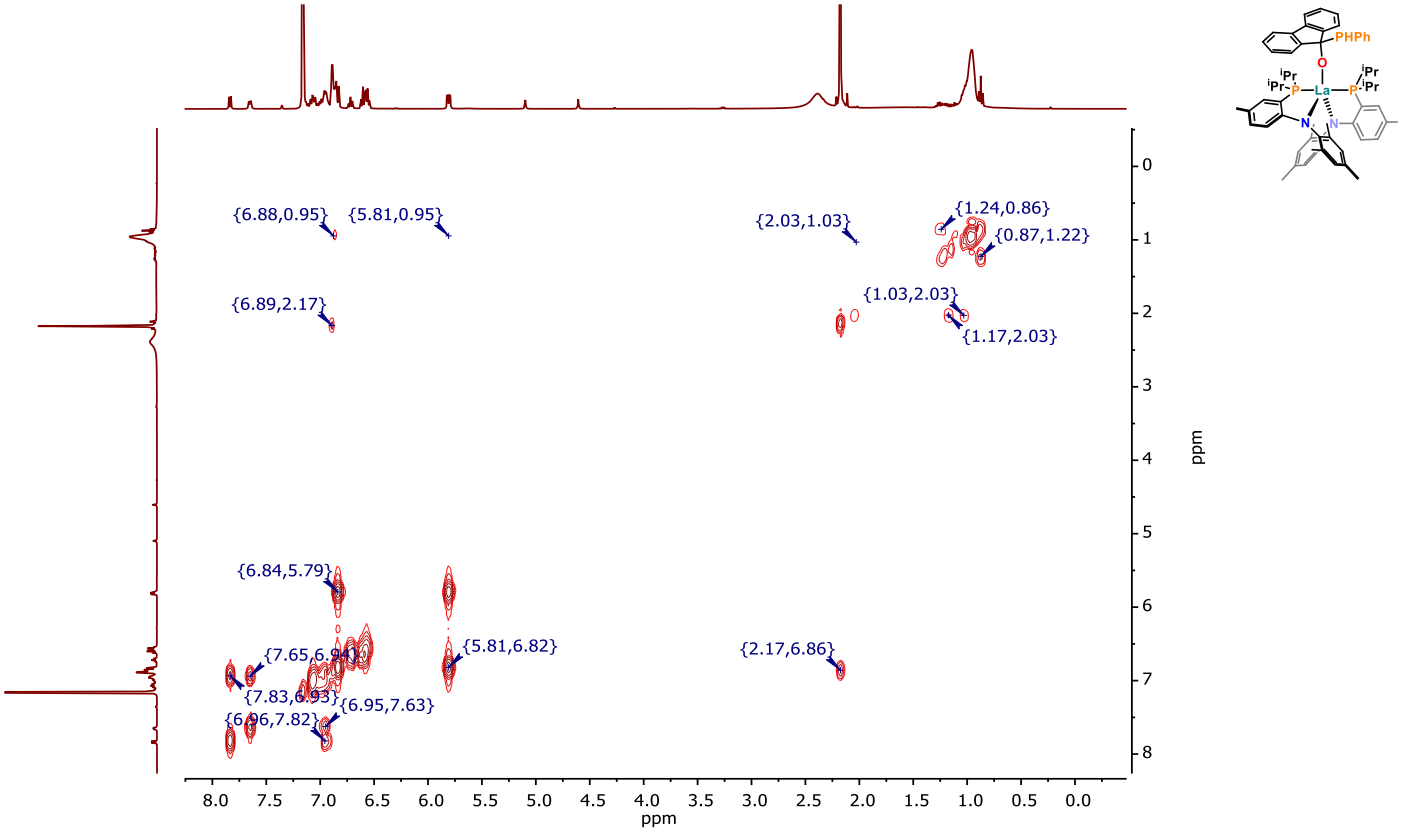



*Figure S 27:* *$^{1}$H–$^{1}$H COSY NMR spectrum of **2b** in $C_6D_6$ (303 K).*

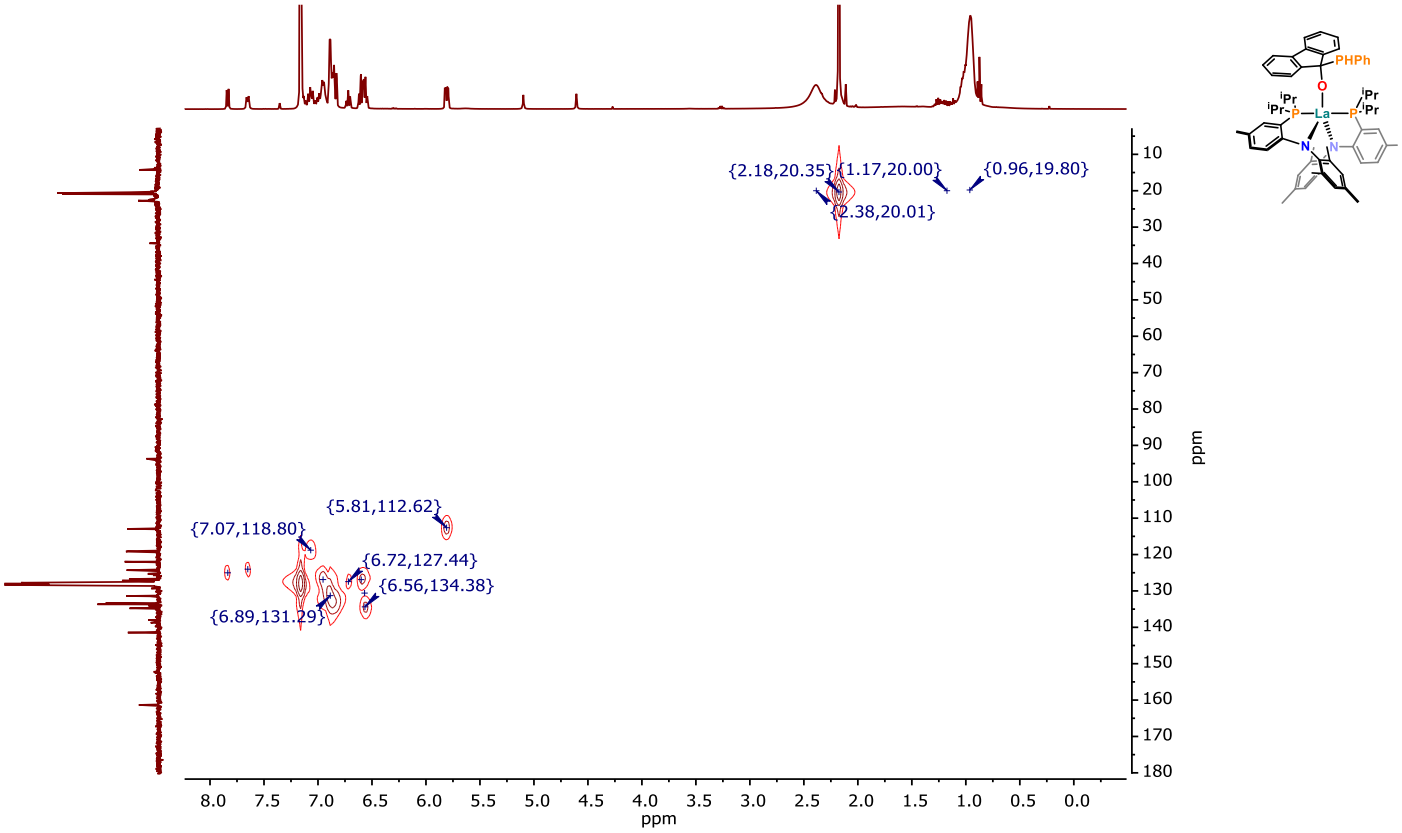
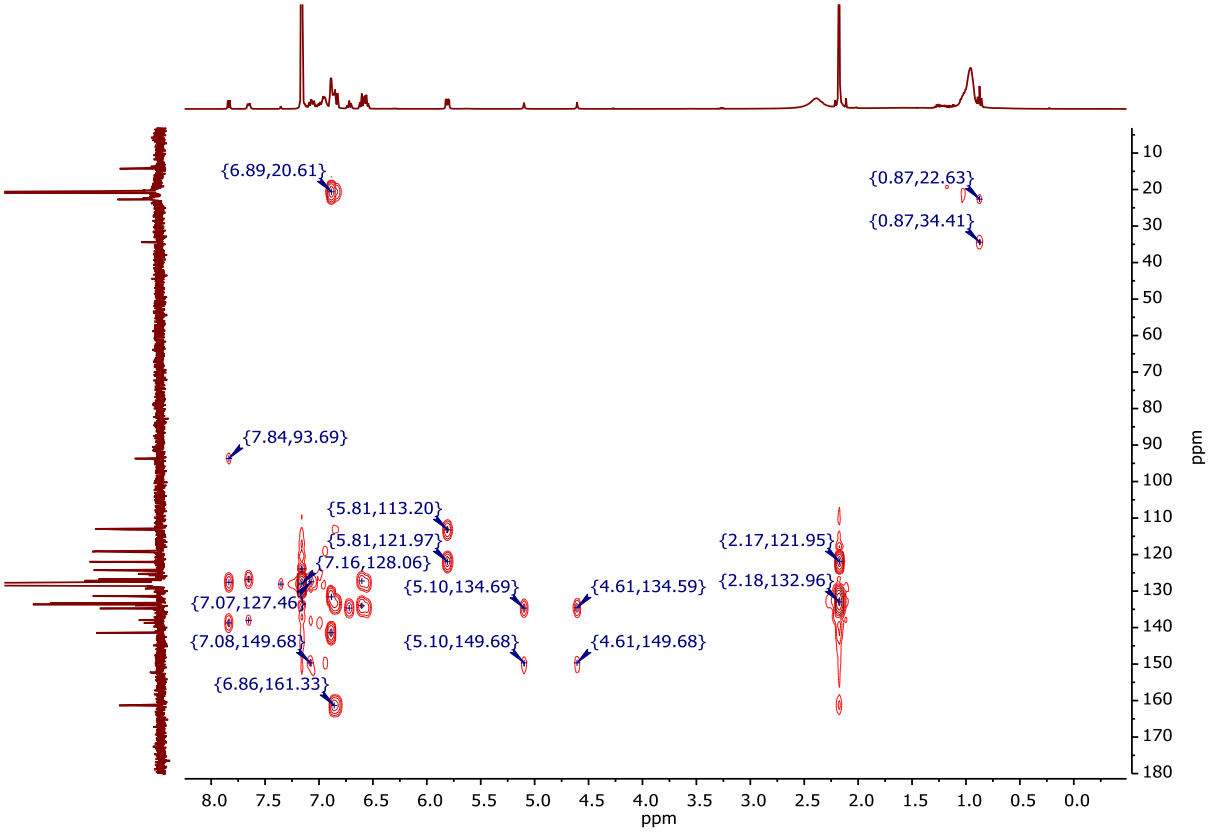



*Figure S 28:* *$^{1}$H–$^{13}$C HSQC NMR spectrum of **2b** in $C_6D_6$ (303 K).*



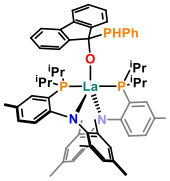
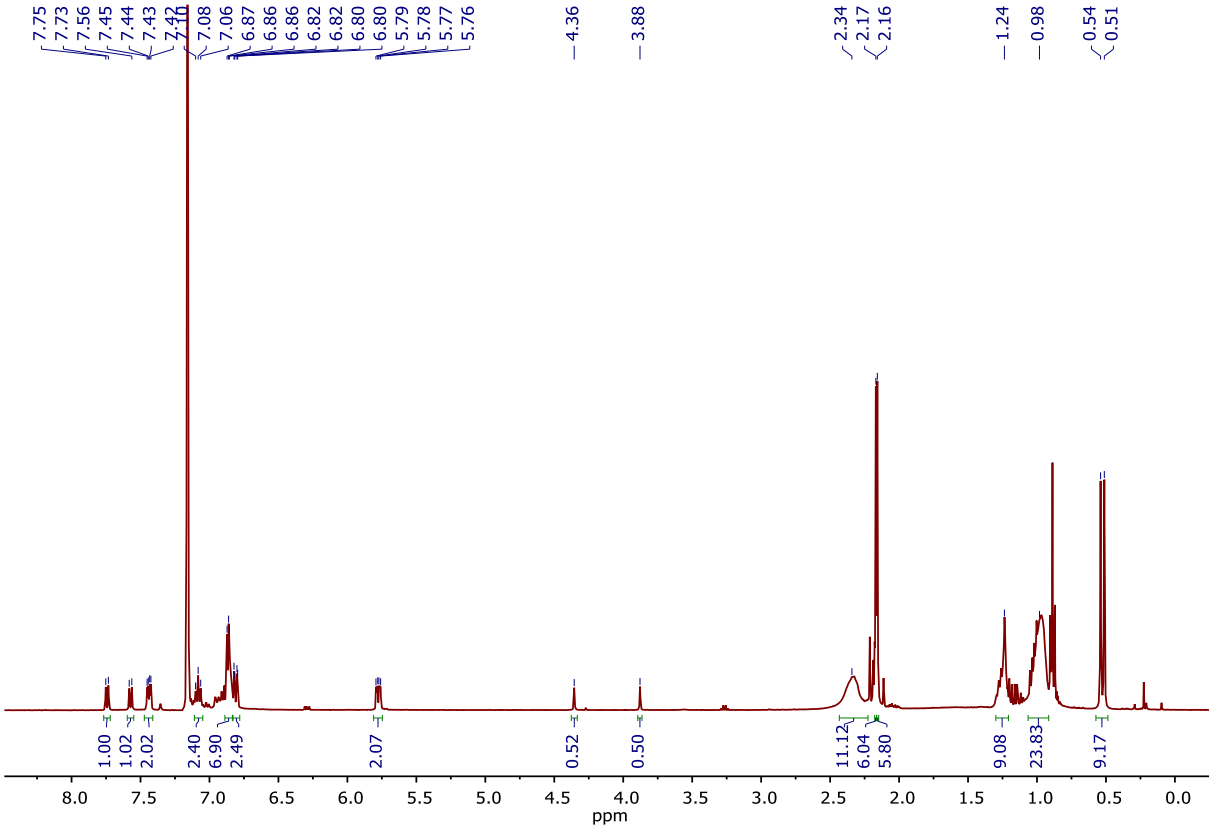




*Figure S 29:* *$^{1}H$–$^{13}C$ HMBC NMR spectrum of **2b** in $C_6D_6$ (303 K).*



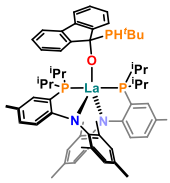
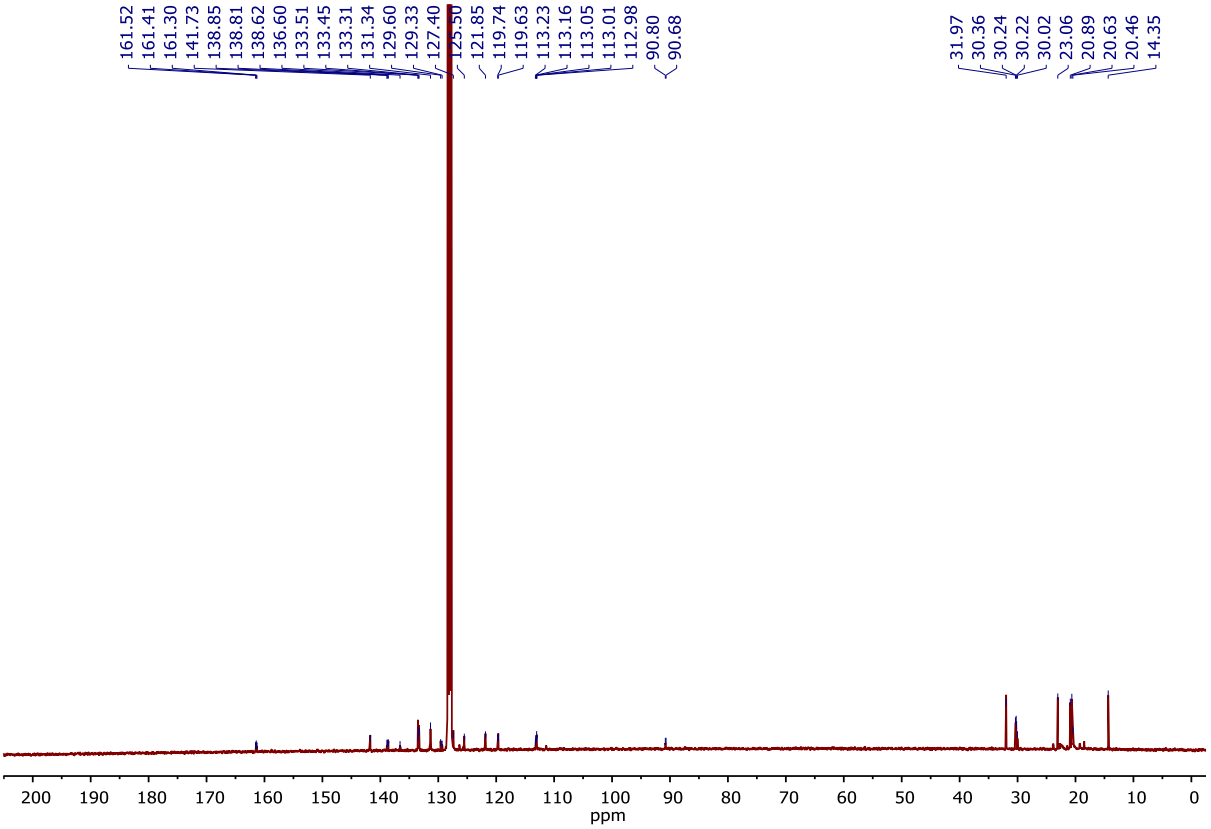




*Figure S 30:* *$^{1}H$ NMR spectrum of **2c** in $C_6D_6$ (303 K).*



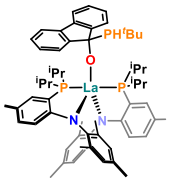
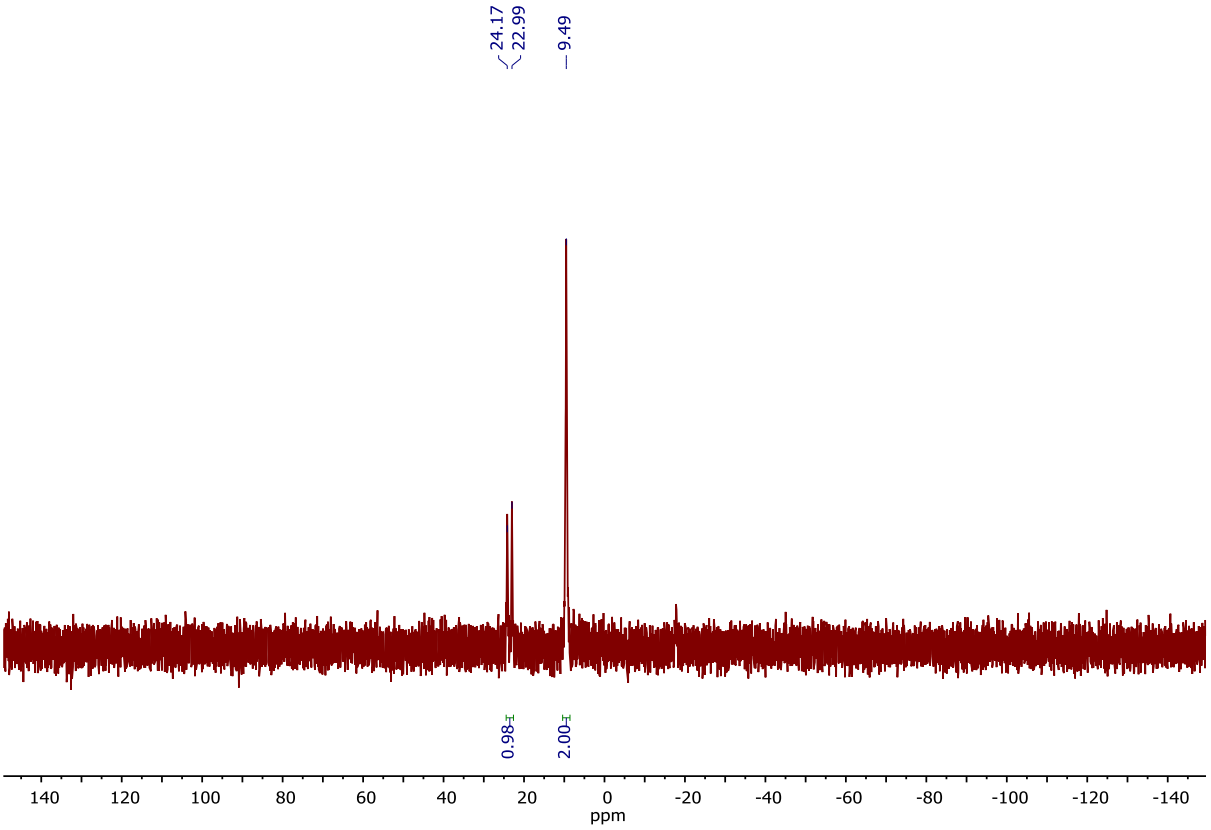




*Figure S 31:* *$^{13}C\{^1H\}$ NMR spectrum of **2c** in $C_6D_6$ (303 K).*



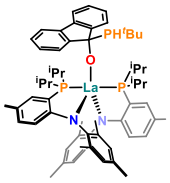




*Figure S 32:* *$^{31}P$ NMR spectrum of **2c** in $C_6D_6$ (303 K). The peak at -17 ppm results from a small impurity of HPN.*

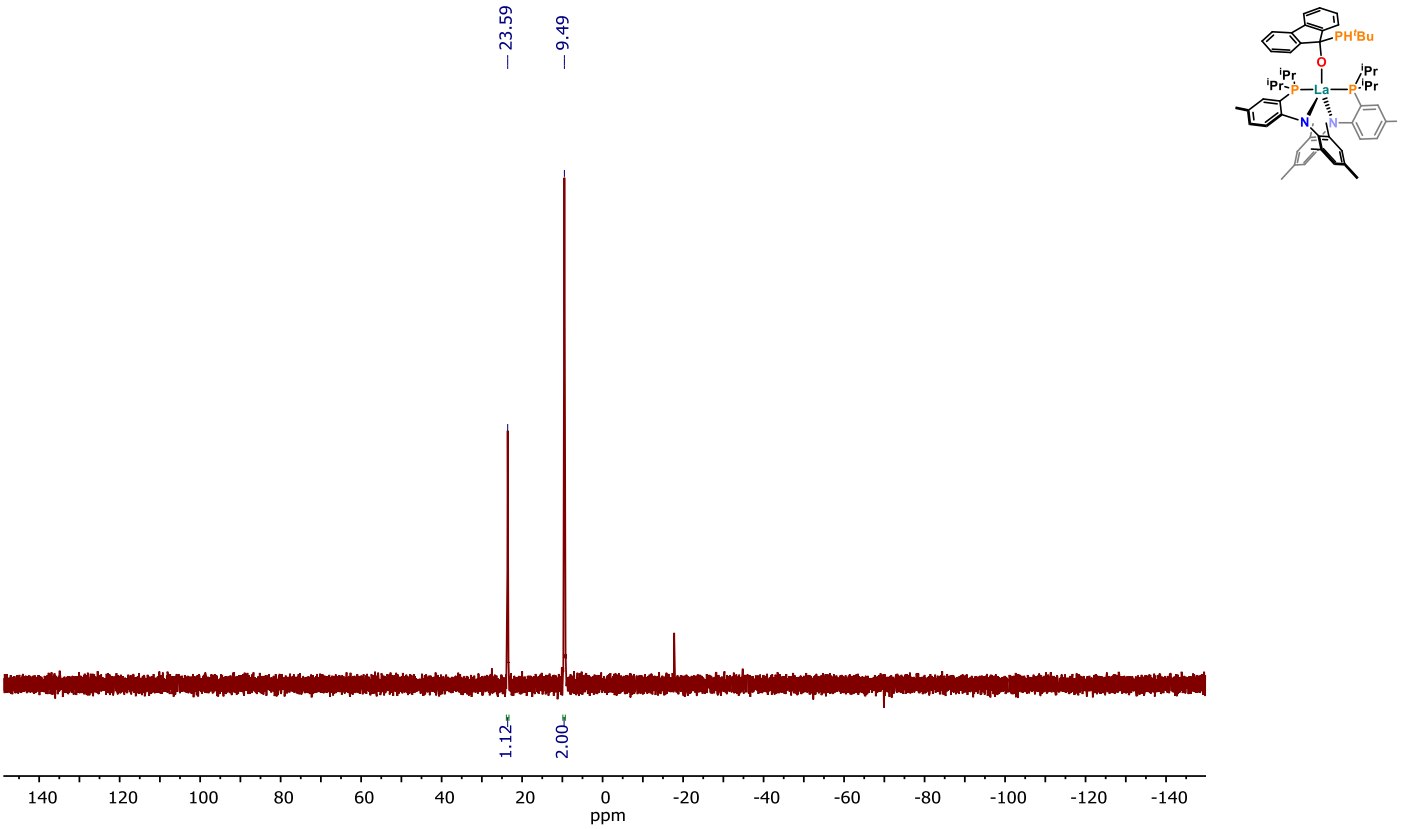



*Figure S 33:* *$^{31}P\{^{1}H\}$ NMR spectrum of **2c** in $C_6D_6$ (303 K). The peak at -17 ppm results from a small impurity of HPN.*

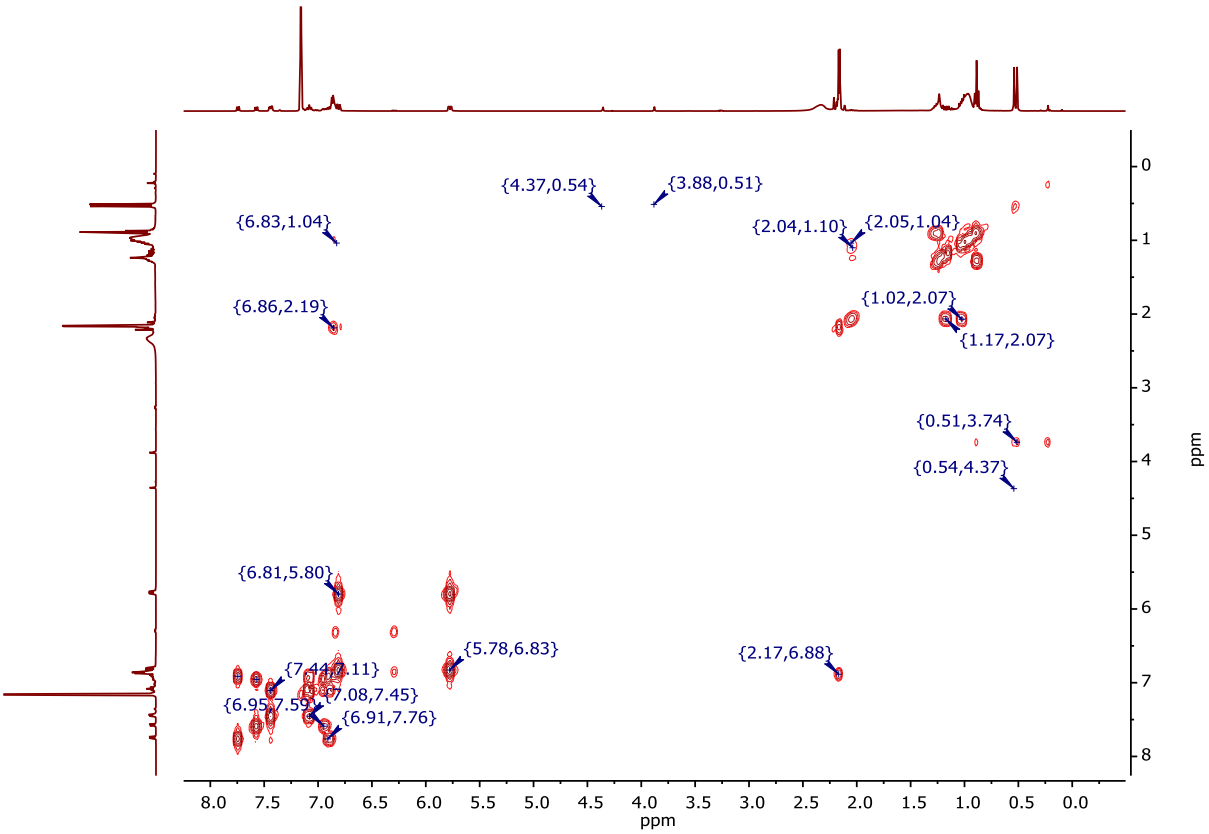



*Figure S 34:* *$^{1}H$–$^{1}H$ COSY NMR spectrum of **2c** in $C_6D_6$ (303 K).*

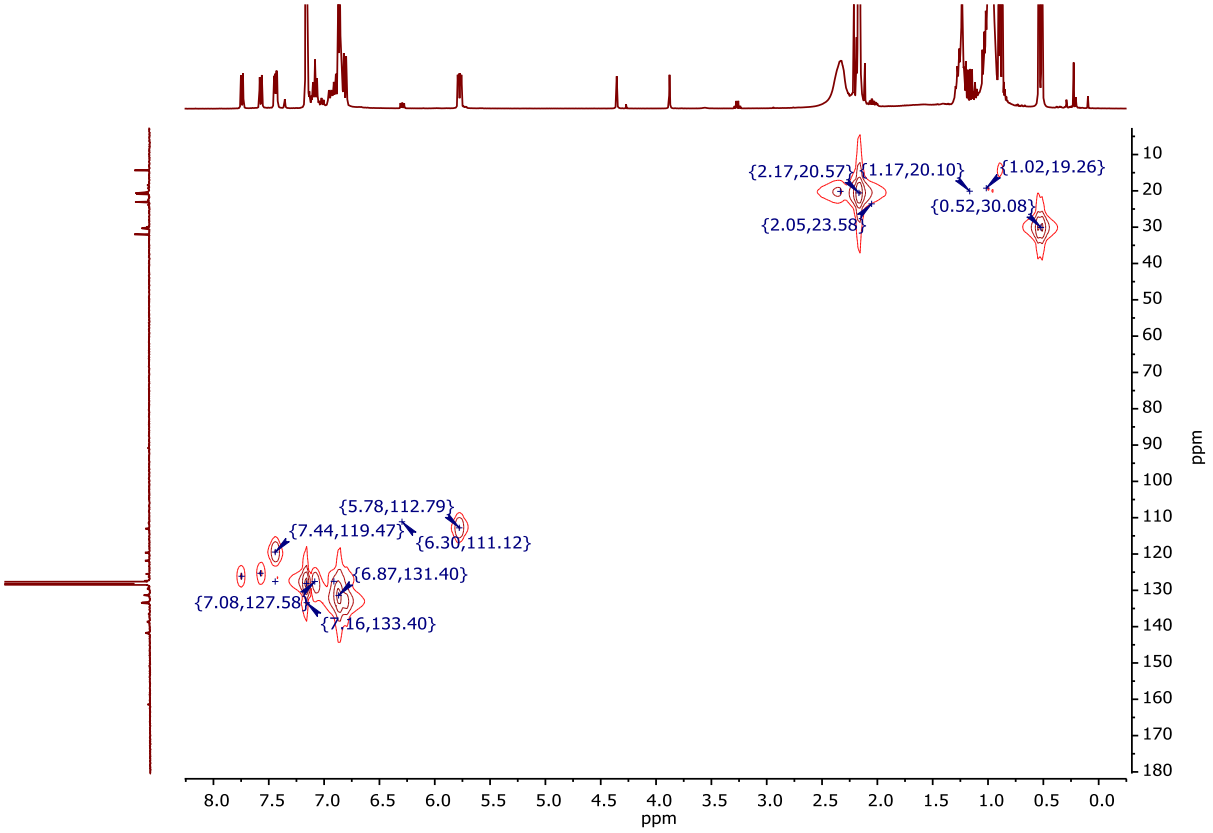



*Figure S 35:* *$^{1}H$–$^{13}C$ HSQC NMR spectrum of **2c** in $C_6D_6$ (303 K).*

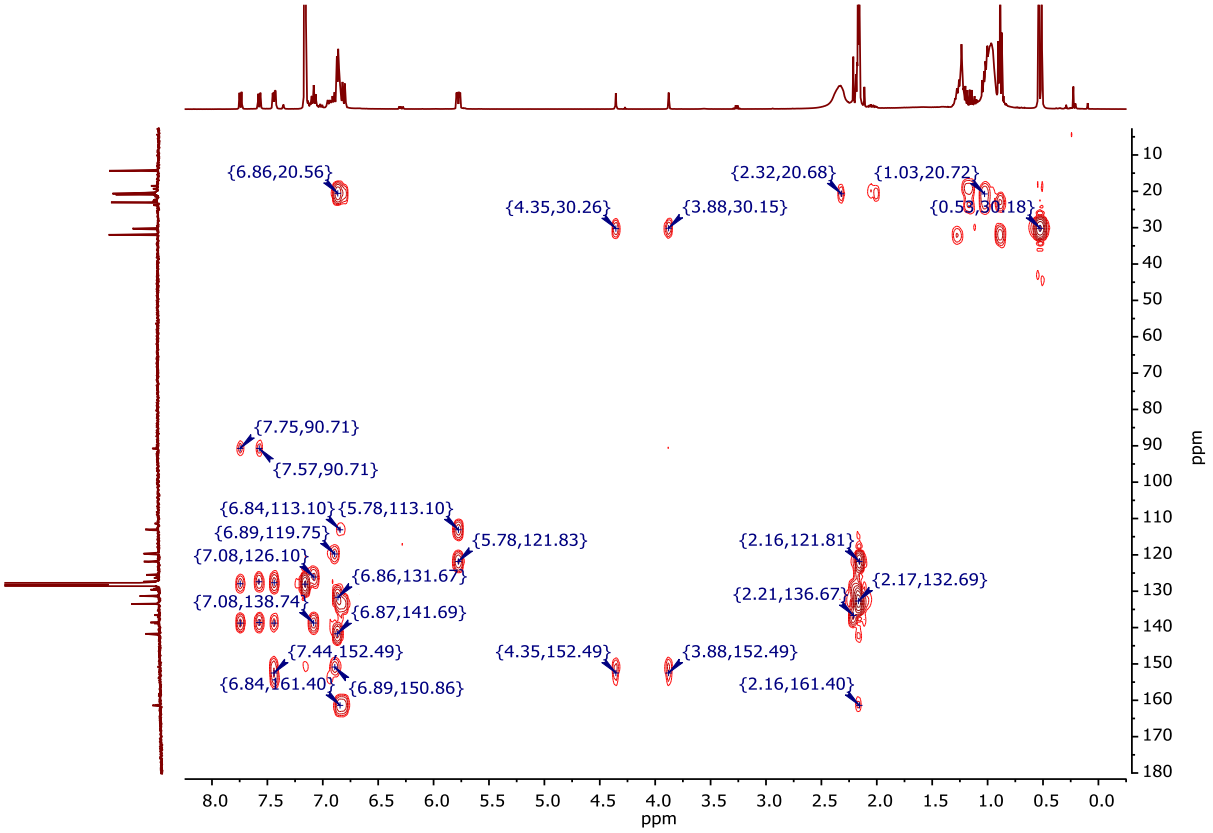



*Figure S 36:* *$^{1}H$–$^{13}C$ HMBC NMR spectrum of **2c** in $C_6D_6$ (303 K).*

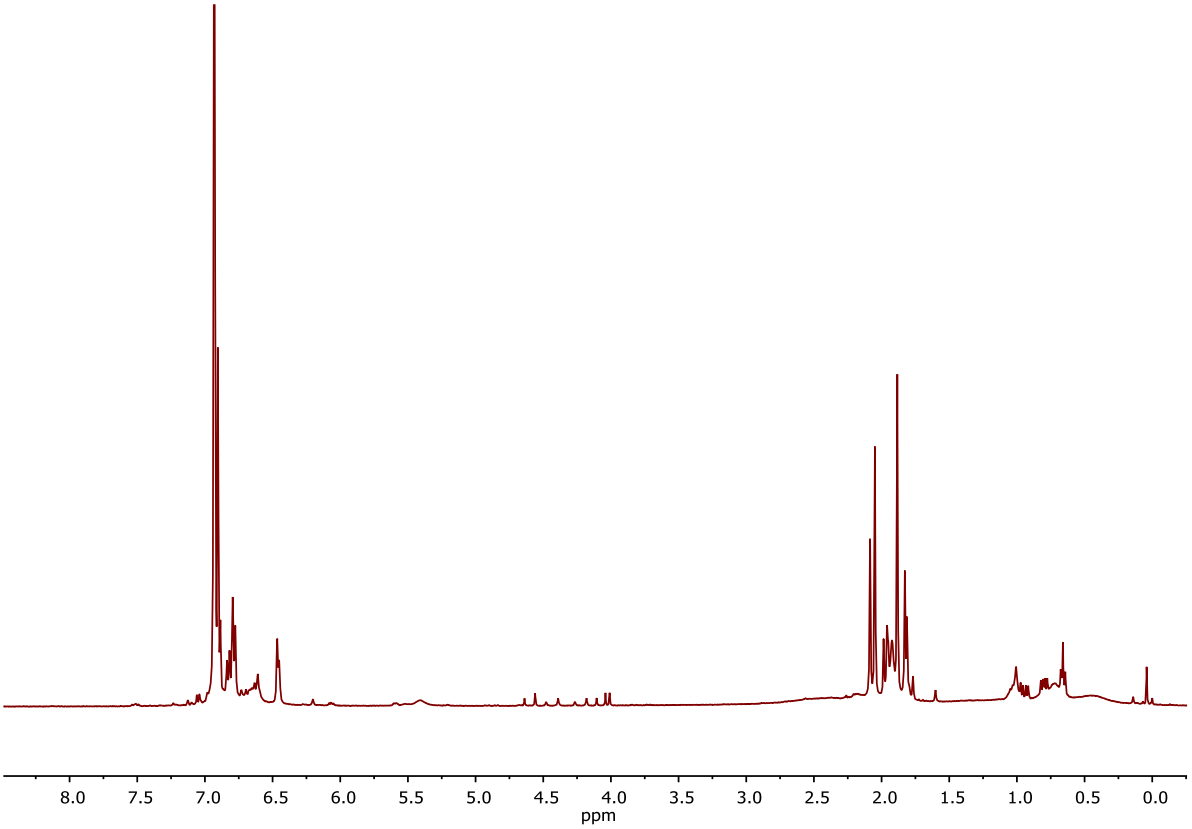



*Figure S 37:* *$^1$H NMR spectrum of **3** in $C_6D_6$ (303 K).*

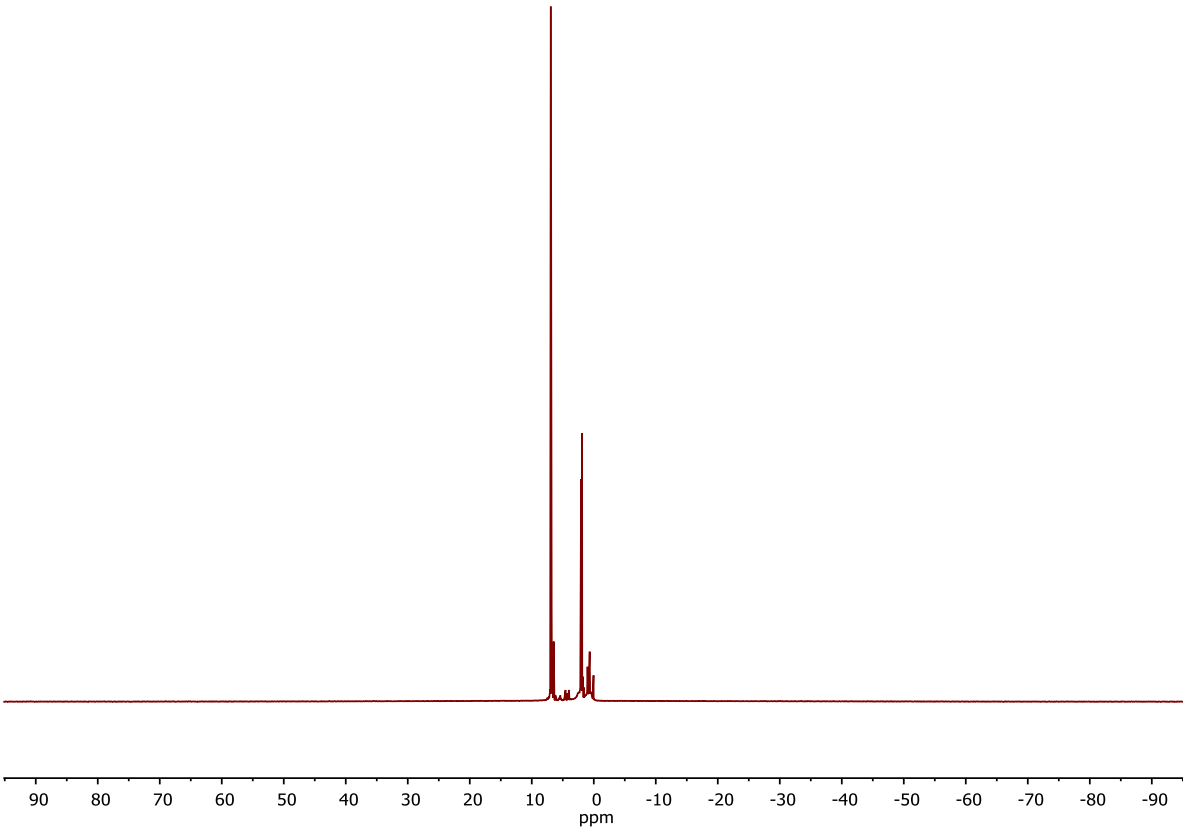



*Figure S 38:* *$^1$H NMR spectrum of **3** in $C_6D_6$ (303 K).*

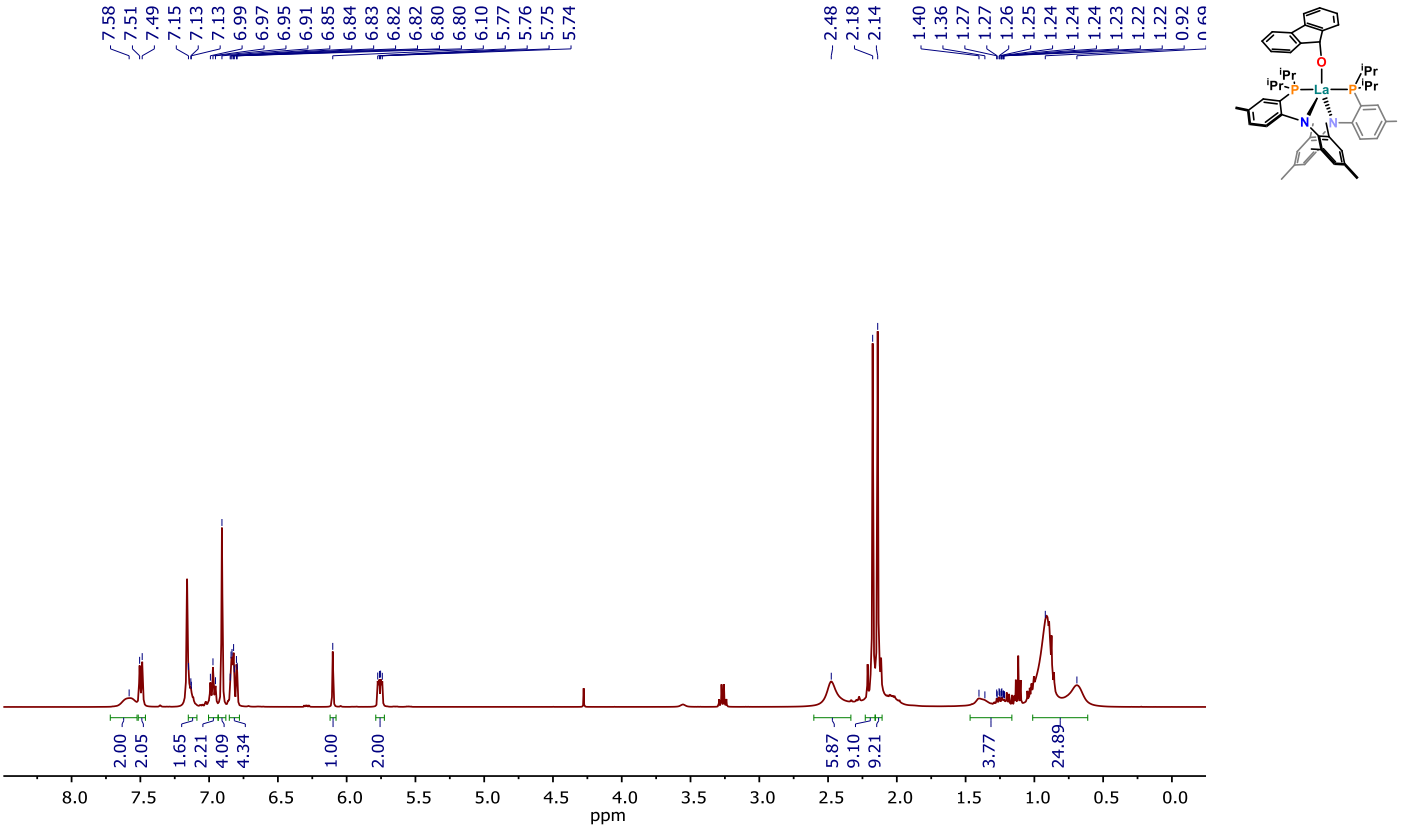



*Figure S 39:* *$^{1}$H NMR spectrum of **4** in $C_6D_6$ (303 K).*

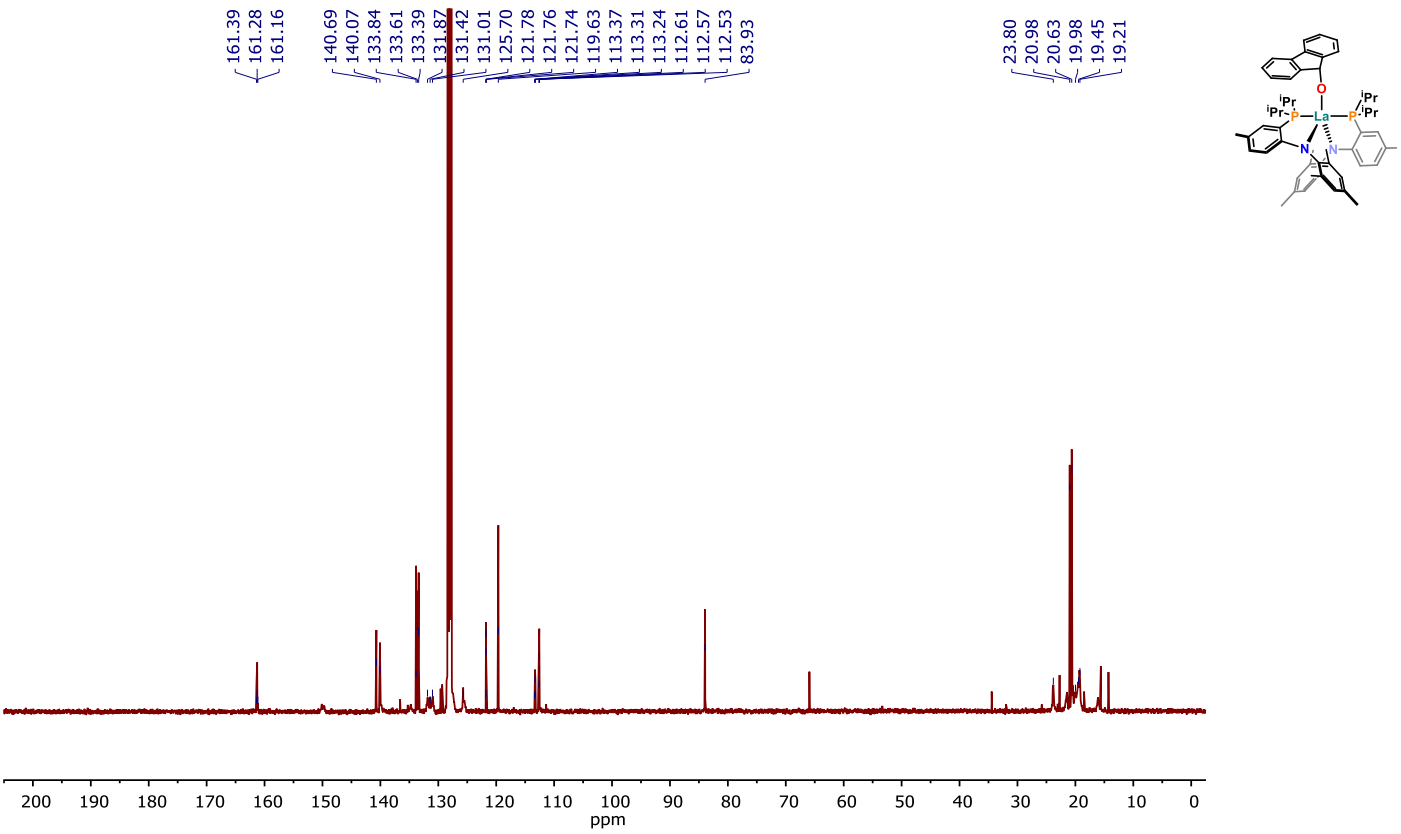



*Figure S 40:* *$^{13}C\{^{1}H\}$ NMR spectrum of **4** in $C_6D_6$ (303 K).*

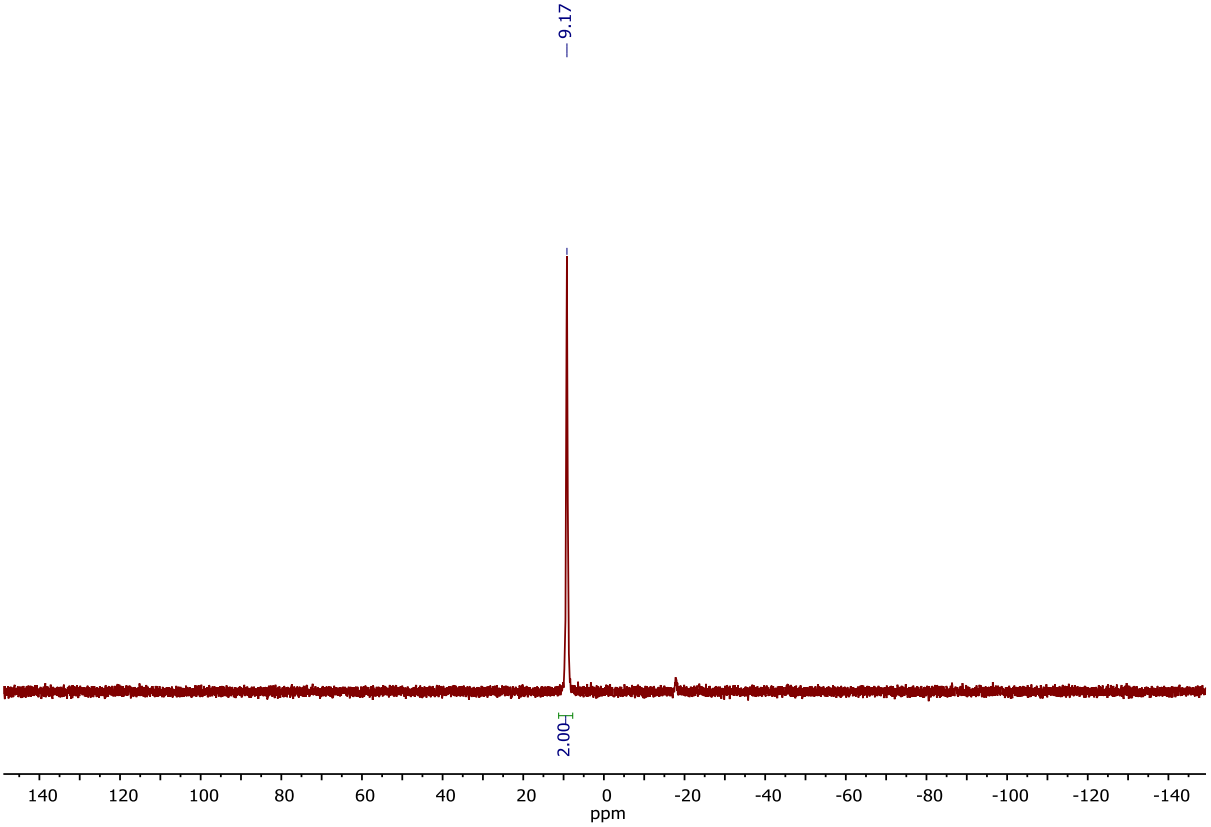



*Figure S 41:* *$^{31}P$ NMR spectrum of **4** in $C_6D_6$ (303 K).*

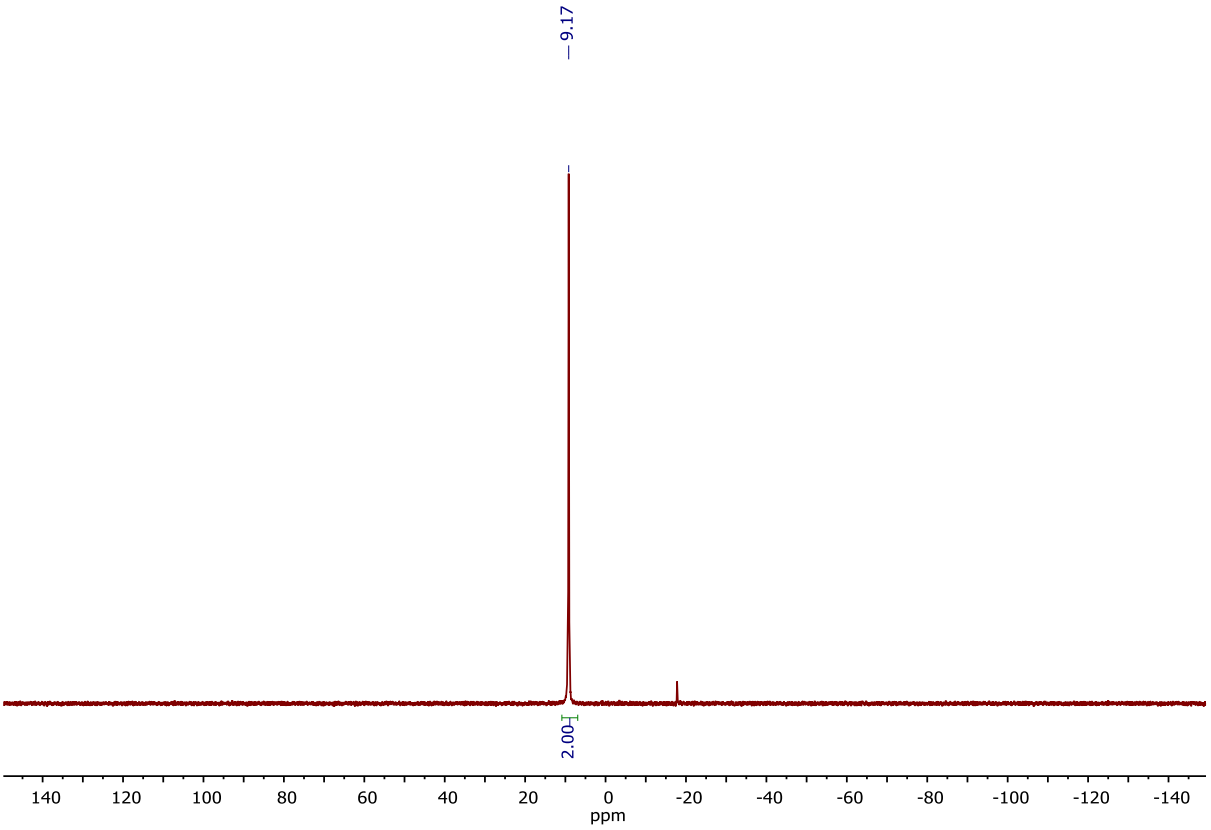



*Figure S 42:* *$^{31}P\{^1H\}$ NMR spectrum of **4** in $C_6D_6$ (303 K). Peak at -17 ppm results from a small impurity of HPN.*

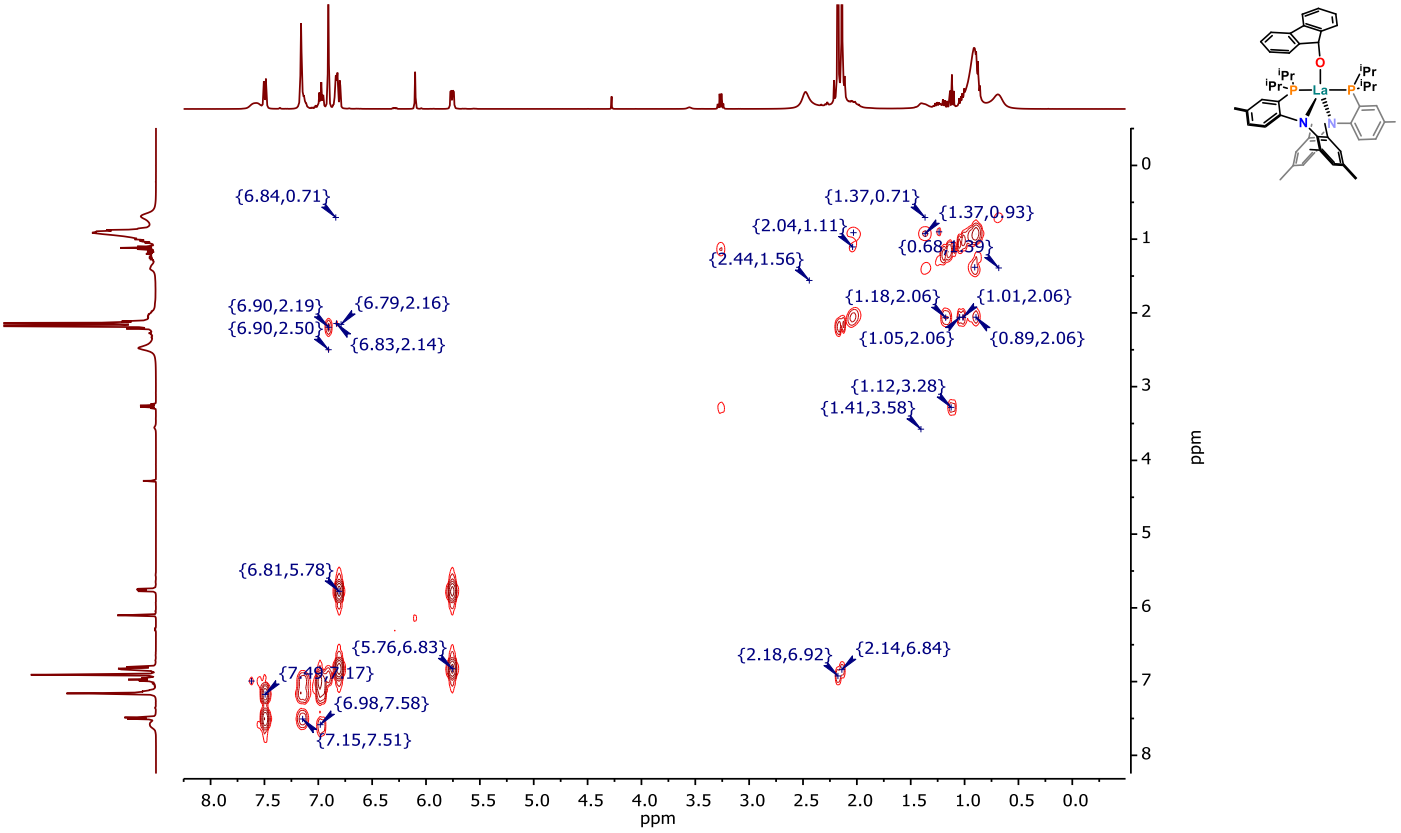



*Figure S 43:* *$^{1}H$–$^{1}H$ COSY NMR spectrum of **4** in $C_6D_6$ (303 K).*

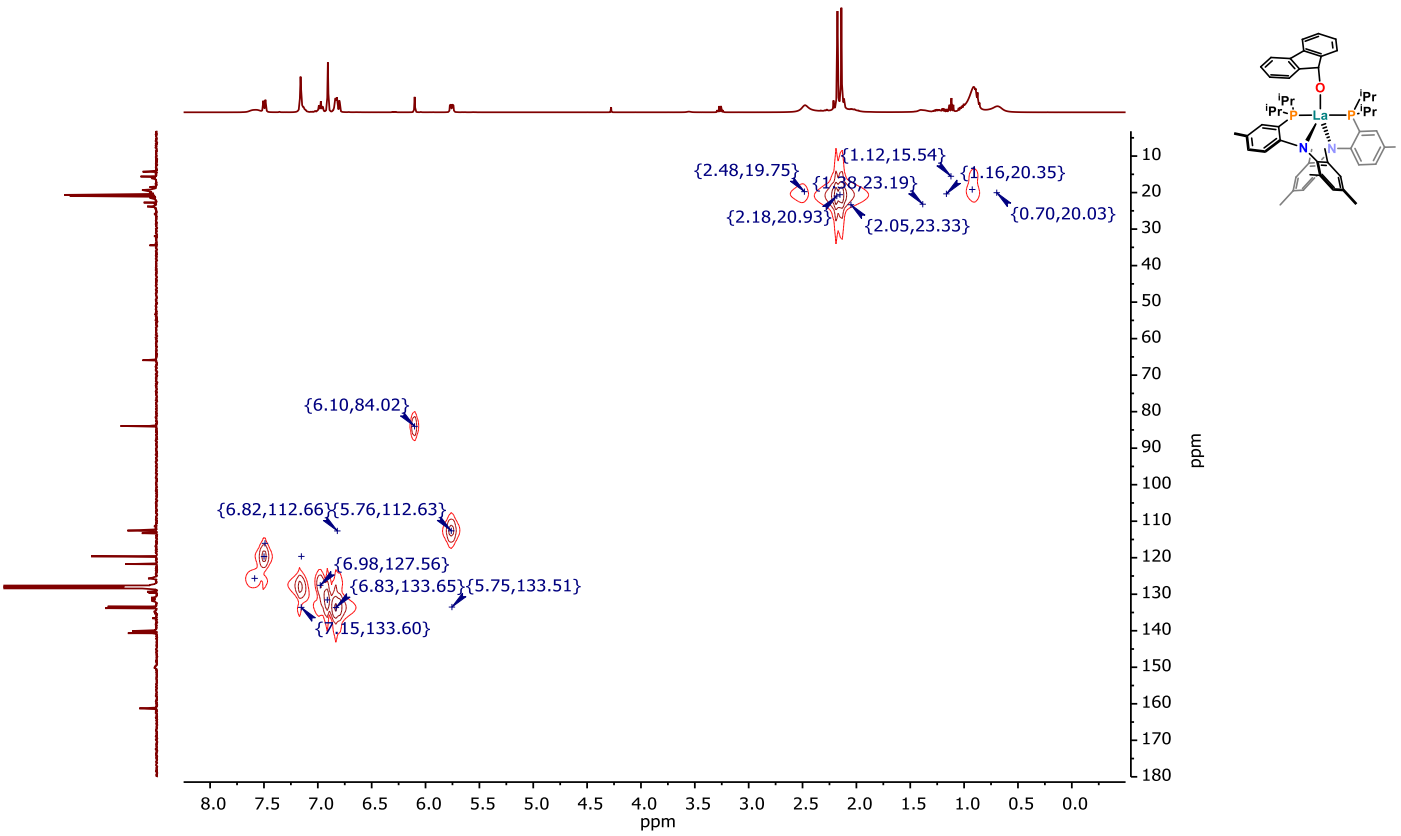



*Figure S 44:* *$^{1}H$–$^{13}C$ HSQC NMR spectrum of **4** in $C_6D_6$ (303 K).*

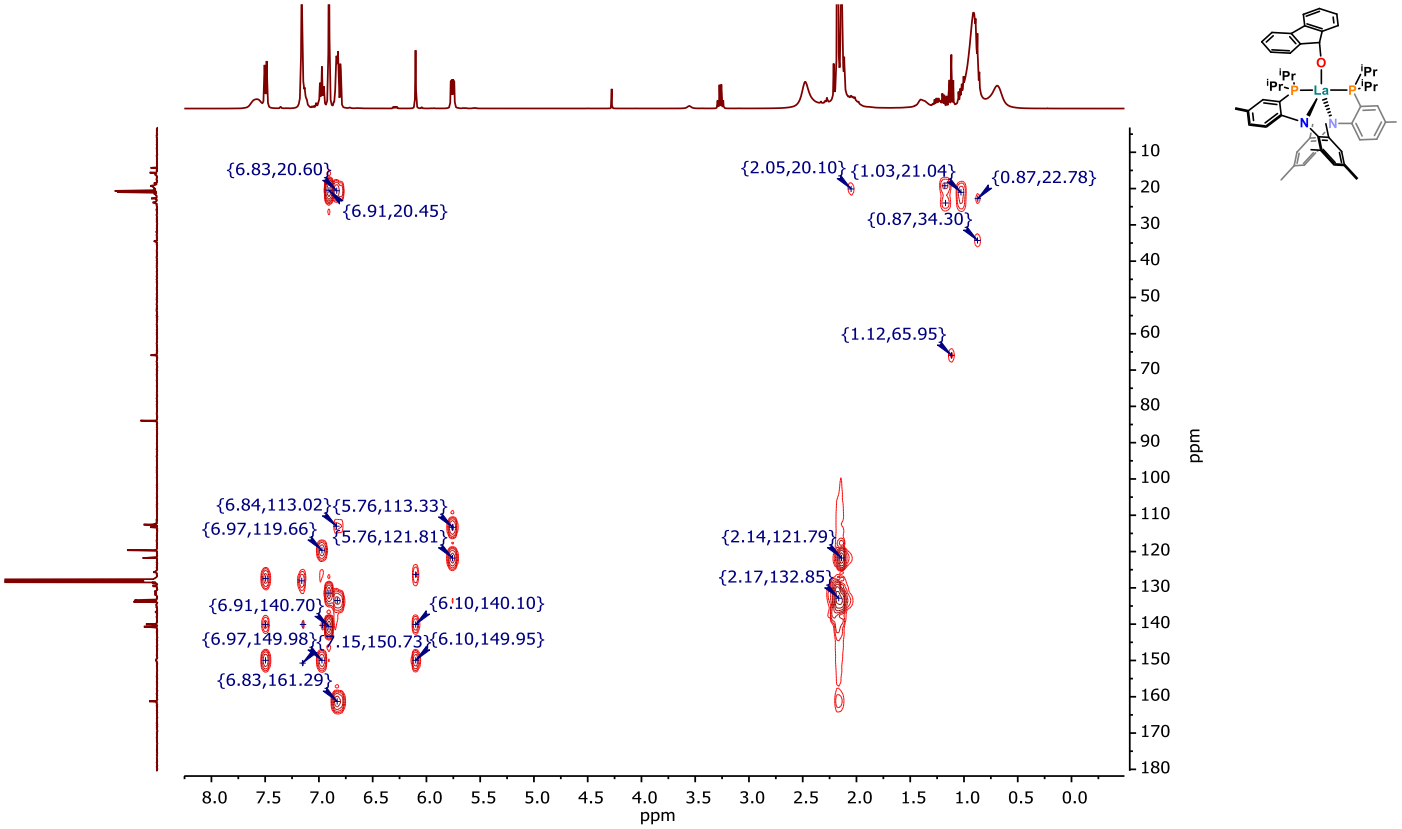



*Figure S 45:* *$^{1}H$–$^{13}C$ HMBC NMR spectrum of **4** in $C_6D_6$ (303 K).*

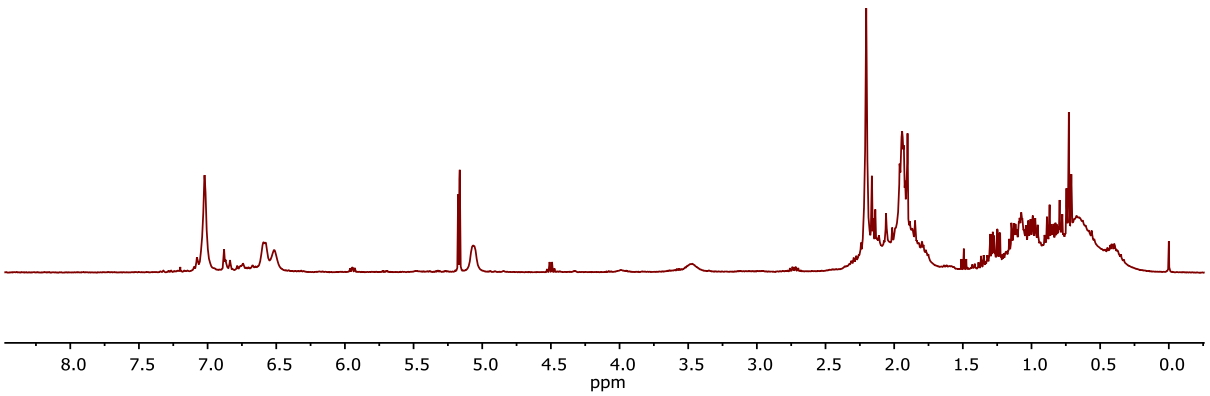



*Figure S 46:* *Crude $^{1}H$ NMR of the reaction to synthesize the cationic fluorenone complex **5**.*

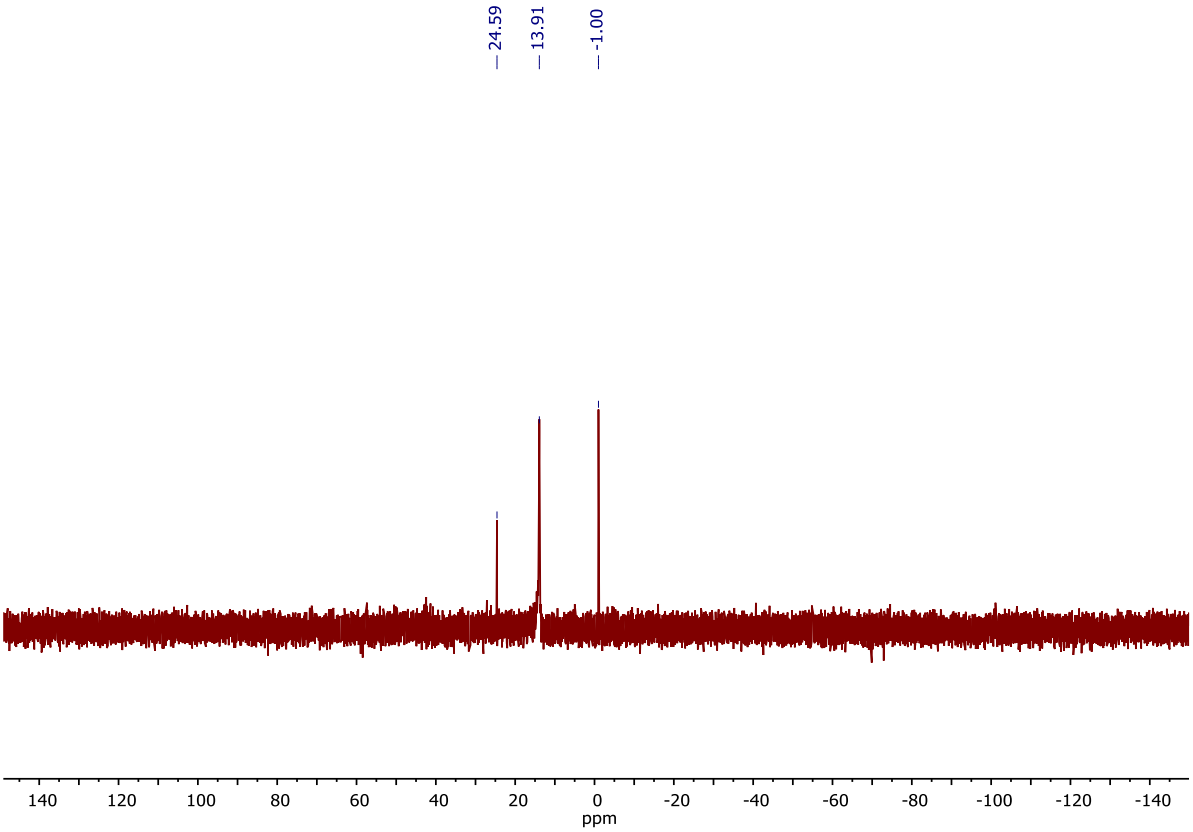



*Figure S 47: Crude $^{31}P$ NMR of the reaction to synthesize the cationic fluorenone complex **5**.*

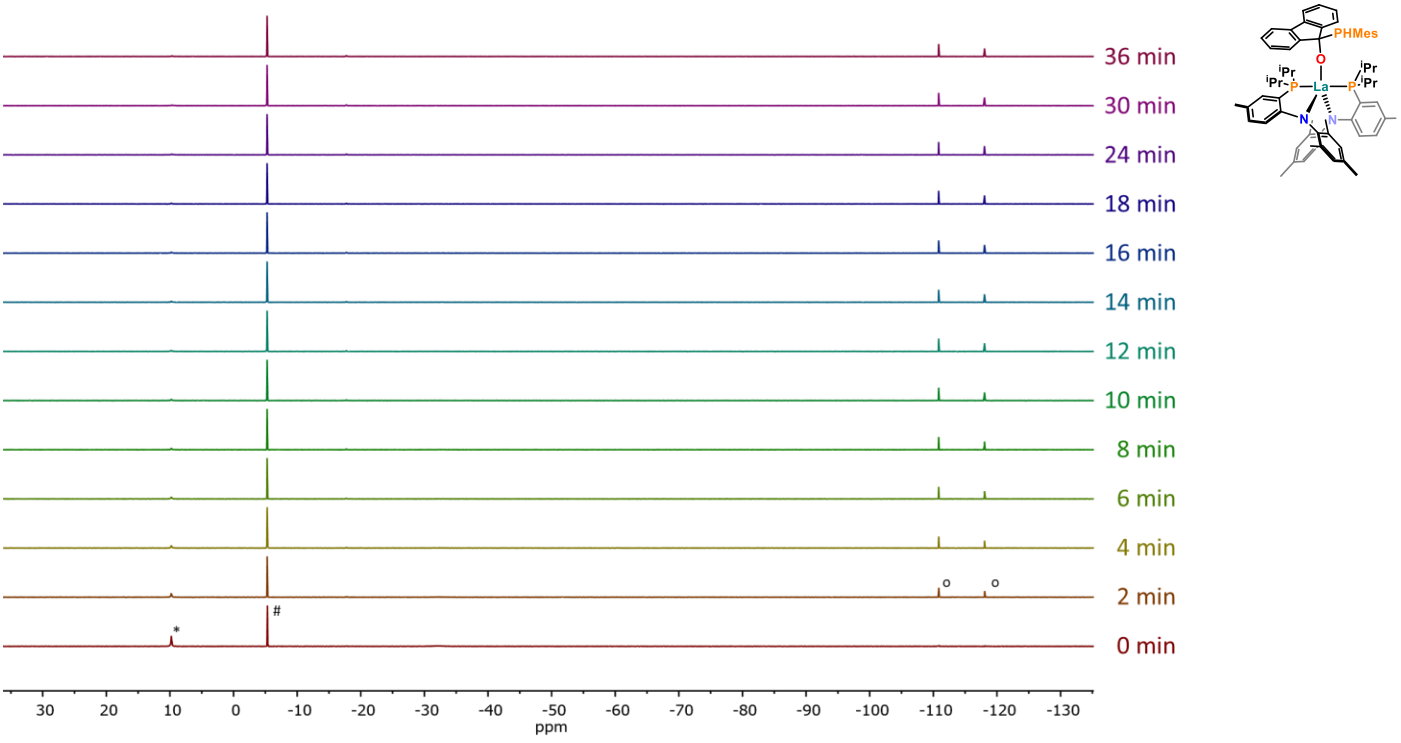



*Figure S 48: $^{31}P\{^{1}H\}$ NMR of the light induced decomposition reaction of **2a** followed over time. # marks the signal of the internal standard ($PPh_3$), * corresponds to the PN ligand signal. Please note that the PH signal is there, but due to its broadening not observed / shown.*

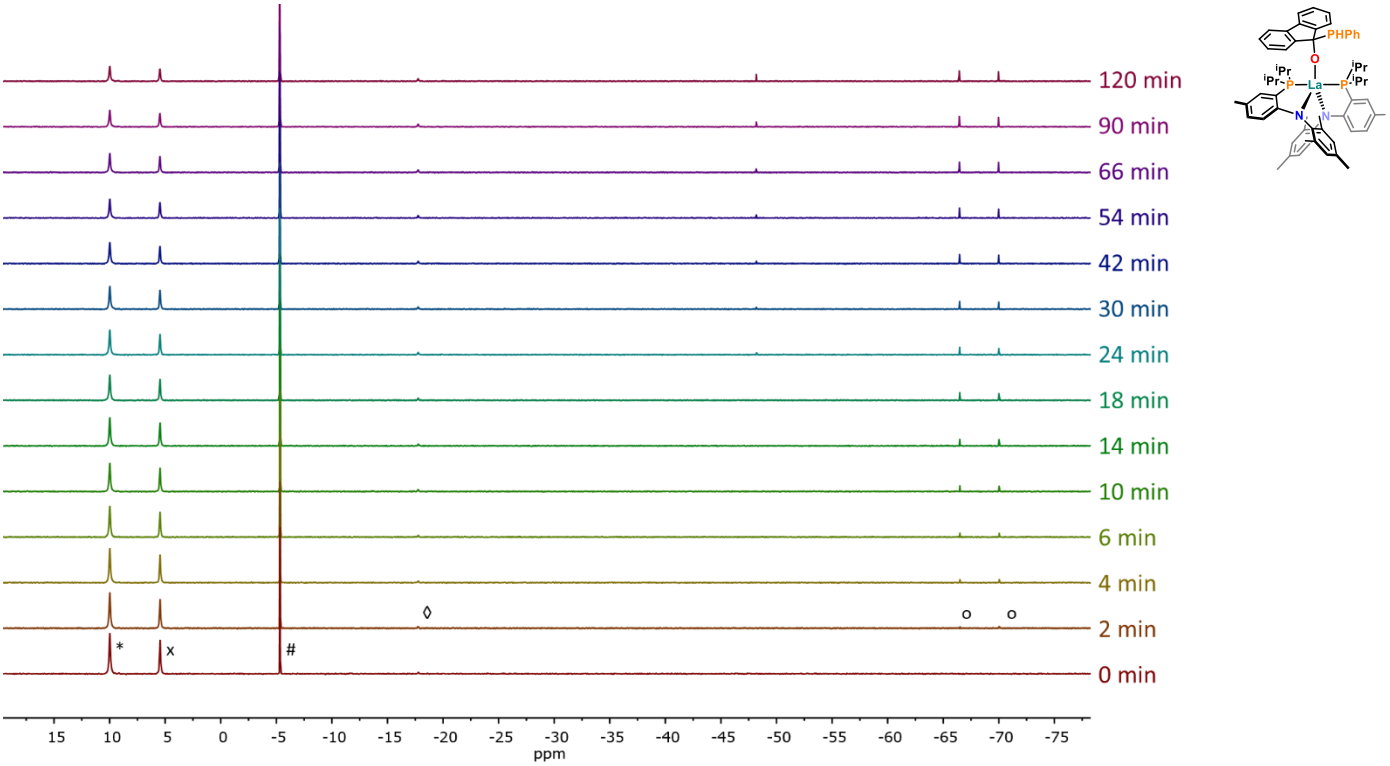



*Figure S 49: $^{31}P\{^{1}H\}$ NMR of the light induced decomposition reaction of **2b** followed over time. # marks the signal of the internal standard ($PPh_3$), * corresponds to the PN ligand signal. $^{X}$ marks the PH resonance while ◊ shows minor impurities of protonated HPN being formed.*

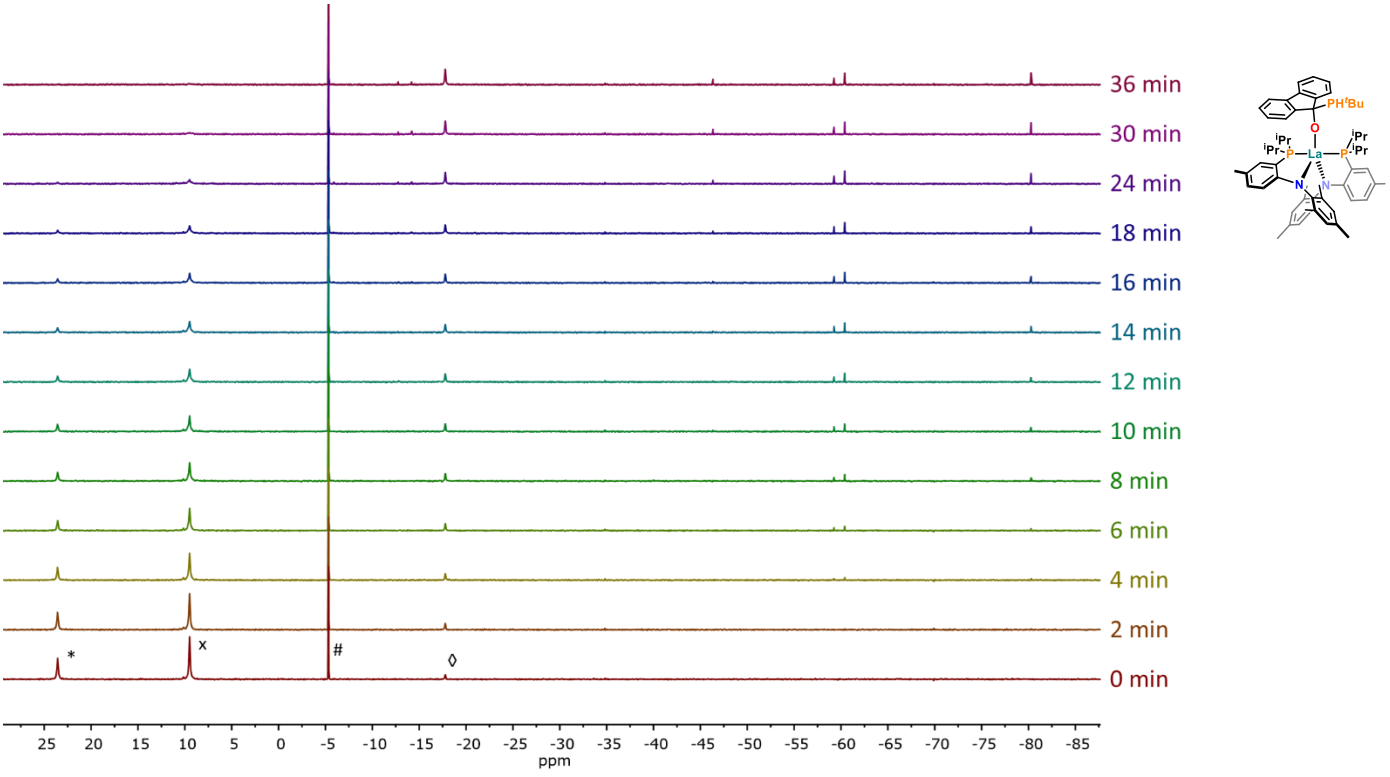



*Figure S 50: $^{31}P\{^{1}H\}$ NMR of the light induced decomposition reaction of **2c** followed over time. # marks the signal of the internal standard ($PPh_3$), * corresponds to the PN ligand signal. $^{X}$ marks the PH resonance while ◊ shows minor impurities of protonated HPN being formed. Two unknown species are also formed after the reaction.*

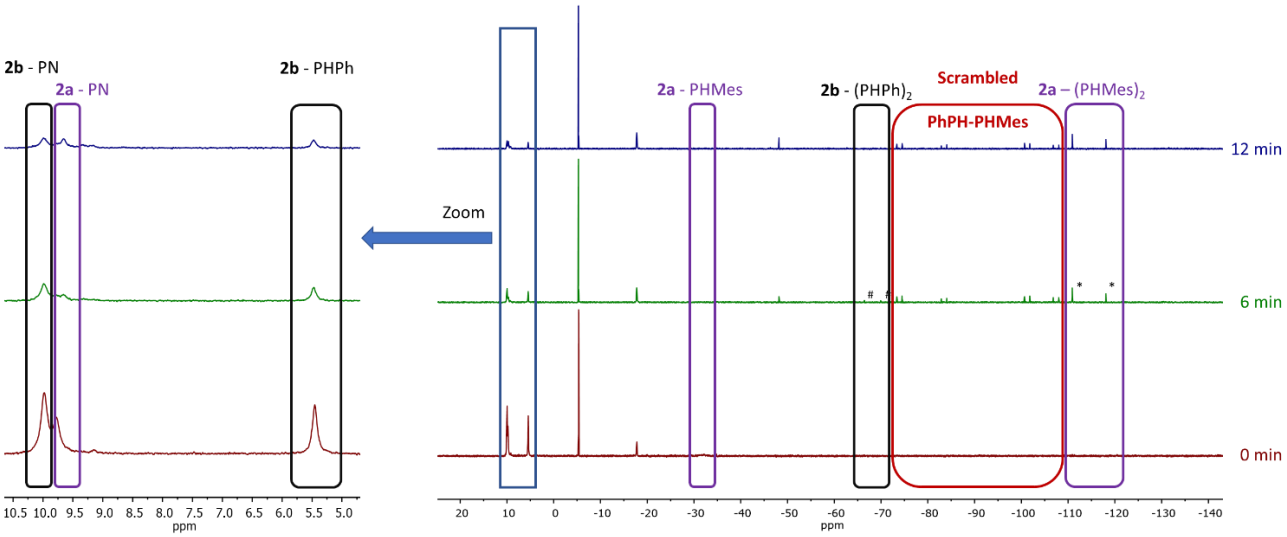



*Figure S 51: Scrambling experiments from an equimolar mixture of **2a** and **2b**.*

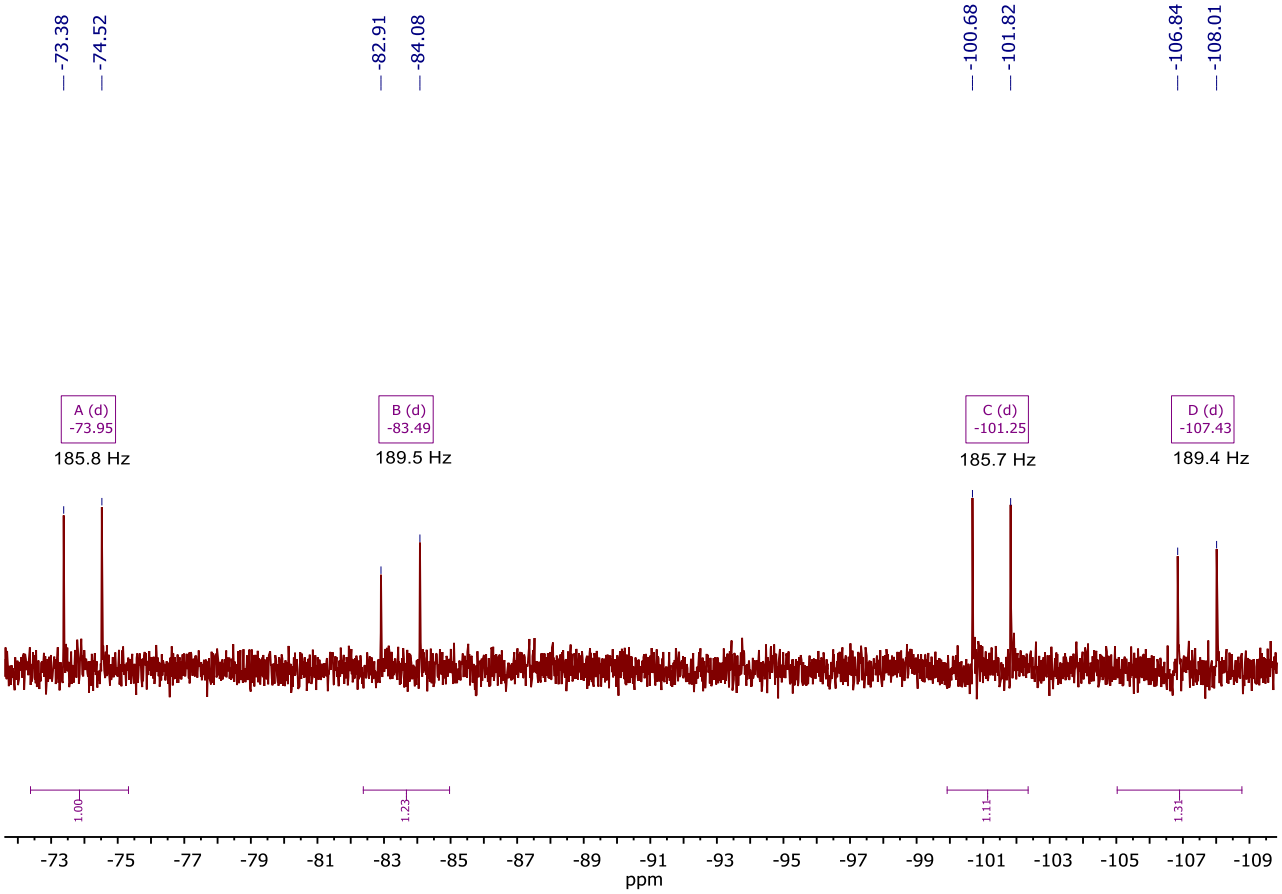
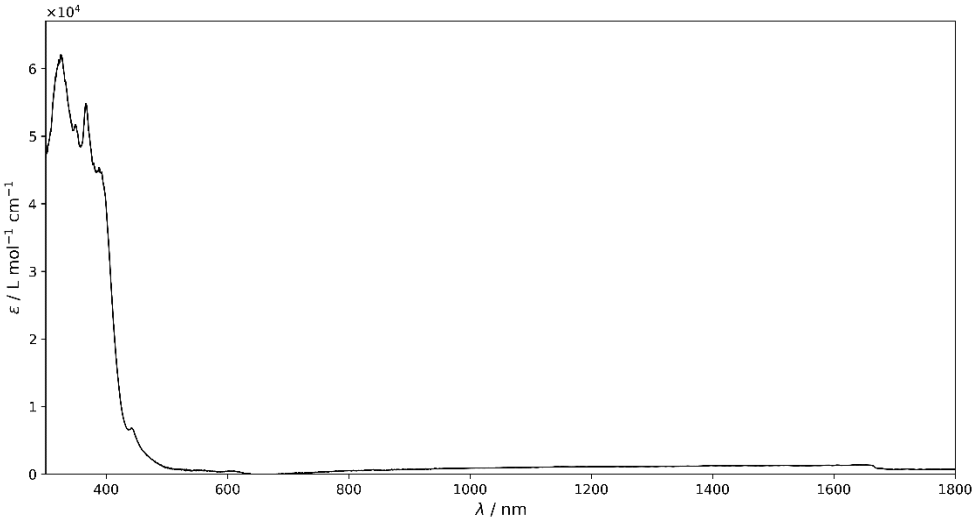



*Figure S 52: Snippet from the $^{31}P$ NMR spectra of the scrambling experiment from Figure S 51 after 12 minutes. The coupling constants clearly display, that signal A and C as well as B and D belong to the same species, namely PhPH-PHMes. The observation of overall 4 doublets is in line with the possible meso and d, l isomers of diphosphines.[5]*

## 3. UV Vis



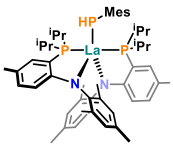
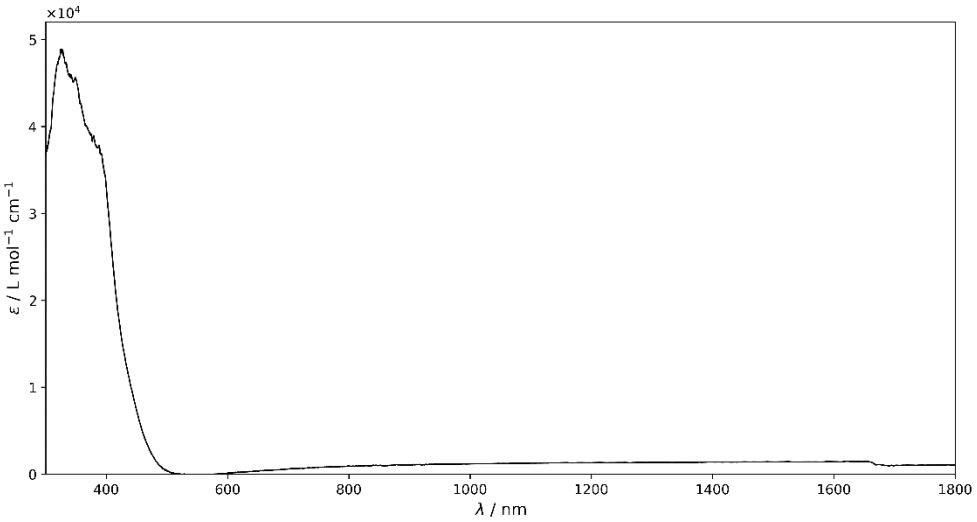




*Figure S 53: UV-Vis of **1a** in toluene at 303K.*



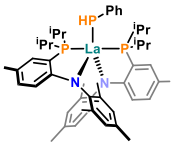
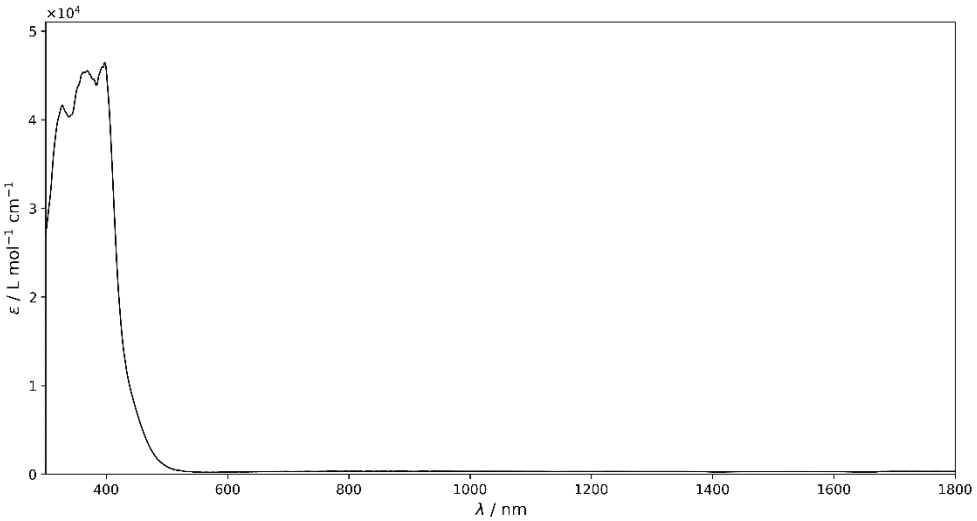




*Figure S 54: UV-Vis of **1b** in toluene at 303K.*



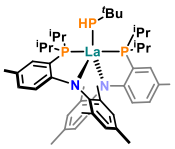
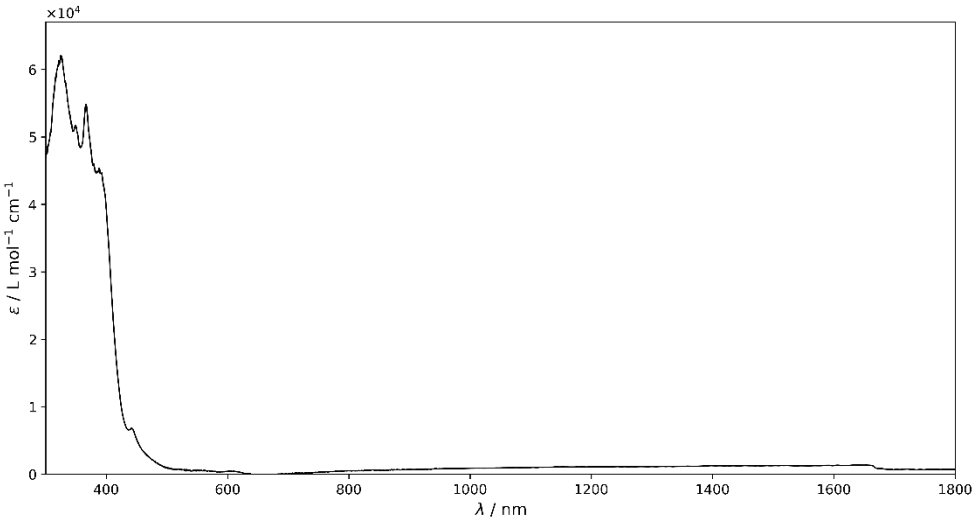




*Figure S 55: UV-Vis of **1c** in toluene at 303K.*



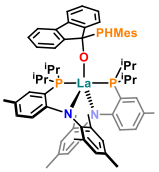
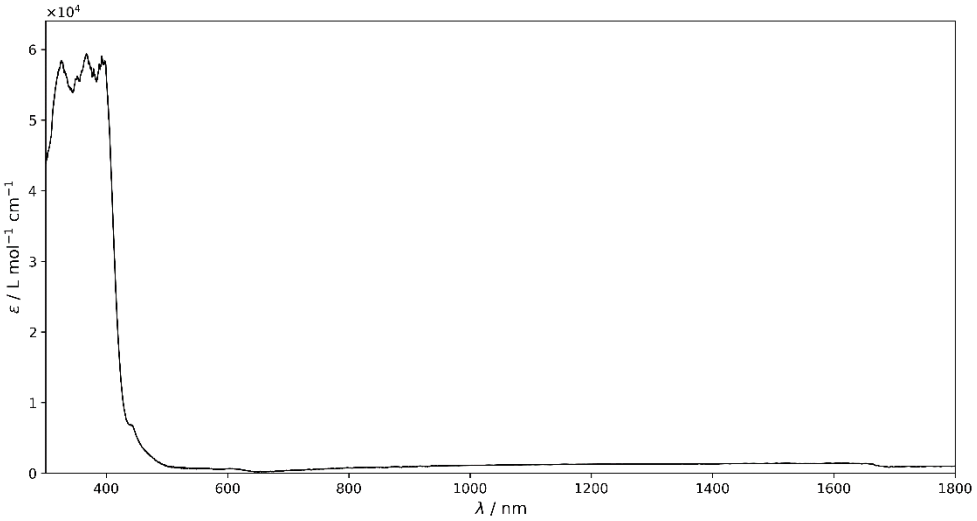




*Figure S 56: UV-Vis of **2a** in toluene at 303K.*



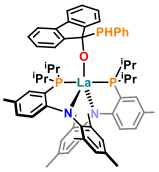
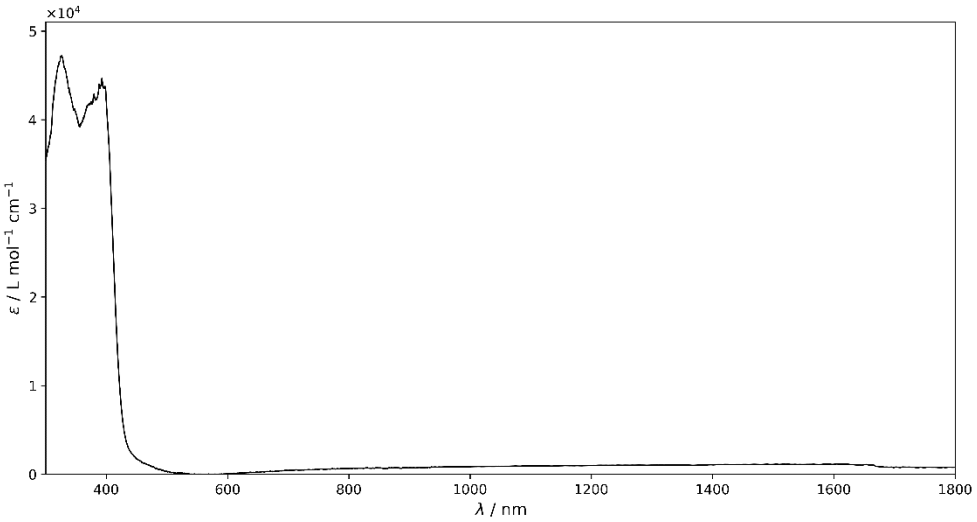




*Figure S 57: UV-Vis of **2b** in toluene at 303K.*



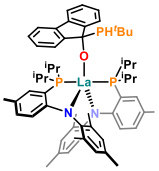
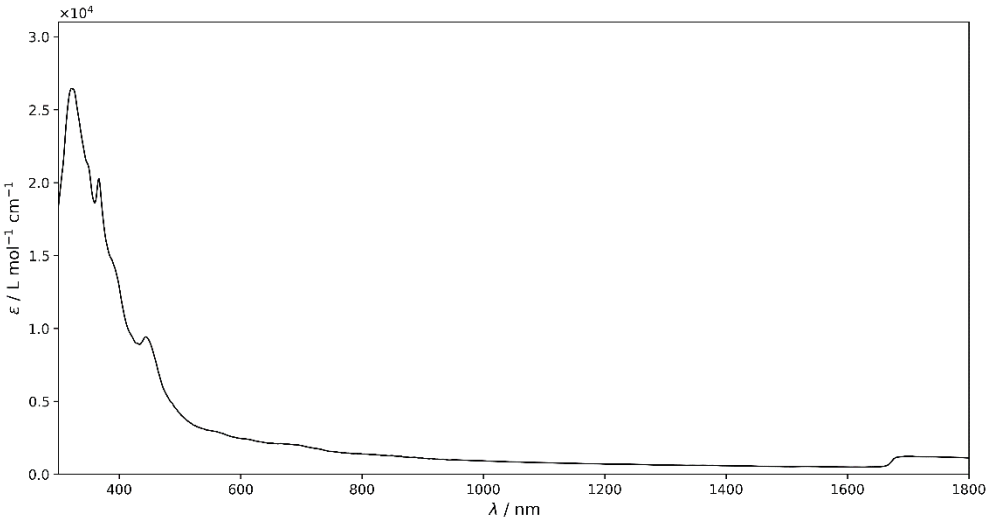




*Figure S 58: UV-Vis of **2c** in toluene at 303K.*



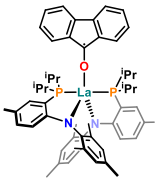
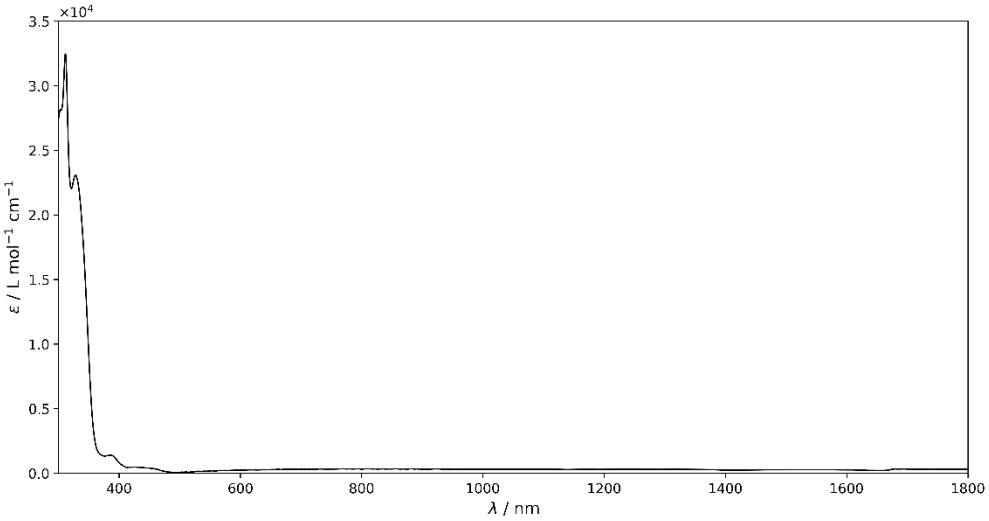



*Figure S 59: UV-Vis of **3** in toluene at 303K.*



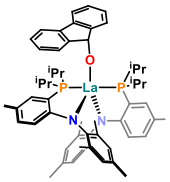
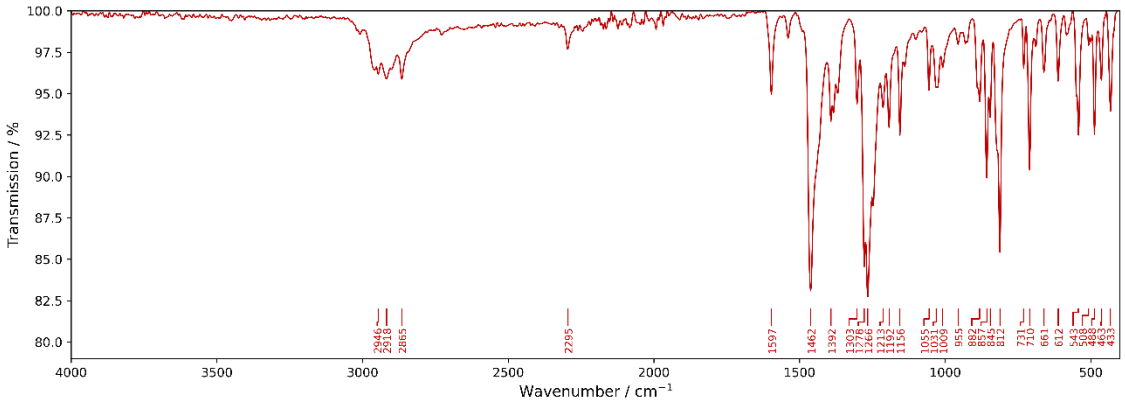



*Figure S 60: UV-Vis of **4** in toluene at 303K.*

# 4. IR



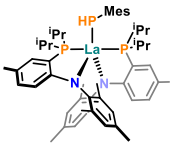
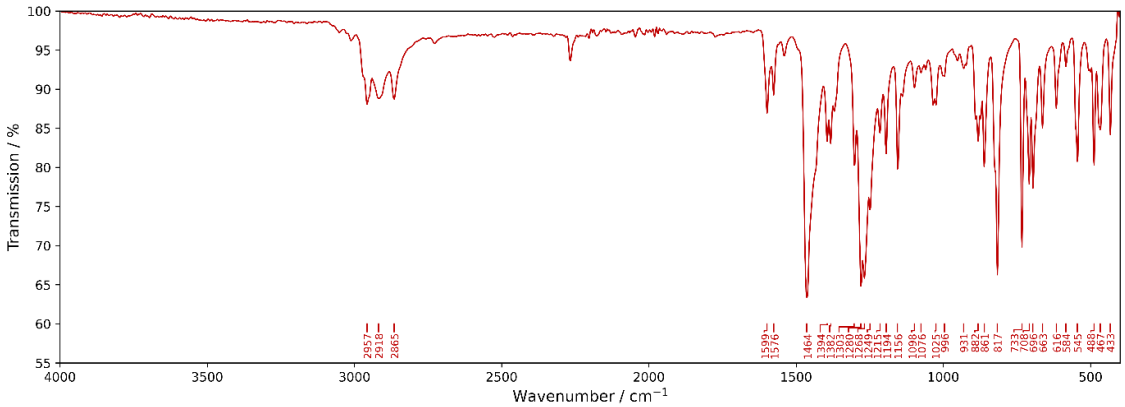




*Figure S 61: ATR-IR spectrum of **1a**.*



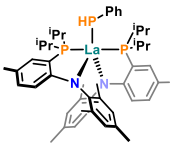
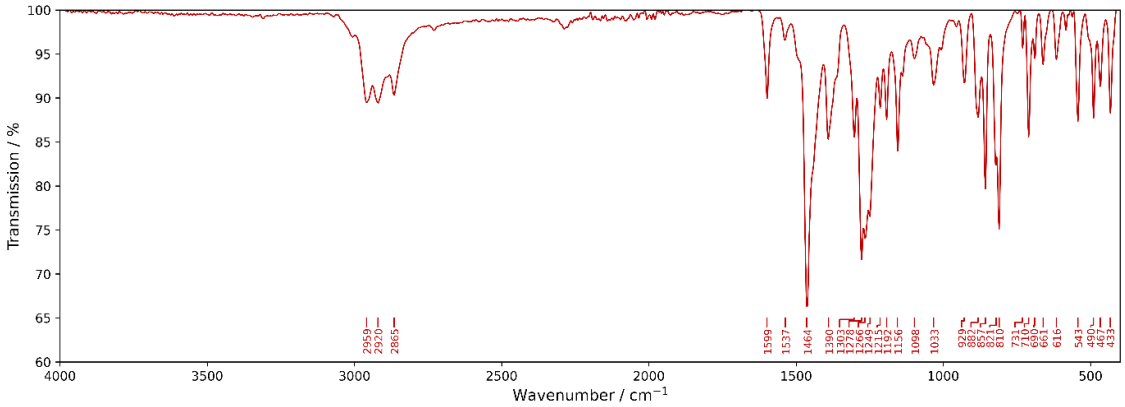




*Figure S 62: ATR-IR spectrum of **1b**.*



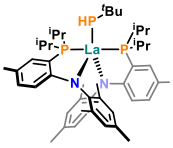




*Figure S 63: ATR-IR spectrum of **1c**.*

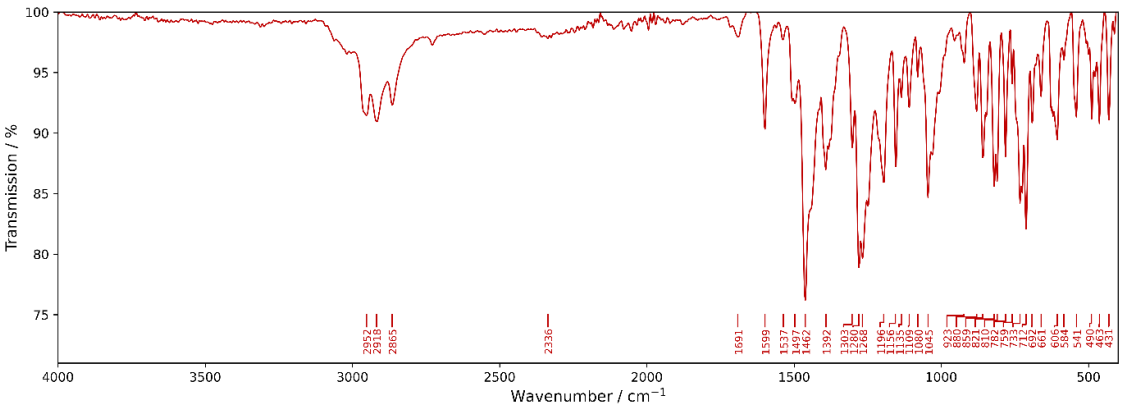



*Figure S 64: ATR-IR spectrum of **2a**.*

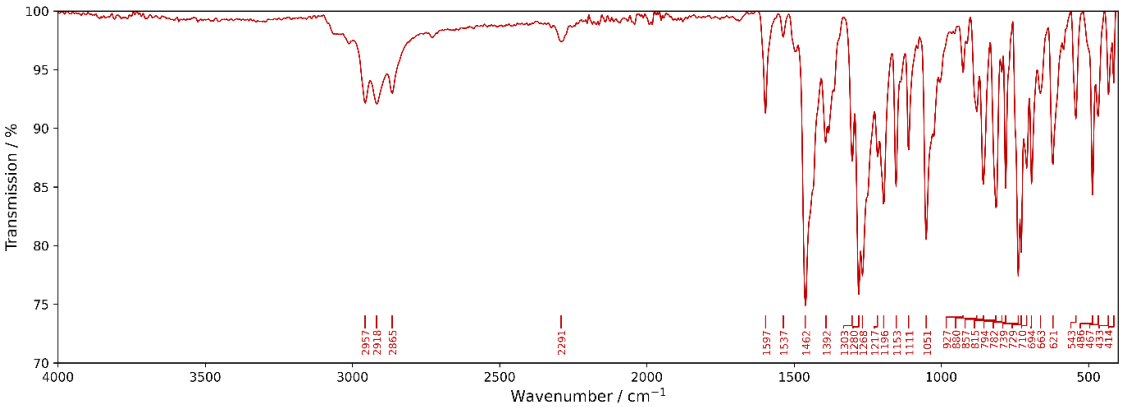



*Figure S 65: ATR-IR spectrum of **2b**.*

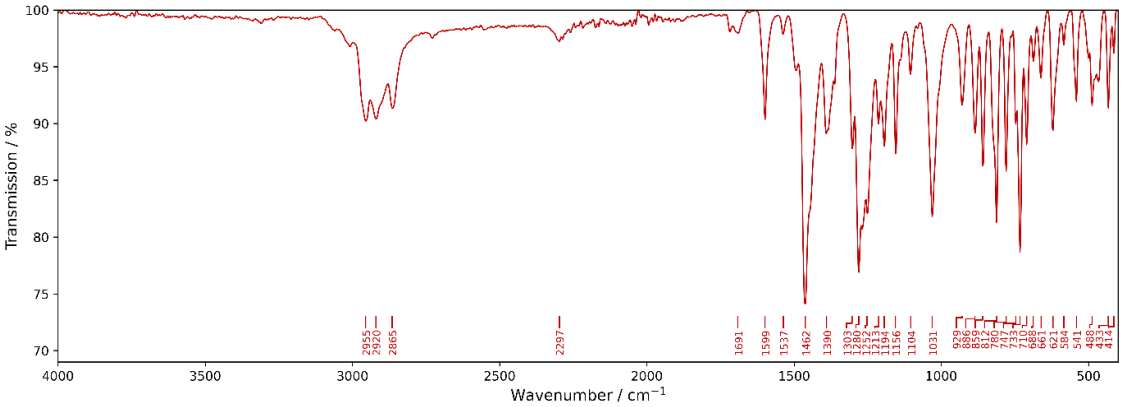



*Figure S 66: ATR-IR spectrum of **2c**.*

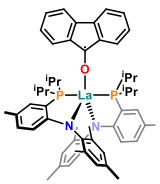




*Figure S 67: ATR-IR spectrum of **3**.*

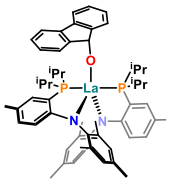




*Figure S 68: ATR-IR spectrum of **4**.*

# 5. Crystallographic Details

*Table S1: Crystallographic details on complexes **1b**, **1c**, **2a-c**, **3**, **3** and **5'**.*

| | **1b** | **1c** | **1d** | **2a** | **2a'*** | **2b** | **2c** | **3** | **4** | **5'** |
|---|---|---|---|---|---|---|---|---|---|---|
| Chemical formula | $C_{50}H_{68}N_2P_3La$ $C_6H_{14}$ | $C_{48}H_{72}N_2P_3La$ | $C_{62}H_{84}N_2P_3La$ | $C_{66}H_{82}N_2O_1P_3La$ 2.3 [$C_7H_8$] | $C_{66}H_{82}N_2O_1P_2La$ 1 [$C_7H_8$] | $C_{63}H_{76}N_2O_1P_3La$ | $C_{61}H_{80}N_2O_1P_3La1$ 2($C_6H_{14}$) | $C_{57}H_{70}N_2O_1P_2La$ | $C_{57}H_{71}N_2O_1P_2La$ | $C_{112}H_{110}N_2O_6P_2Cl_5La$ 2($B_1C_{24}F_{20}$) 4.11($CH_2Cl_2$) 1.25 $C_5H_{12}$ |
| $M_r$ | 1015.05 | 908.89 | 1089.13 | 1409.63 | 1242.78 | 1109.07 | 1261.43 | 1000.00 | 1001.00 | 4153.36 |
| Crystal system | Monoclinic | Monoclinic | Monoclinic | Triclinic | Triclinic | Monoclinic | Monoclinic | Monoclinic | Triclinic | Triclinic |
| Space group | $P2_1/c$ | $P2_1/c$ | $C2/c$ | $P$-1 | $P$-1 | $Pc$ | $P2_1/c$ | $C2/c$ | $P$-1 | $P$-1 |
| a (Å) | 17.744(2) | 13.2662(5) | 15.214(3) | 11.2622(5) | 11.2398(5) | 19.2050(11) | 19.7451(12) | 22.8982(12) | 14.6738(8) | 21.6976(11) |
| b (Å) | 11.872(1) | 16.5766(6) | 20.568(3) | 12.9391(6) | 12.9575(5) | 21.1858(12) | 14.8165(8) | 18.2040(11) | 16.8989(7) | 23.1126(12) |
| c (Å) | 25.871(3) | 23.4434(8) | 19.803(4) | 24.8329(12) | 24.8031(11) | 15.0967(7) | 22.0097(16) | 14.9403(9) | 22.1725(1) | 23.6214(12) |
| α (°) | 90 | 90 | 90 | 84.844(2) | 85.005(2) | 90 | 90 | 90 | 87.752(2) | 116.781(2) |
| β (°) | 100.603(2) | 106.2670(10) | 108.256(3) | 87.632(2) | 87.618(2) | 108.506(2) | 93.176(2) | 124.754(2) | 78.029(2) | 90.201(2) |
| γ (°) | 90 | 90 | 90 | 67.020(3) | 66.917(2) | 90 | 90 | 90 | 75.074(2) | 116.275(2) |
| V (Å$^3$) | 5356.9(9) | 4949.0(3) | 5885.0(18) | 3318.0(3) | 3310.4(2) | 5824.8(5) | 6429.1(7) | 5116.7(5) | 5196.5(4) | 972.7(8) |
| Z | 4 | 4 | 4 | 2 | 2 | 4 | 4 | 4 | 4 | 2 |
| Densitiy (g cm$^{-3}$) | 1.259 | 1.220 | 1.229 | 1.411 | 1.247 | 1.265 | 1.303 | 1.298 | 1.279 | 1.504 |
| F(000) | 2136 | 1904 | 2288 | 1485 | 1303 | 2312 | 2680 | 2084 | 2088 | 4146 |
| Radiation Type | MoKα | MoKα | MoKα | MoKα | MoKα | MoKα | MoKα | MoKα | MoKα | MoKα |
| μ (mm$^{-1}$) | 0.923 | 0.991 | 0.845 | 0.769 | 0.761 | 0.857 | 0.784 | 0.937 | 0.923 | 0.991 |
| Crystal size | 0.45x0.38x0.01 | 0.10x0.09x0.08 | 0.10x0.08x0.07 | 0.20x0.19x0.07 | 0x20x0.19x0.07 | 0.38x0.32x0.30 | 0.45x0.40x0.35 | 0.05x0.04x0.02 | 0.15x0.14x0.10 | 0.21x0.18x0.15 |
| Meas. Refl. | 51208 | 119090 | 19415 | 168394 | 118106 | 172927 | 117564 | 56087 | 174927 | 37781 |
| Indep. Refl. | 11410 | 11399 | 5473 | 15305 | 11780 | 28386 | 14784 | 4763 | 19335 | 37781 |
| Obsvd. [$I > 2\sigma(I)$] | 8701 | 10596 | 4338 | 14278 | 9283 | 24611 | 12436 | 3804 | 13350 | 27796 |
| $R_{int}$ | 0.0701 | 0.0391 | 0.0662 | 0.0385 | 0.1365 | 0.0597 | 0.0564 | 0.1188 | 0.1382 | 0.0861 |
| R [$F^2 > 2\sigma(F^2)$] | 0.0414 | 0.0291 | 0.0403 | 0.0273 | 0.0405 | 0.0305 | 0.0296 | 0.0406 | 0.0475 | 0.0878 |
| wR($F^2$) | 0.1327 | 0.0687 | 0.0894 | 0.0690 | 0.0946 | 0.0617 | 0.0834 | 0.1057 | 0.1299 | 0.2174 |
| S | 0.887 | 1.073 | 1.016 | 1.097 | 1.017 | 1.008 | 1.019 | 1.014 | 1.035 | 1.111 |
| $\Delta\rho_{max}$ | 1.891 | 0.880 | 0.799 | 0.657 | 0.436 | 0.430 | 0.329 | 0.456 | 2.787 | 1.980 |
| $\Delta\rho_{min}$ | -0.835 | -0.710 | -1.006 | -0.708 | -0.890 | -0.520 | -0.653 | -1.013 | -0.938 | -1.197 |
| CCDC | 2125273 | 2214931 | 2125577 | 2214933 | 2300656 | 2214999 | 2214932 | 2214929 | 2214934 | 2214930 |

*data after irradiation for 20 h with broad band light source used for photolysis experiments inside the EPR tube/instrument.

*Table S2: Selected bond lengths in Å and angles in ° of complexes **1b**, **2a**, **2b**, **3a**, **3b**.*

| | **1b** | **1c** | **1d** | **2a** | **2a'*** | **2b** | **2c** | **3** | **4** | **5'#** |
|---|---|---|---|---|---|---|---|---|---|---|
| La1 – P1 | 3.126(1) | 3.1164(5) | 3.1142(9) | 3.1364(5) | 3.1359(9) | 3.1334(11) | 3.1520(6) | 3.1444(10) | 3.1718(13) | - |
| La1 – P2 | 3.1400(9) | 3.1195(5) | - | 3.1609(5) | 3.1576(96) | 3.1659(12) | 3.1394(5) | - | 3.11757(13) | - |
| La1 – N1 | 2.414(3) | 2.4230(17) | 2.404(3) | 2.4463(14) | 2.444(3) | 2.453(3) | 2.4452(16) | 2.395(3) | 2.419(4) | - |
| La1 – N2 | 2.392(3) | 2.4131(16) | - | 2.4421(15) | 2.2437(3) | 2.443(3) | 2.4572(16) | - | 2.422(4) | - |
| La1 – P70 | 3.009(1) | 2.8364(6) | 2.9216(14) | - | - | - | - | - | - | - |
| La1 – O1 | - | - | - | 2.1867(13) | 2.182(2) | 2.191(3) | 2.1776(14) | 2.261(4) | 2.193(3) | 2.469(9) |
| | | | | | | | | | | - |
| O1 – C80 | - | - | - | 1.401(2) | 1.400(4) | 1.402(5) | 1.413(2) | 1.303(6) | 1.395(6) | 1.228(16) |
| P70 – C70 | 1.763(5) | 1.843(3) | 1.851(3) | - | | - | - | - | - | - |
| C80 – P70 | - | - | - | 1.9163(19) | 1.918(4) | 1.924(4) | 1.895(2) | - | - | - |
| P70 – H70 | 1.32(2) | 1.37(4) | - | 1.32(4) | 1.34(5) | 1.39(3) | 1.39(5) | - | - | - |
| | | | | | | | | | | |
| P1–La1–P2/P1 | 157.86(3) | 162.302(15) | 158.77(4) | 158.119(13) | 158.02(3) | 162.73(3) | 158.087(14) | 172.44(4) | 177.58(4) | - |
| N1–La1–N2/N1 | 124.2(1) | 125.11(6) | 116.97(13) | 124.17(5) | 124.15(10) | 122.55(11) | 123.65(6) | 115.08(15) | 115.89(14) | - |
| N1–La1–O1/P70 | 112.23(8) | 114.12(4) | 121.51(7) | 117.28(5) | 117.60(9) | 120.93(11) | 117.22(6) | 122.46(8) | 120.45(13) | - |
| N2–La1–O1/P70 | 121.67(7) | 120.77(4) | - | 118.54(5) | 118.25(10) | 116.38(11) | 118.91(6) | - | 123.66(13) | - |
| P1–La1–O1/P70 | 85.14(3) | 97.480(19) | 100.617(18) | 100.09(4) | 100.12(47) | 98.67(8) | 100.44(5) | 86.22(18) | 87.38(9) | - |
| P2–La1–O1/P70 | 117.01(3) | 100.17(2) | - | 101.77(4) | 101.85(7) | 98.13(8) | 101.00(5) | - | 90.20(9) | - |
| La1–P70–C70 | 101.3(1) | 144.59(9) | 126.65(10) | - | - | - | - | - | - | |
| La1–O1–C80 | - | - | | 177.79(12) | 178.0(2) | 167.8(3) | 176.90(15) | 180.0 | 176.2(3) | 170.2(11) |
| O1–C80–P70 | - | - | | 103.22(12) | 103.5(2) | 107.4(3) | 103.35(14) | - | - | - |

[#] Only the La1-O1 and the O1-C80 distances, as well as the PN bound La1-O1-C80 angles are given since all other structural parameters are merely comparable to the body structures of the manuscript. The values given are averages over all La1-O1 (range 2.457(9) – 2.484(11) Å) and O1-C80 (range 1.223(15) – 1.243(15) Å) distances.

*data after irradiation for 20 h with broad band light source used for photolysis experiments inside the EPR tube/instrument.

## 6. Computational Details

All DFT calculations were performed with Gaussian 09.[6] Geometries were fully optimized in gas phase without symmetry constraints, employing the B3PW91 functional.[7,8] La atom was treated with a Stuttgart effective core potential[9] augmented with a polarization function ($\zeta_f$ = 1.000 for La).[10] For P, N, C and H atoms, Pople's double-ζ basis set 6-31G(d,p) was used.[11,12] Calculations of vibrational frequencies were systematically done in order to characterize the nature of stationary points. Analytical frequency calculations at 298.15 K and 1 atm were systematically done in order to characterize the nature of stationary points. IRC calculations were carried out in order to confirm the connectivity between reactant(s), transition state and product(s). TDDFT calculations were also carried out using Gaussian09.

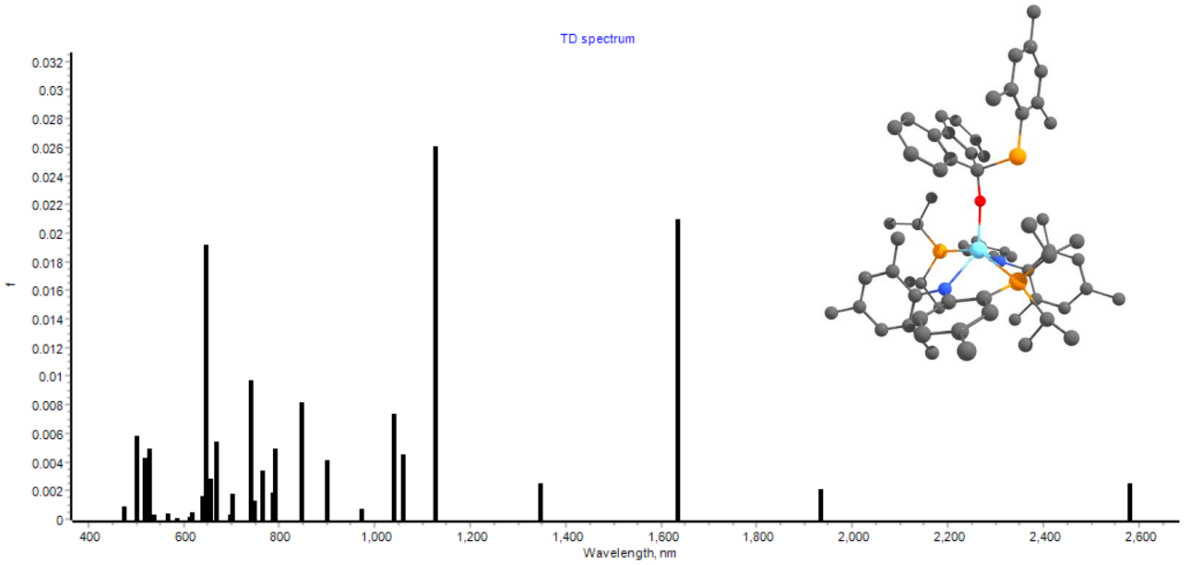



*Figure S 69: TD-DFT spectra of complex **2a**.*

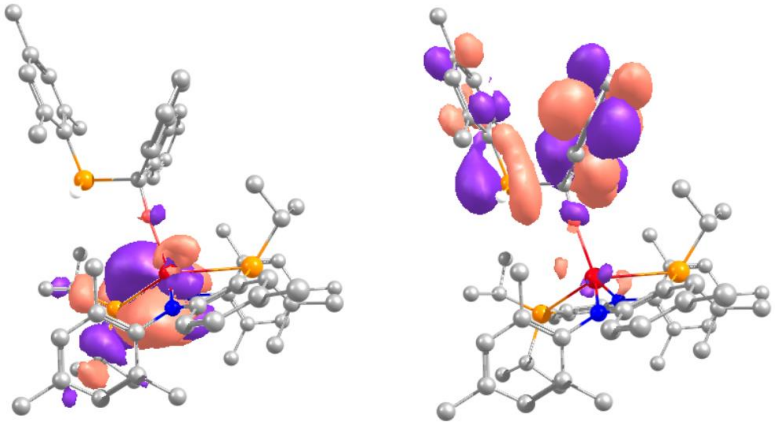


*Figure S 70: Calculated HOMO (right) and LUMO (left) of complex **2a**. The LUMO corresponds to the antibonding P-C orbital.*

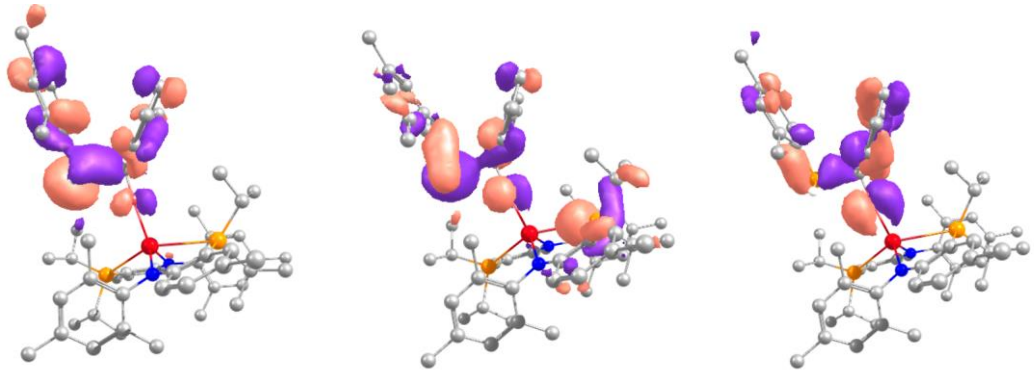


*Figure S 71: Calculated HOMO-3, HOMO-15 and HOMO-17 involving the P-C bond.*

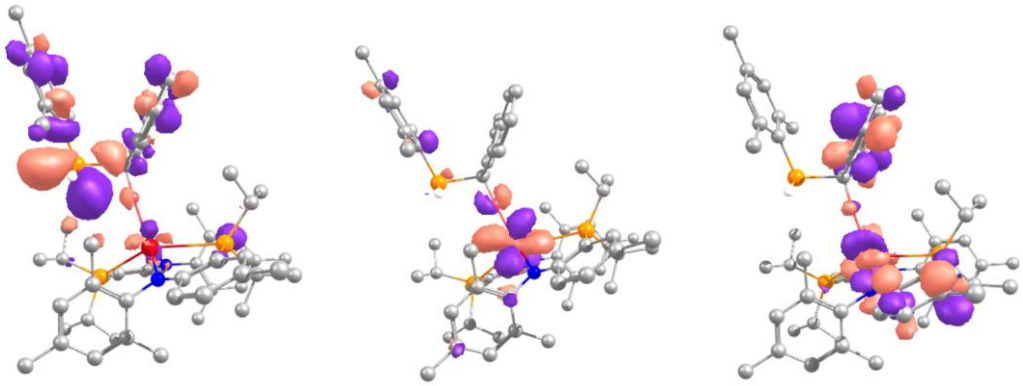


*Figure S 72: MOs energies that equate to transitions of ~600nm and ~1000nm (LUMO+24, LUMO+21 and LUMO + 22; from left to right).*

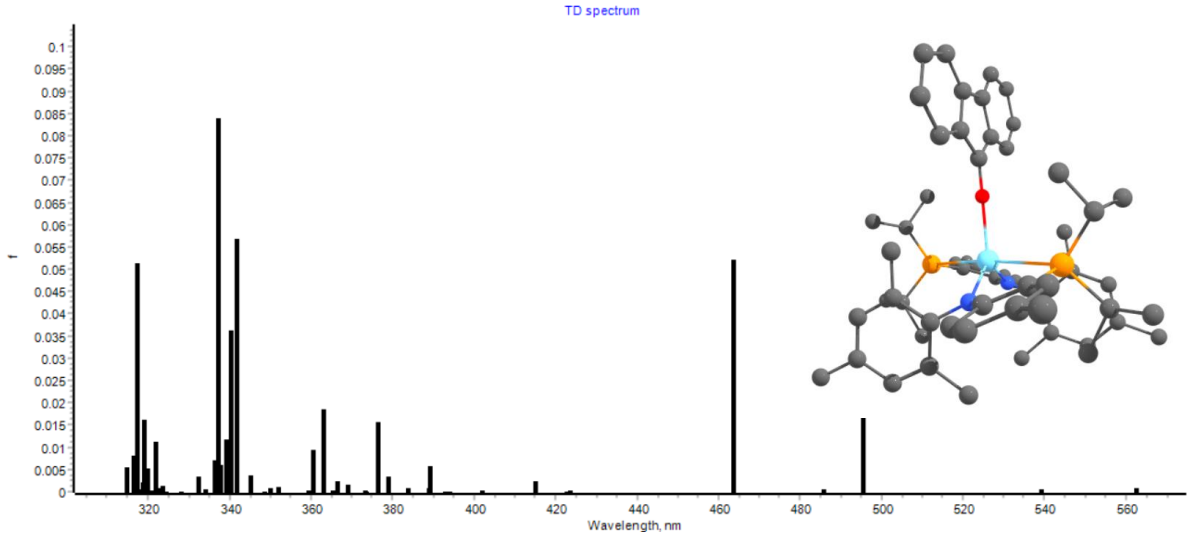



*Figure S 73: TD-DFT spectrum of fluorenyl radical complex **3**.*

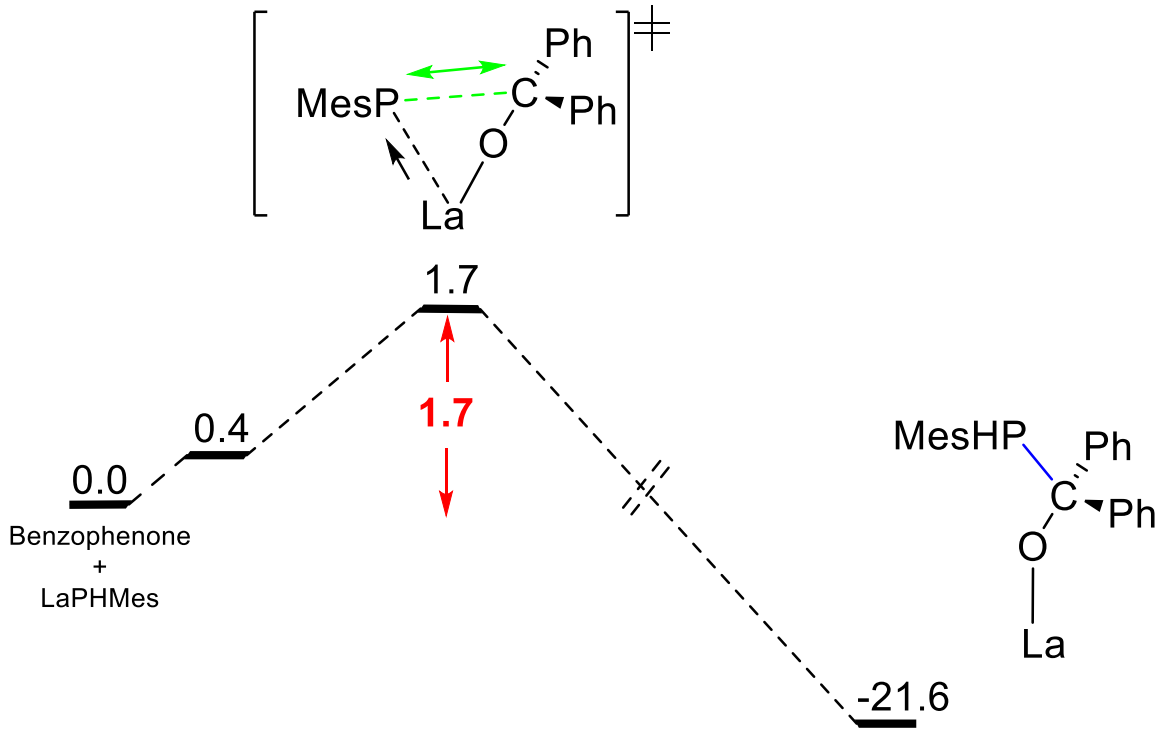



*Figure S 74: Calculated insertion mechanism of benzophenone into the La-P bond.*

***Geometries***

Complex 2a:

| | | | |
|---|---|---|---|
| La | 11.201164000 | 5.327251000 | 19.263369000 |
| P | 10.761487000 | 7.554692000 | 21.370879000 |
| P | 10.803173000 | 2.388315000 | 17.986607000 |
| P | 13.824178000 | 8.449082000 | 17.224819000 |
| O | 12.227108000 | 6.332051000 | 17.609430000 |
| N | 12.564882000 | 3.546100000 | 20.177610000 |
| N | 8.683343000 | 5.875518000 | 19.830662000 |
| C | 7.777188000 | 4.930062000 | 19.270181000 |
| C | 8.128687000 | 6.990380000 | 20.372540000 |
| C | 9.018405000 | 7.936793000 | 21.076695000 |
| C | 13.008777000 | 2.316280000 | 19.725004000 |
| C | 12.344584000 | 1.633135000 | 18.666412000 |
| C | 13.445491000 | 6.180203000 | 15.472824000 |
| C | 11.628007000 | 9.249862000 | 21.273067000 |
| H | 11.219049000 | 9.859792000 | 22.086736000 |
| C | 14.294001000 | 4.993350000 | 21.170448000 |
| C | 12.686442000 | 7.005304000 | 16.489659000 |
| C | 12.848643000 | 0.415256000 | 18.191659000 |
| H | 12.341599000 | -0.078370000 | 17.365659000 |
| C | 8.413237000 | 9.120570000 | 21.587154000 |
| H | 9.028924000 | 9.846821000 | 22.109298000 |
| C | 13.210359000 | 4.092658000 | 21.319470000 |
| C | 14.147039000 | 1.672159000 | 20.274008000 |
| H | 14.672997000 | 2.152903000 | 21.093459000 |
| C | 12.986691000 | 6.465021000 | 14.172063000 |
| C | 7.056952000 | 4.044226000 | 20.101436000 |
| C | 13.130760000 | 9.077663000 | 21.500087000 |
| H | 13.359197000 | 8.602221000 | 22.458952000 |
| H | 13.632878000 | 10.052528000 | 21.482581000 |
| H | 13.578936000 | 8.466909000 | 20.708848000 |
| C | 7.600679000 | 4.887924000 | 17.872899000 |
| C | 12.791023000 | 3.739322000 | 22.625568000 |
| C | 14.912259000 | 9.125963000 | 15.868242000 |
| C | 14.407955000 | 10.192923000 | 15.088996000 |
| C | 10.747406000 | 8.345888000 | 24.217623000 |
| H | 11.466392000 | 9.156241000 | 24.067769000 |
| H | 10.859737000 | 8.005837000 | 25.255682000 |
| H | 9.738138000 | 8.759478000 | 24.120312000 |
| C | 14.892330000 | 5.252347000 | 19.811923000 |
| H | 15.234129000 | 4.313489000 | 19.361621000 |
| H | 15.750346000 | 5.925303000 | 19.891615000 |
| H | 14.191495000 | 5.702352000 | 19.100116000 |
| C | 11.339001000 | 9.950753000 | 19.948895000 |
| H | 11.756669000 | 9.391606000 | 19.105788000 |
| H | 11.809907000 | 10.941778000 | 19.940539000 |
| H | 10.265797000 | 10.084131000 | 19.787044000 |
| C | 6.206419000 | 8.467709000 | 20.777628000 |
| H | 5.149965000 | 8.684570000 | 20.659691000 |
| C | 6.704651000 | 3.962198000 | 17.329673000 |
| H | 6.556819000 | 3.952197000 | 16.251624000 |
| C | 14.611046000 | 0.460360000 | 19.787708000 |
| H | 15.494961000 | 0.017482000 | 20.244139000 |
| C | 16.256825000 | 8.715371000 | 15.673386000 |
| C | 10.962180000 | 7.174046000 | 23.261846000 |
| H | 11.999834000 | 6.823269000 | 23.337433000 |
| C | 10.853737000 | 1.963749000 | 16.144999000 |
| H | 10.952074000 | 0.873858000 | 16.073719000 |
| C | 7.058150000 | 9.393967000 | 21.450421000 |
| C | 7.182407000 | 4.103804000 | 21.599064000 |
| H | 8.216921000 | 4.268715000 | 21.911326000 |
| H | 6.821792000 | 3.179651000 | 22.058532000 |
| H | 6.597546000 | 4.936254000 | 22.006778000 |
| C | 11.618673000 | 7.656807000 | 15.634633000 |
| C | 10.037649000 | 6.014866000 | 23.618282000 |

| | | | |
|---|---|---|---|
| H | 8.986688000 | 6.316185000 | 23.550234000 |
| H | 10.226521000 | 5.670619000 | 24.642205000 |
| H | 10.187482000 | 5.161646000 | 22.949700000 |
| C | 6.755648000 | 7.296276000 | 20.255701000 |
| H | 6.121148000 | 6.602213000 | 19.713961000 |
| C | 13.573435000 | 5.855904000 | 13.063785000 |
| H | 13.229745000 | 6.080737000 | 12.057492000 |
| C | 5.983197000 | 3.073152000 | 18.127383000 |
| C | 14.877967000 | 5.565132000 | 22.304208000 |
| H | 15.711822000 | 6.252510000 | 22.172084000 |
| C | 13.413366000 | 4.324129000 | 23.729607000 |
| H | 13.083241000 | 4.038707000 | 24.726912000 |
| C | 13.981705000 | -0.199643000 | 18.724510000 |
| C | 9.408177000 | 1.275589000 | 18.647826000 |
| H | 8.496967000 | 1.788444000 | 18.315942000 |
| C | 13.027048000 | 10.765555000 | 15.279196000 |
| H | 12.288208000 | 10.254184000 | 14.653958000 |
| H | 13.014392000 | 11.824599000 | 15.003505000 |
| H | 12.687253000 | 10.681379000 | 16.315637000 |
| C | 6.184442000 | 3.128886000 | 19.509723000 |
| H | 5.633742000 | 2.446821000 | 20.155294000 |
| C | 11.845438000 | 7.380769000 | 14.273757000 |
| C | 14.449083000 | 5.252638000 | 23.595734000 |
| C | 15.210951000 | 10.767035000 | 14.097411000 |
| H | 14.801695000 | 11.583591000 | 13.504981000 |
| C | 8.309955000 | 5.872424000 | 16.983145000 |
| H | 8.211248000 | 6.893952000 | 17.360782000 |
| H | 7.904794000 | 5.847587000 | 15.968339000 |
| H | 9.386122000 | 5.670218000 | 16.880591000 |
| C | 11.727477000 | 2.697165000 | 22.826294000 |
| H | 10.803873000 | 2.951472000 | 22.297579000 |
| H | 11.492798000 | 2.573998000 | 23.886942000 |
| H | 12.051747000 | 1.727988000 | 22.431380000 |
| C | 14.602498000 | 4.936560000 | 13.267051000 |
| H | 15.068142000 | 4.450907000 | 12.413875000 |
| C | 14.503697000 | -1.506317000 | 18.187871000 |
| H | 13.871323000 | -1.885228000 | 17.379236000 |
| H | 14.541703000 | -2.278839000 | 18.965453000 |
| H | 15.520508000 | -1.404922000 | 17.789017000 |
| C | 14.452683000 | 5.244707000 | 15.671156000 |
| H | 14.775819000 | 4.986433000 | 16.675606000 |
| C | 9.434023000 | 1.288426000 | 20.175111000 |
| H | 10.347447000 | 0.821766000 | 20.556728000 |
| H | 8.576750000 | 0.732624000 | 20.572142000 |
| H | 9.378848000 | 2.304651000 | 20.574308000 |
| C | 15.029384000 | 4.622903000 | 14.560456000 |
| H | 15.814825000 | 3.885976000 | 14.704309000 |
| C | 10.543762000 | 8.440691000 | 16.032356000 |
| H | 10.371364000 | 8.649120000 | 17.084893000 |
| C | 16.944302000 | 7.678632000 | 16.527017000 |
| H | 16.986301000 | 7.980765000 | 17.579660000 |
| H | 17.973983000 | 7.533160000 | 16.188736000 |
| H | 16.440257000 | 6.710044000 | 16.480391000 |
| C | 6.472309000 | 10.656809000 | 22.006432000 |
| H | 5.676350000 | 10.430549000 | 22.727224000 |
| H | 6.008237000 | 11.250367000 | 21.208333000 |
| H | 7.222466000 | 11.276834000 | 22.503867000 |
| C | 9.399496000 | -0.159500000 | 18.124228000 |
| H | 9.301386000 | -0.216303000 | 17.036263000 |
| H | 8.548361000 | -0.701628000 | 18.554541000 |
| H | 10.308248000 | -0.694779000 | 18.417006000 |
| C | 12.065065000 | 2.610181000 | 15.479143000 |
| H | 12.017203000 | 3.701771000 | 15.533073000 |
| H | 12.104919000 | 2.336025000 | 14.418552000 |
| H | 13.001858000 | 2.293723000 | 15.944085000 |
| C | 17.017962000 | 9.323383000 | 14.673655000 |

| | | | |
|---|---|---|---|
| H | 18.047162000 | 8.998036000 | 14.533298000 |
| C | 4.993924000 | 2.108477000 | 17.527615000 |
| H | 3.964083000 | 2.457409000 | 17.672120000 |
| H | 5.065380000 | 1.118908000 | 17.990673000 |
| H | 5.150996000 | 1.989692000 | 16.451828000 |
| C | 9.552934000 | 2.379171000 | 15.456951000 |
| H | 8.670002000 | 1.914068000 | 15.904687000 |
| H | 9.582369000 | 2.091553000 | 14.399268000 |
| H | 9.415832000 | 3.464553000 | 15.497424000 |
| C | 15.094419000 | 5.884874000 | 24.801128000 |
| H | 16.187062000 | 5.860994000 | 24.728385000 |
| H | 14.807836000 | 5.371216000 | 25.723132000 |
| H | 14.803264000 | 6.936981000 | 24.906463000 |
| C | 11.007971000 | 7.920395000 | 13.297716000 |
| H | 11.178593000 | 7.721174000 | 12.243003000 |
| C | 9.931710000 | 8.714263000 | 13.698887000 |
| H | 9.267357000 | 9.136942000 | 12.949942000 |
| C | 16.512184000 | 10.337311000 | 13.857966000 |
| C | 9.694049000 | 8.964745000 | 15.053883000 |
| H | 8.846872000 | 9.578453000 | 15.347435000 |
| C | 17.348476000 | 10.940795000 | 12.761704000 |
| H | 17.301964000 | 10.331245000 | 11.850532000 |
| H | 18.401972000 | 11.008437000 | 13.051009000 |
| H | 17.002710000 | 11.945196000 | 12.500090000 |
| H | 14.765946000 | 7.523680000 | 17.763571000 |

**Complex 3**

| | | | |
|---|---|---|---|
| La | 12.437235000 | 7.387199000 | 19.587345000 |
| P | 13.886627000 | 10.152582000 | 20.280964000 |
| P | 10.931660000 | 4.606672000 | 19.145028000 |
| O | 13.002938000 | 7.529405000 | 17.427225000 |
| N | 13.324419000 | 5.482832000 | 20.791233000 |
| N | 11.023040000 | 9.159719000 | 20.436616000 |
| C | 9.746080000 | 8.578610000 | 20.643612000 |
| C | 11.110894000 | 10.540723000 | 20.462037000 |
| C | 12.368486000 | 11.200394000 | 20.351805000 |
| C | 13.284443000 | 4.113422000 | 20.595606000 |
| C | 12.262458000 | 3.512498000 | 19.806522000 |
| C | 14.300497000 | 6.773017000 | 15.477840000 |
| C | 15.024334000 | 11.048960000 | 19.067686000 |
| H | 15.154472000 | 12.072807000 | 19.438545000 |
| C | 15.548129000 | 6.466172000 | 21.151540000 |
| C | 13.342180000 | 7.611188000 | 16.161348000 |
| C | 12.279890000 | 2.132399000 | 19.567816000 |
| H | 11.505894000 | 1.697399000 | 18.939494000 |
| C | 12.425898000 | 12.599295000 | 20.312612000 |
| H | 13.393332000 | 13.083120000 | 20.199002000 |
| C | 14.317050000 | 5.993725000 | 21.666450000 |
| C | 14.257919000 | 3.238704000 | 21.140751000 |
| H | 15.048458000 | 3.656675000 | 21.756989000 |
| C | 14.374984000 | 7.192157000 | 14.116063000 |
| C | 9.267766000 | 8.328476000 | 21.955800000 |
| C | 16.393570000 | 10.367658000 | 19.023914000 |
| H | 16.885196000 | 10.347503000 | 20.001585000 |
| H | 17.055464000 | 10.900727000 | 18.331607000 |
| H | 16.309813000 | 9.336059000 | 18.665691000 |
| C | 8.934008000 | 8.227182000 | 19.540109000 |
| C | 14.092410000 | 6.047746000 | 23.065058000 |
| C | 15.222913000 | 11.842419000 | 22.238084000 |
| H | 15.945994000 | 12.189941000 | 21.494150000 |
| H | 15.720460000 | 11.877587000 | 23.215234000 |
| H | 14.392425000 | 12.554389000 | 22.269727000 |
| C | 15.879126000 | 6.303226000 | 19.689410000 |
| H | 15.683137000 | 5.278190000 | 19.360401000 |
| H | 16.933471000 | 6.526335000 | 19.504892000 |

| | | | |
|---|---|---|---|
| H | 15.308804000 | 6.966523000 | 19.024547000 |
| C | 14.383139000 | 11.106687000 | 17.682075000 |
| H | 14.219323000 | 10.104790000 | 17.274521000 |
| H | 15.038627000 | 11.641590000 | 16.985042000 |
| H | 13.420604000 | 11.624436000 | 17.702222000 |
| C | 10.063683000 | 12.755640000 | 20.545473000 |
| H | 9.151326000 | 13.344465000 | 20.626896000 |
| C | 7.690836000 | 7.621700000 | 19.762033000 |
| H | 7.069959000 | 7.370866000 | 18.903688000 |
| C | 14.236418000 | 1.874516000 | 20.896018000 |
| H | 15.014377000 | 1.251897000 | 21.335187000 |
| C | 14.725098000 | 10.424059000 | 21.967013000 |
| H | 15.581565000 | 9.738666000 | 21.935440000 |
| C | 10.551944000 | 3.911187000 | 17.430076000 |
| H | 10.293278000 | 2.853039000 | 17.557019000 |
| C | 11.294047000 | 13.409891000 | 20.404031000 |
| C | 10.078726000 | 8.749558000 | 23.149180000 |
| H | 11.090515000 | 8.334587000 | 23.118239000 |
| H | 9.602075000 | 8.431874000 | 24.080455000 |
| H | 10.193484000 | 9.838872000 | 23.177446000 |
| C | 12.822939000 | 8.555568000 | 15.199118000 |
| C | 13.782600000 | 9.956115000 | 23.075417000 |
| H | 12.873020000 | 10.564629000 | 23.098952000 |
| H | 14.273708000 | 10.045707000 | 24.051354000 |
| H | 13.498003000 | 8.908138000 | 22.949191000 |
| C | 9.968561000 | 11.372985000 | 20.572920000 |
| H | 8.991571000 | 10.908486000 | 20.668447000 |
| C | 15.232078000 | 6.546487000 | 13.232647000 |
| H | 15.297558000 | 6.858498000 | 12.193117000 |
| C | 7.213027000 | 7.364655000 | 21.046102000 |
| C | 16.502706000 | 7.000074000 | 22.024188000 |
| H | 17.452205000 | 7.341934000 | 21.615505000 |
| C | 15.075806000 | 6.582253000 | 23.897877000 |
| H | 14.893577000 | 6.609755000 | 24.970909000 |
| C | 13.253014000 | 1.282080000 | 20.093472000 |
| C | 9.394070000 | 4.148600000 | 20.167635000 |
| H | 8.637106000 | 4.862583000 | 19.819256000 |
| C | 8.021284000 | 7.729261000 | 22.128908000 |
| H | 7.664195000 | 7.548551000 | 23.141599000 |
| C | 13.446916000 | 8.306566000 | 13.940497000 |
| C | 16.287648000 | 7.071552000 | 23.400912000 |
| C | 9.348593000 | 8.590437000 | 18.136162000 |
| H | 9.649310000 | 9.641295000 | 18.082143000 |
| H | 8.522246000 | 8.434076000 | 17.437413000 |
| H | 10.188713000 | 7.998066000 | 17.747957000 |
| C | 12.828170000 | 5.485199000 | 23.651915000 |
| H | 11.937934000 | 5.915384000 | 23.183879000 |
| H | 12.777761000 | 5.670540000 | 24.728256000 |
| H | 12.769952000 | 4.403302000 | 23.487928000 |
| C | 16.013987000 | 5.483997000 | 13.696358000 |
| H | 16.687002000 | 4.973567000 | 13.012774000 |
| C | 13.252207000 | -0.197165000 | 19.811196000 |
| H | 12.381535000 | -0.487973000 | 19.215729000 |
| H | 13.231293000 | -0.786501000 | 20.735673000 |
| H | 14.146735000 | -0.505049000 | 19.255915000 |
| C | 15.083454000 | 5.704344000 | 15.930416000 |
| H | 15.017901000 | 5.372007000 | 16.961946000 |
| C | 9.671162000 | 4.432699000 | 21.643341000 |
| H | 10.475865000 | 3.794091000 | 22.021162000 |
| H | 8.773843000 | 4.233595000 | 22.240665000 |
| H | 9.948460000 | 5.477043000 | 21.809519000 |
| C | 15.937015000 | 5.067567000 | 15.032967000 |
| H | 16.549607000 | 4.235801000 | 15.370775000 |
| C | 11.881806000 | 9.584300000 | 15.328068000 |
| H | 11.416389000 | 9.787088000 | 16.287851000 |
| C | 11.386500000 | 14.912108000 | 20.352278000 |

| | | | |
|---|---|---|---|
| H | 10.976257000 | 15.375603000 | 21.257589000 |
| H | 10.829537000 | 15.323826000 | 19.501833000 |
| H | 12.424740000 | 15.243423000 | 20.254960000 |
| C | 8.872710000 | 2.725768000 | 19.975752000 |
| H | 8.608052000 | 2.505207000 | 18.937361000 |
| H | 7.967952000 | 2.580756000 | 20.578986000 |
| H | 9.607777000 | 1.986266000 | 20.308183000 |
| C | 11.783397000 | 4.011549000 | 16.531373000 |
| H | 12.089017000 | 5.052027000 | 16.386445000 |
| H | 11.563657000 | 3.592891000 | 15.542390000 |
| H | 12.633921000 | 3.464490000 | 16.946238000 |
| C | 5.857537000 | 6.747144000 | 21.269966000 |
| H | 5.151898000 | 7.478959000 | 21.681321000 |
| H | 5.907270000 | 5.915869000 | 21.981496000 |
| H | 5.431128000 | 6.366894000 | 20.337514000 |
| C | 9.352560000 | 4.638623000 | 16.818889000 |
| H | 8.449529000 | 4.550311000 | 17.430973000 |
| H | 9.125027000 | 4.221788000 | 15.830945000 |
| H | 9.565473000 | 5.704299000 | 16.682155000 |
| C | 17.324818000 | 7.658609000 | 24.321894000 |
| H | 18.336770000 | 7.504695000 | 23.934835000 |
| H | 17.272884000 | 7.210562000 | 25.318864000 |
| H | 17.185018000 | 8.739751000 | 24.444727000 |
| C | 13.118801000 | 9.079597000 | 12.832976000 |
| H | 13.588250000 | 8.898239000 | 11.869126000 |
| C | 12.173957000 | 10.100994000 | 12.971579000 |
| H | 11.911260000 | 10.710384000 | 12.111153000 |
| C | 11.564074000 | 10.350153000 | 14.209267000 |
| H | 10.836103000 | 11.152581000 | 14.295512000 |

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