Supporting information

UV-Vis method for investigation of gallium(III) complexation kinetics with NOTA and TRAP chelators: advantages, limitations and comparison with radiolabelling

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Table of content

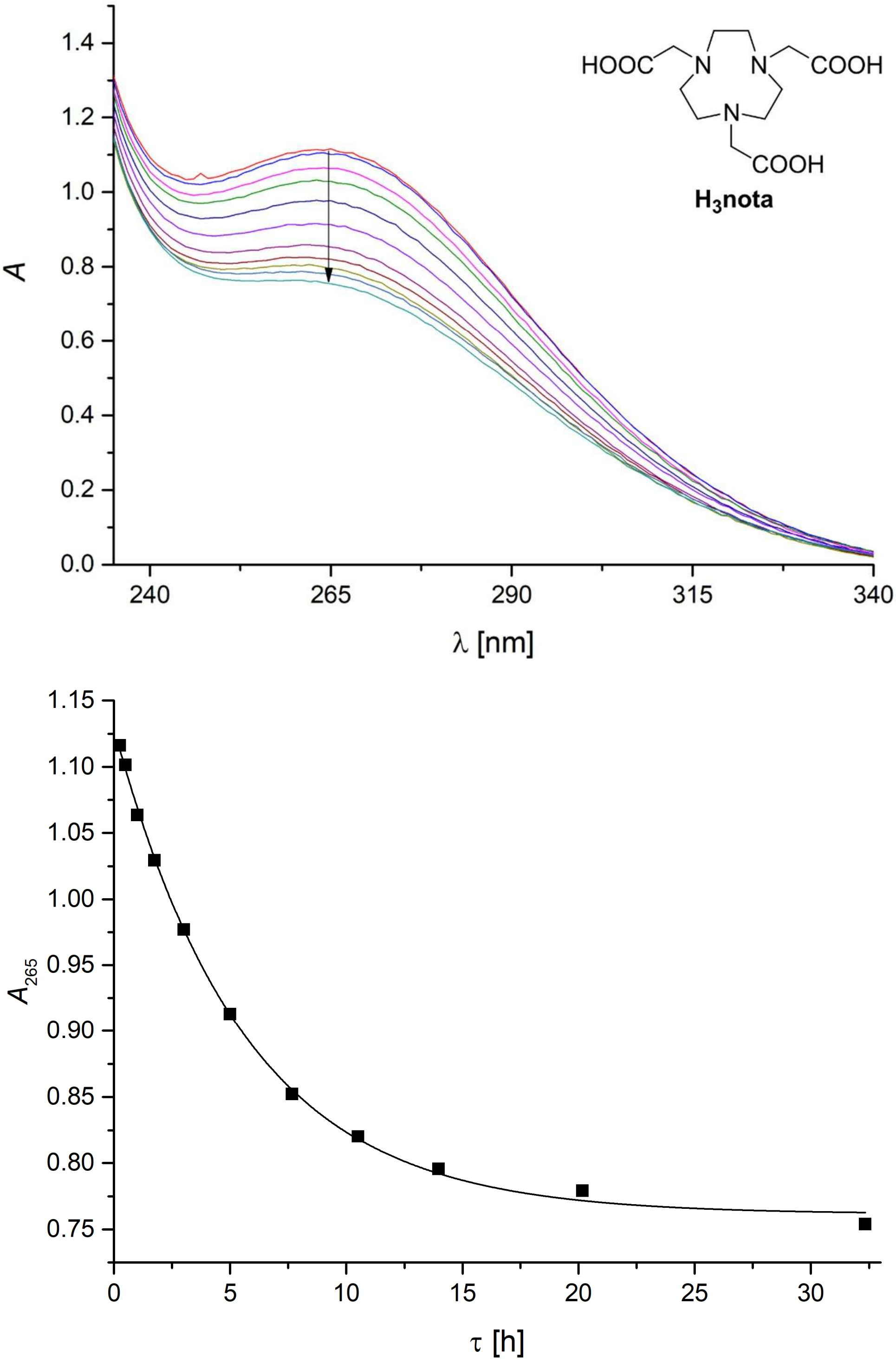

Figure S1. Example of change of the Cu^{II} complex spectra in the course of Ga^{III} complexation experiments with H_3nota (top) and the corresponding Cu^{II} complex absorbance at 265 nm as function of time (bottom). The line corresponds to the best fit according to Equation 1 (30 °C, c_{chel} = 0.4 mM, c_{Ga} = 0.2 mM, pH 1.25).

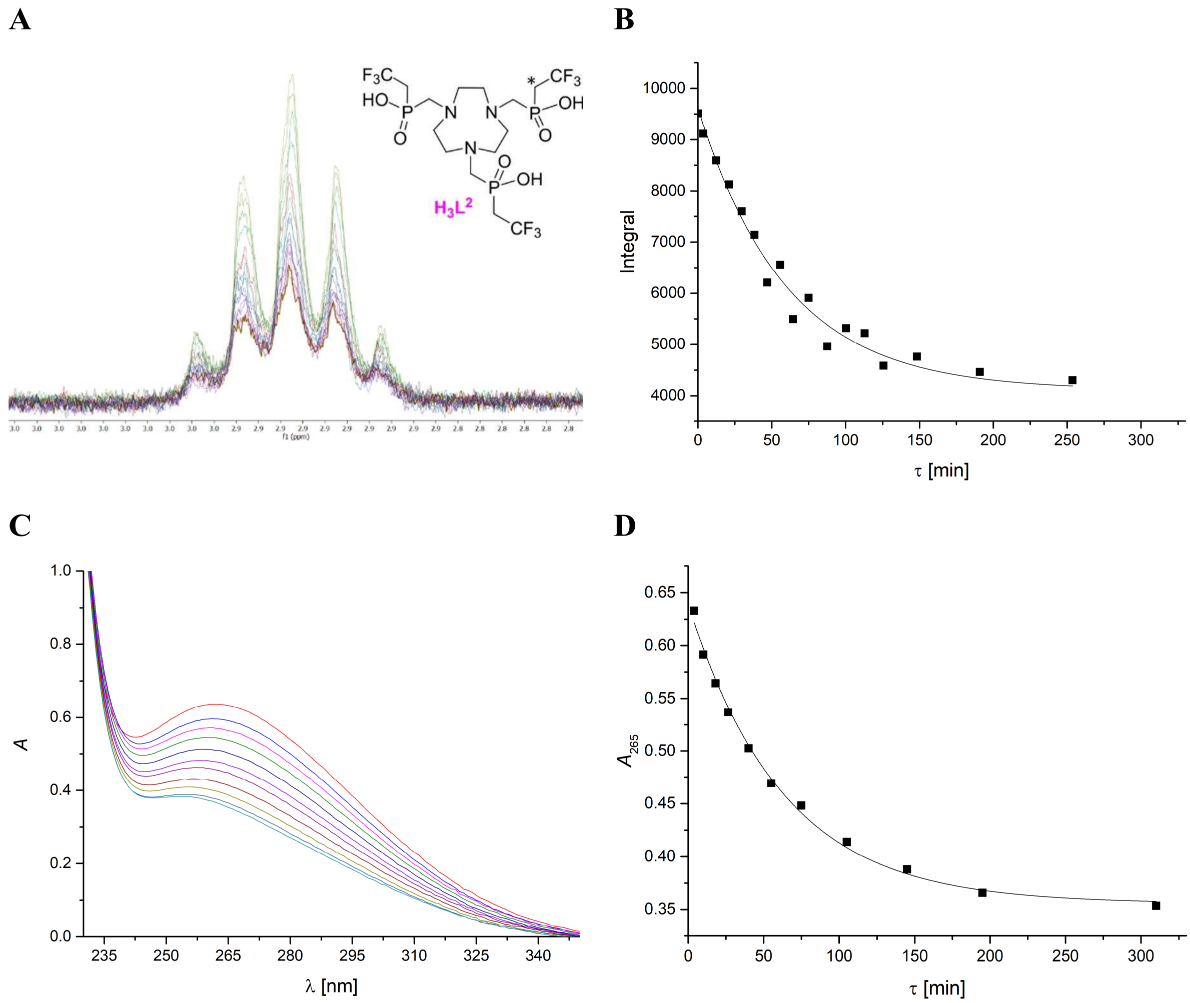

Figure S2. Comparison of UV-Vis and ^{1}H NMR data for Ga^{III} complexation kinetics with $H_3\mathbf{L}^2$. Change of P–C$\mathbf{H}_2$–CF_3 integral in ^{1}H NMR spectra during Ga^{III} complexation experiment (**A**) and the integral intensity as a function of time (**B**). The line corresponds to the best fit according to Equation 2. Change of the Cu^{II} complex spectra in the course of Ga^{III} complexation experiments with $H_3\mathbf{L}^2$ (**C**) and the corresponding complex absorbance at 265 nm as function of time (**D**). The line corresponds to the best fit according to Equation 1 (30 °C, c_{chel} = 0.4 mᴍ, c_{Ga} = 0.2 mᴍ, pH 1.00).

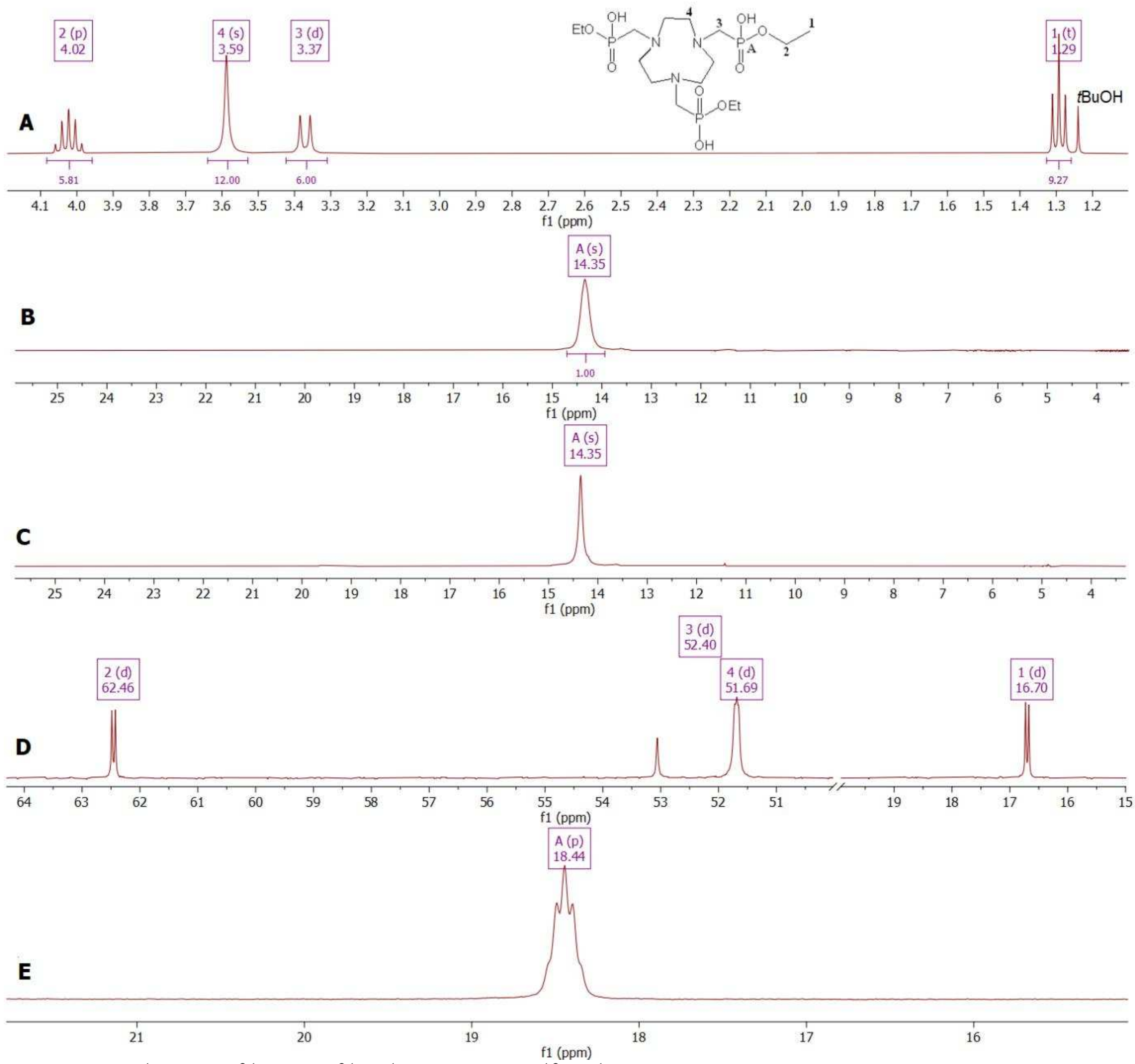

Figure S3. ^{1}H (**A**), ^{31}P (**B**), $^{31}P\{^{1}H\}$ (**C**) and $^{13}C\{^{1}H\}$ (**D**) NMR spectra of $H_3\mathbf{L^1}$ (D_2O, pD 1.4) and detail of ^{31}P NMR spectra (**E**) (162 MHz, D_2O + NaOD, pD 10.4)

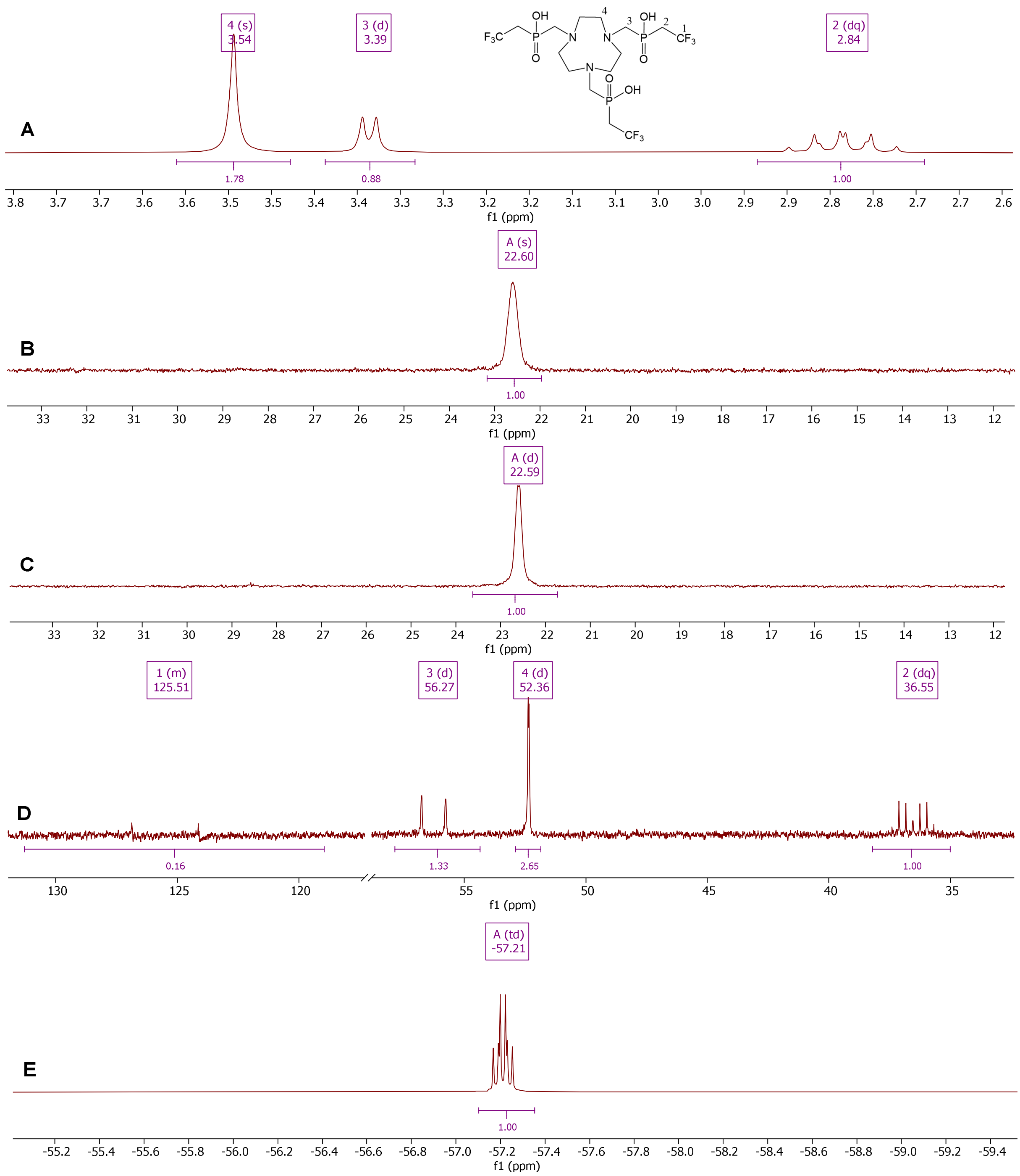

Figure S4. ^{1}H (**A**), ^{31}P (**B**), $^{31}P\{^{1}H\}$ (**C**) $^{13}C\{^{1}H\}$ (**D**), ^{19}F (**E**) NMR spectra of H_3**L**$^{\mathbf{2}}$ (D_2O, pD 1.6)

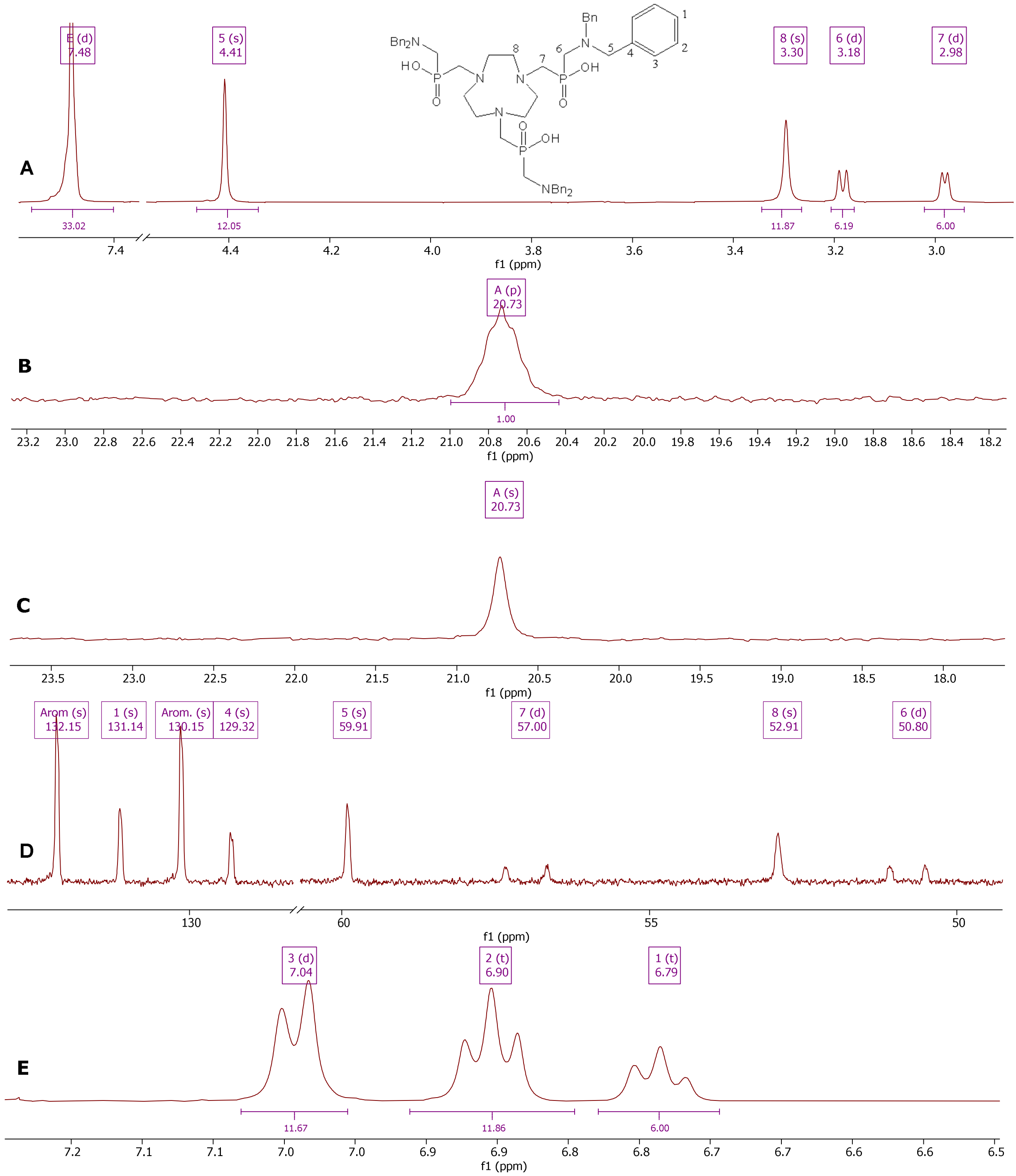

Figure S5. ^{1}H (**A**), ^{31}P (**B**), ^{31}P{^{1}H} (**C**) and ^{13}C{^{1}H} (**D**) NMR spectra of H_3**L^3** (D_2O, pD 1.9) and detail of aromatic region of ^{1}H NMR spectra (**E**) (D_2O + NaOD, pD 10.7)

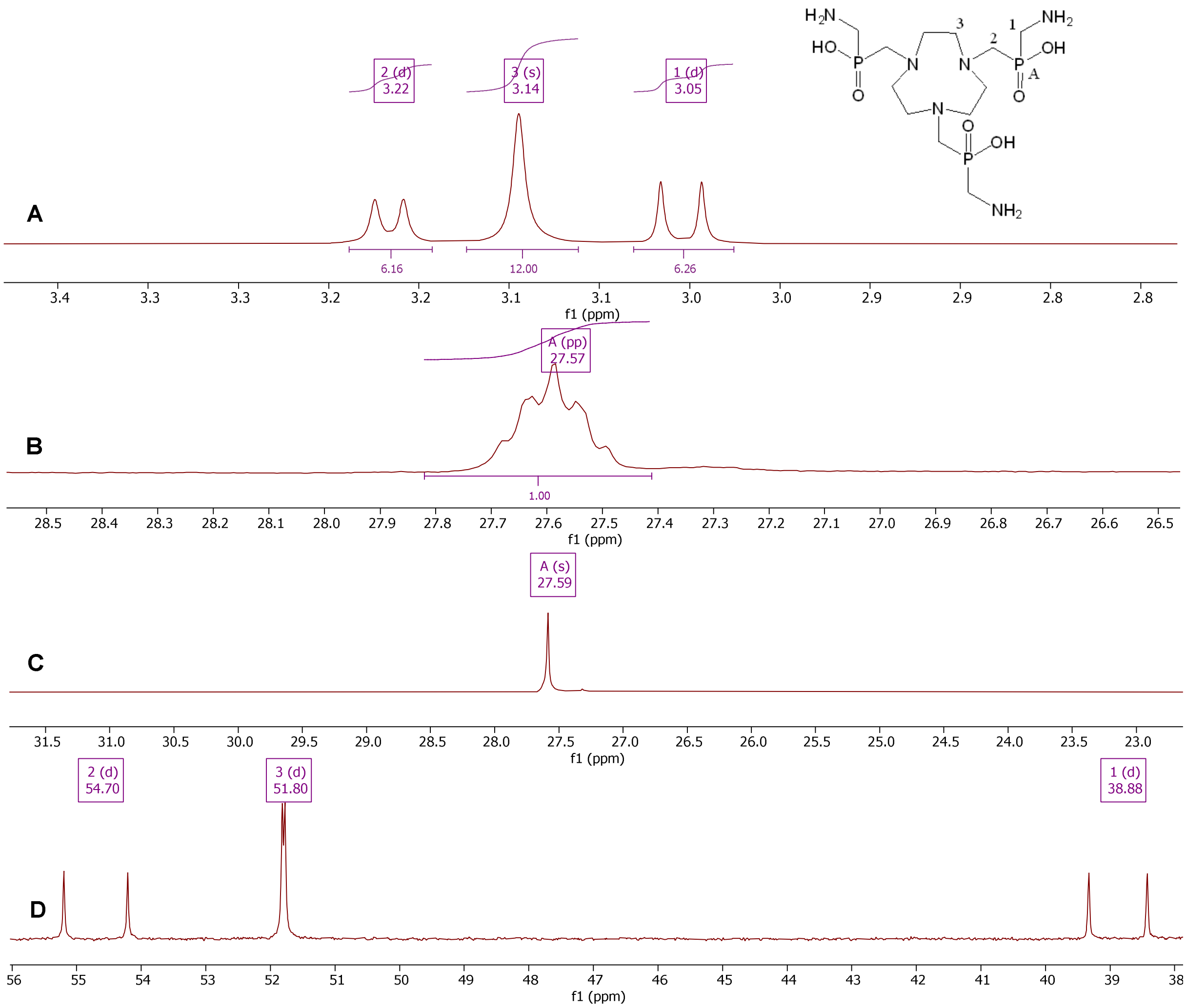

Figure S6. ^{1}H (**A**), ^{31}P (**B**), ^{31}P{^{1}H} (**C**) and ^{13}C{^{1}H} (**D**) NMR spectra of H_3**L**$^{\mathbf{4}}$ (D_2O, pD 8.0)

Characterisation of gallium(III) complexes

Ga–L1

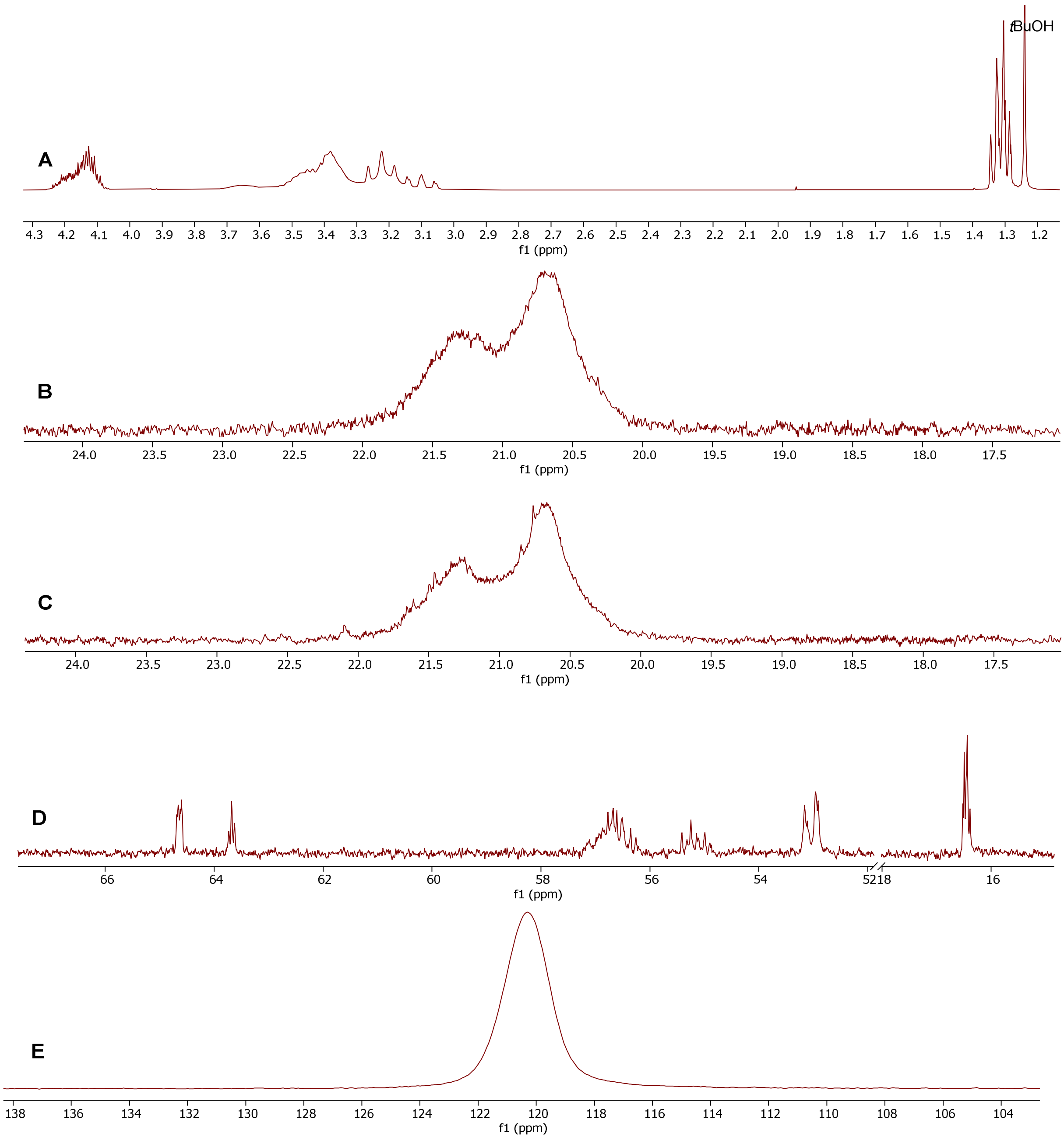

Figure S7a. ^{1}H (**A**), ^{31}P (**B**), $^{31}P\{^{1}H\}$ (**C**), $^{13}C\{^{1}H\}$ (**D**) and ^{71}Ga (**E**) NMR spectra of [Ga$\mathbf{L^1}$] at 25 °C (D_2O, pD 7.6)

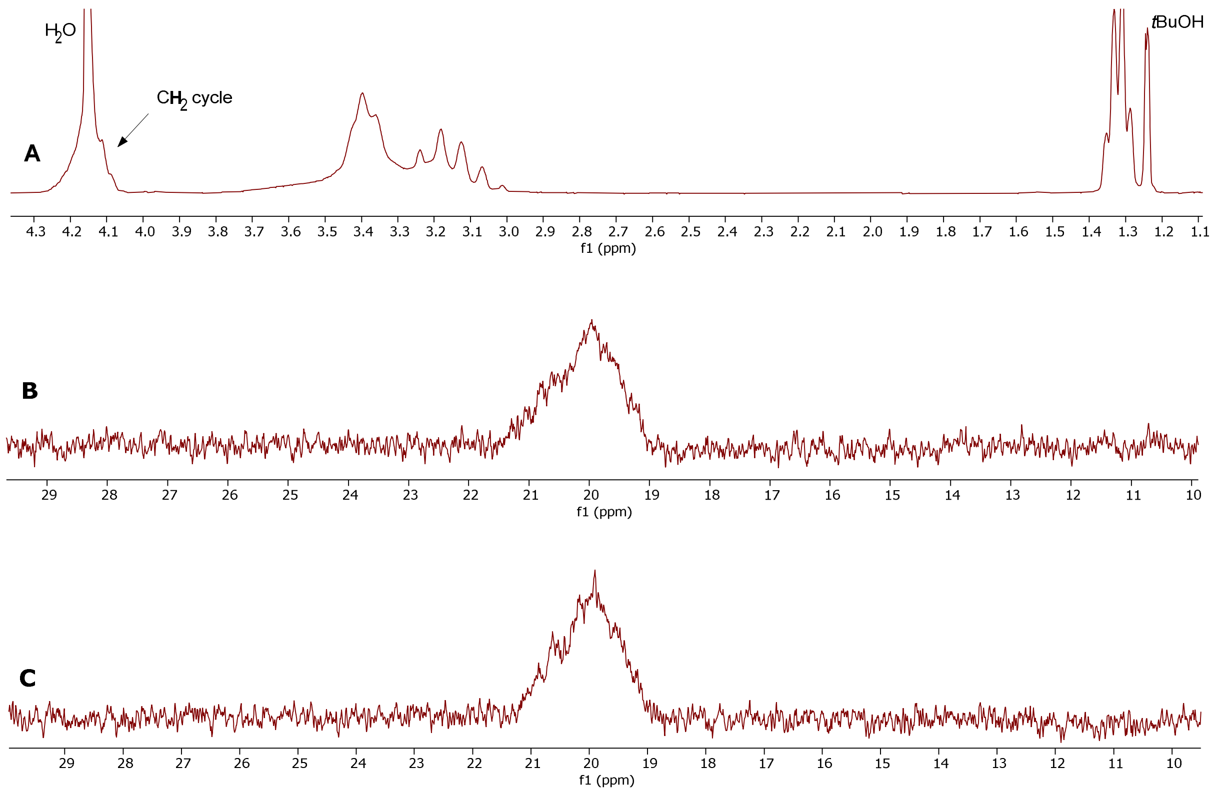

Figure S7b. ^{1}H (**A**), ^{31}P (**B**) and $^{31}P\{^{1}H\}$ (**C**) NMR spectra of [Ga$\mathbf{L^1}$] at 90 °C (D_2O, pD 6.2)

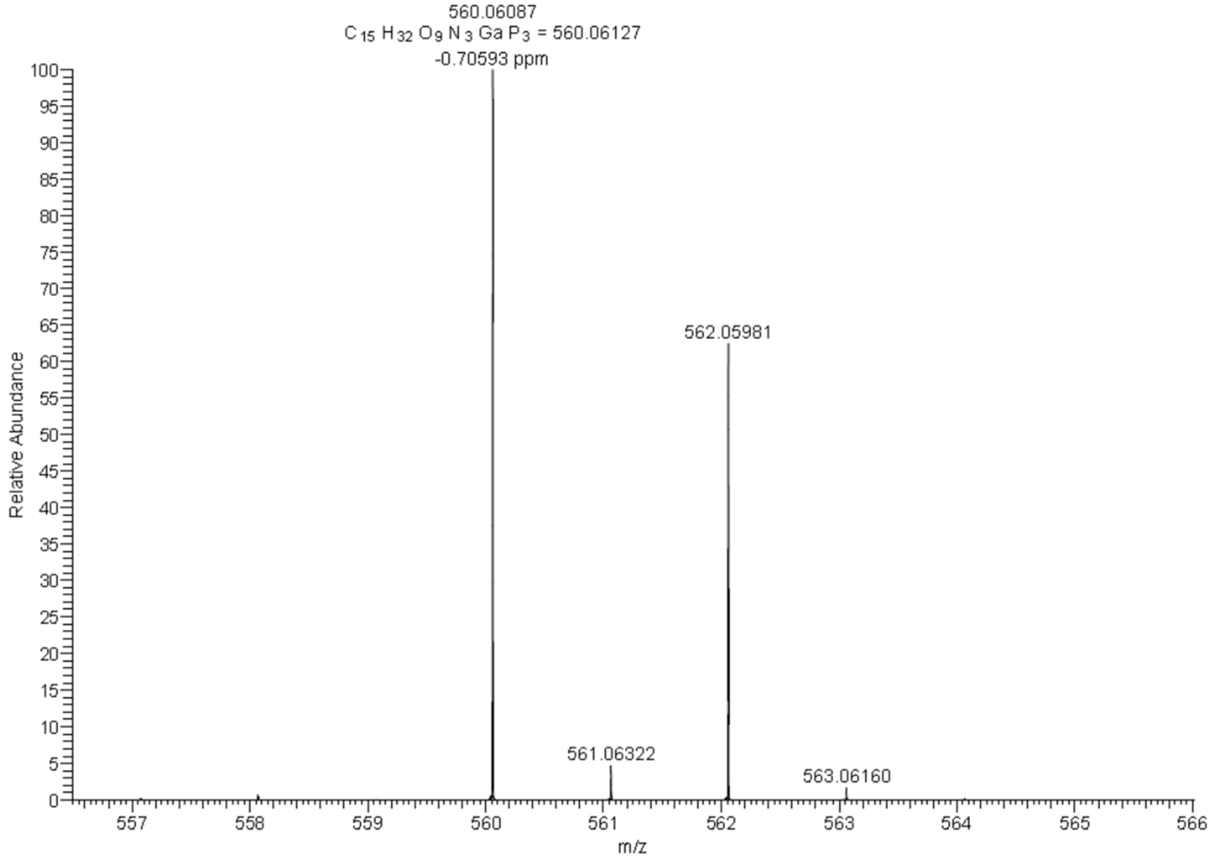

Figure S8. High-resolution mass spectra of [Ga**L**^{1}] in the negative mode

Ga–L^2

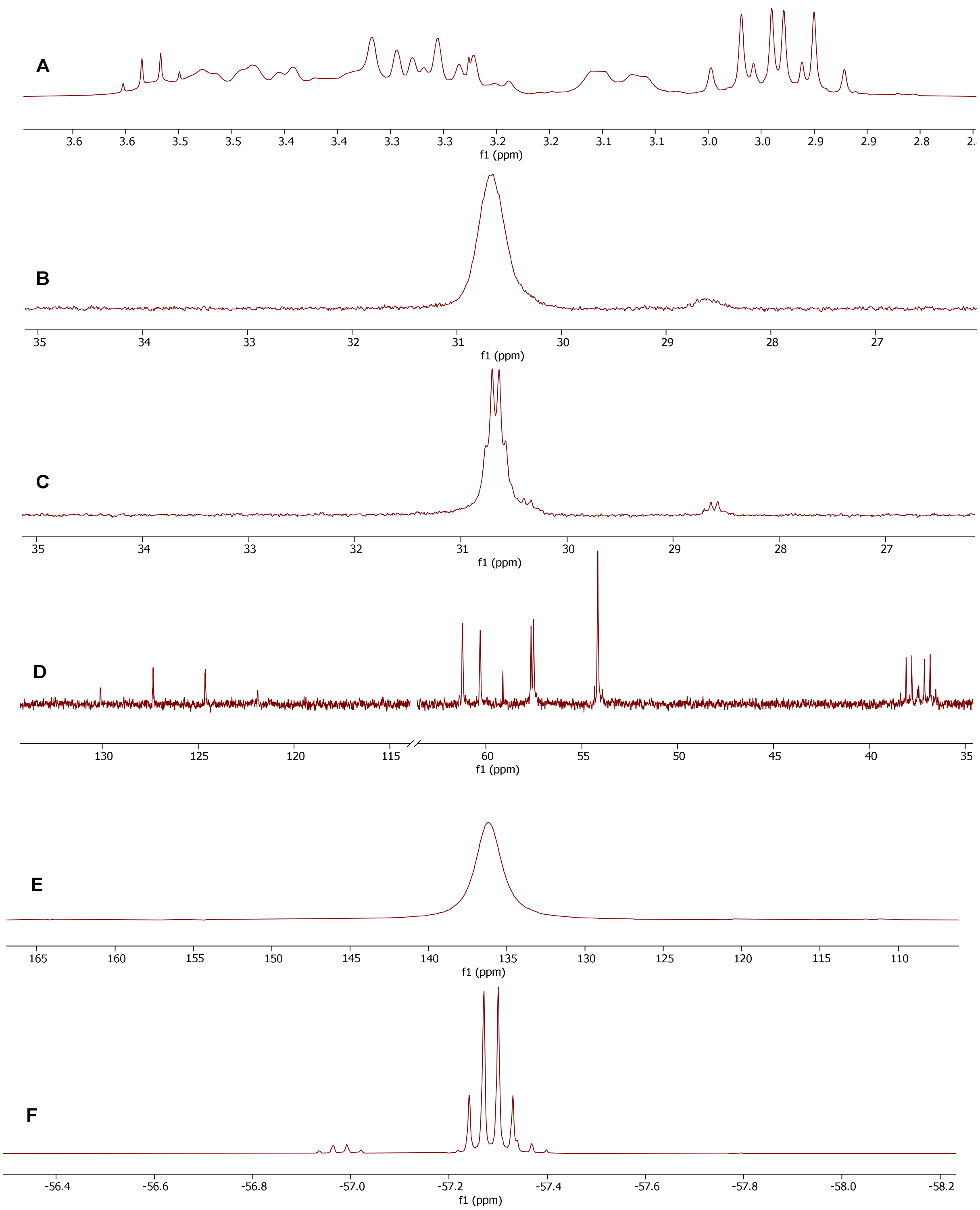

Figure S9. ^{1}H (**A**), ^{31}P (**B**), ^{31}P{^{1}H} (**C**), ^{13}C{^{1}H} (**D**), ^{71}Ga (**E**) and ^{19}F (**F**) NMR spectra of [Ga$\mathbf{L^2}$] (D_2O, pD 5.4)

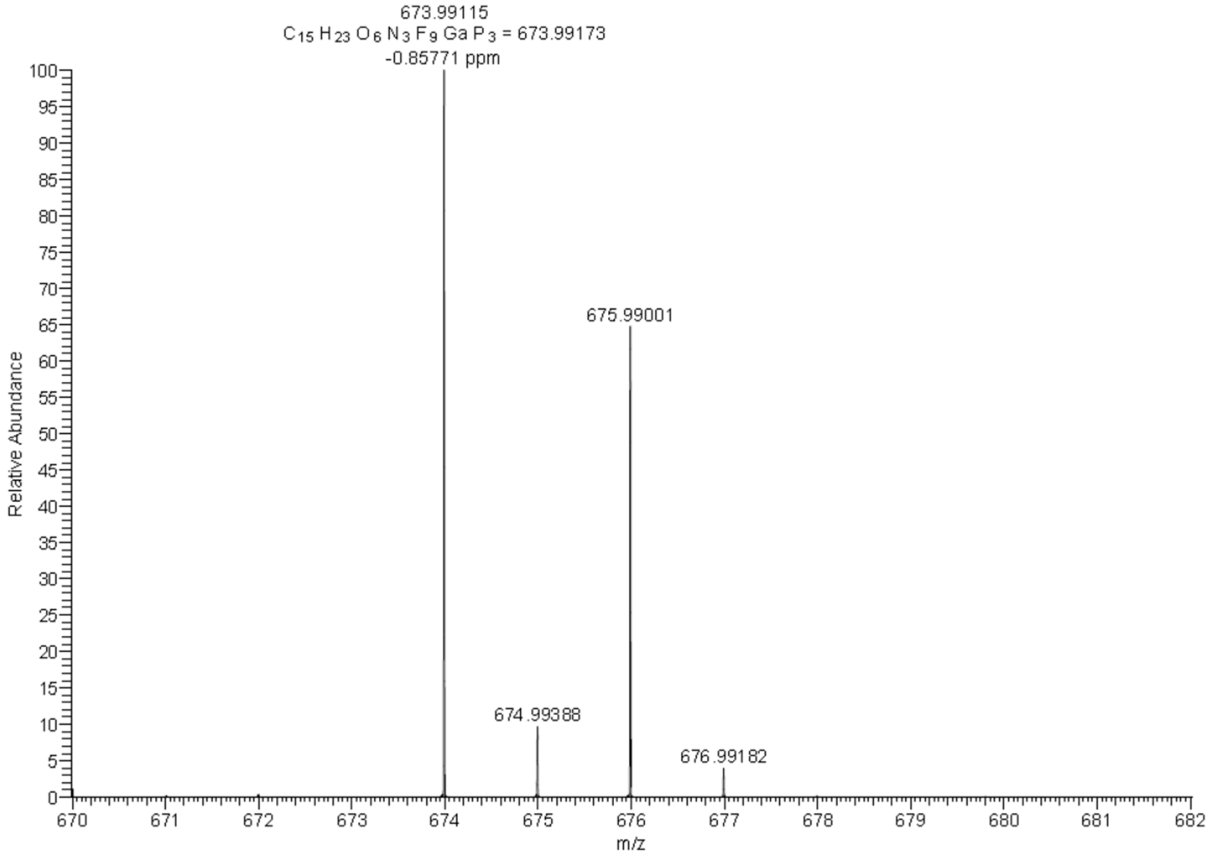

Figure S10. High-resolution mass spectra of [Ga**L**^{2}] in the negative mode

Ga–L^4

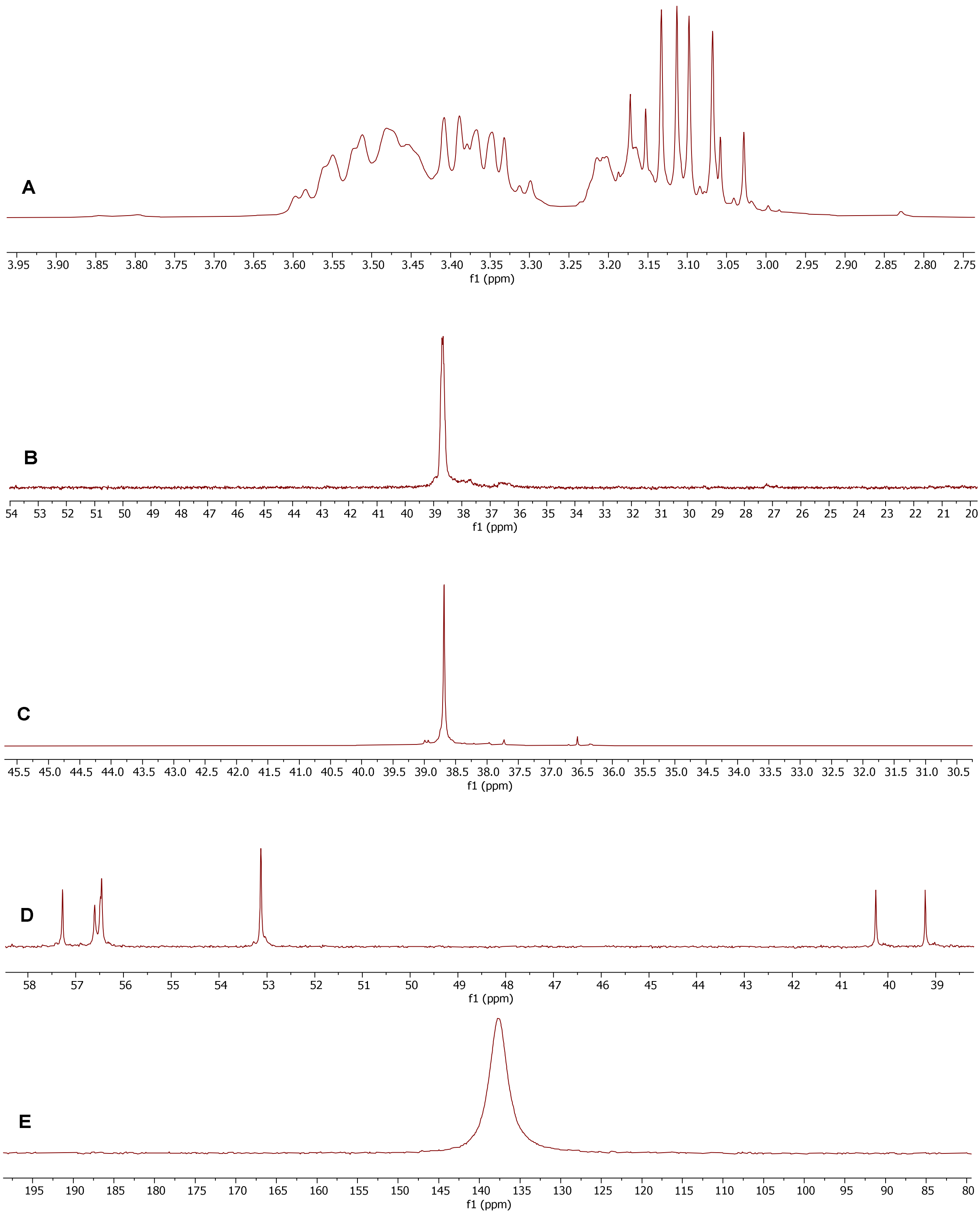

Figure S11. ^{1}H (**A**), ^{31}P (**B**), $^{31}P\{^{1}H\}$ (**C**), $^{13}C\{^{1}H\}$ (**D**) and ^{71}Ga (**E**) NMR spectra of [Ga**L^4**] (D_2O, pD 7.6)

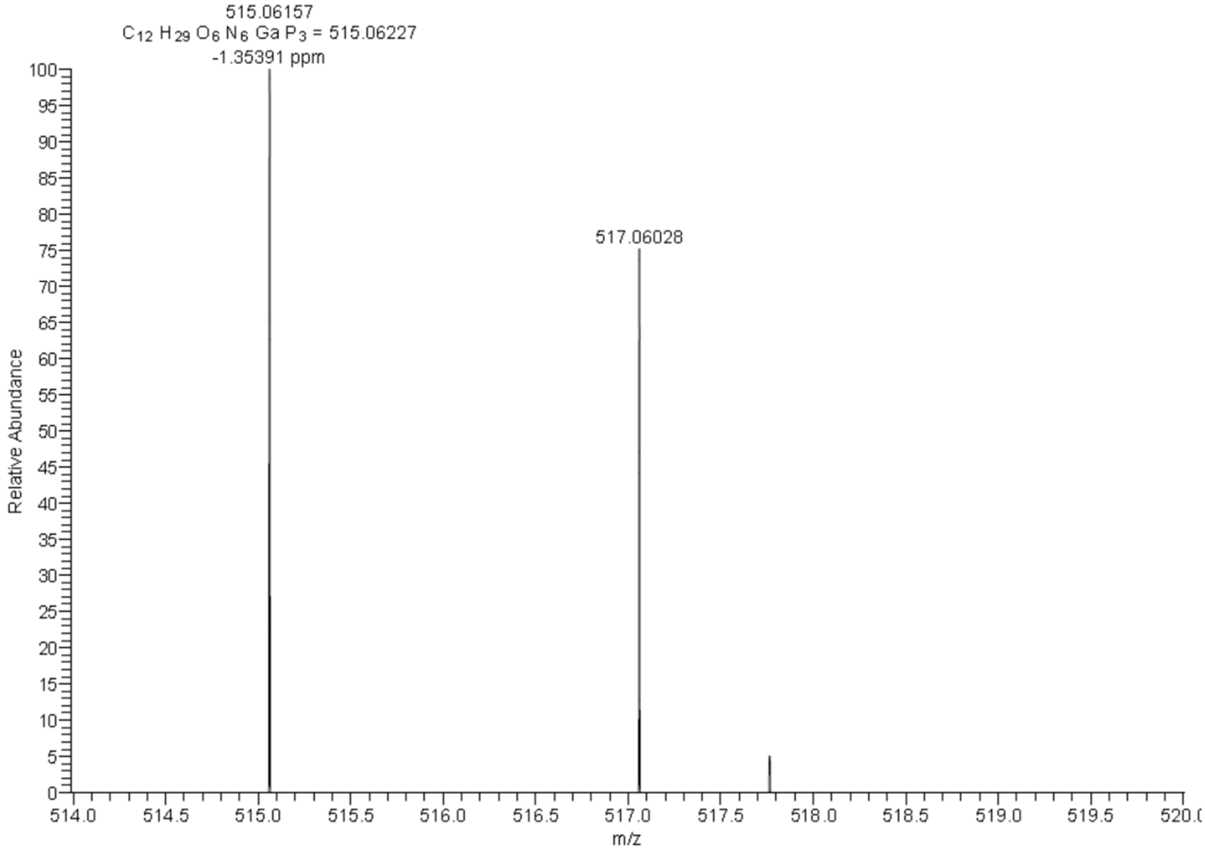

Figure S12. High-resolution mass spectra of [Ga**L**^{4}] in the negative mode

Table S1. Overall protonation constants (logβ) of ligands $H_3\mathbf{L^1}$ and $H_3\mathbf{L^3}$ (I = 0.1M $(NMe_4)Cl$, 25 °C)

Species	$H_3\mathbf{L^1}$	$H_3\mathbf{L^4}$
HL	11.54(2)	11.21(1)
H_2L	14.97(5)	20.04(2)
H_3L	16.37(6)	28.20(1)
H_4L	-	35.50(1)
H_5L	-	37.59(2)

Table S2. Overall stability constants (logβ) of $H_3\mathbf{L^1}$ complexes (I = 0.1M $(NMe_4)Cl$, 25 °C)

Species	Ga^{III}	Cu^{II}
[M(L)]	20.5(3)	14.7(5)
[M(HL)]	22.3(3)	-
[M(L)(OH)]	14.1(2)	3.69(6)

Table S3. Rate constants and times necessary for 99% complexation of Ga^{III} complexation with the studied chelators as function of pH obtained by UV-Vis experiments (c_{chel} = 0.4 mM, c_{Ga} = 0.2 mM, 30 °C, pH 0.25–3.0)

H_3notP^{Pr}

pH	k_{obs} [s^{-1}]	$t_{99\%}$ [s]	$t_{99\%}$
0.25	$1.2(2)\cdot10^{-5}$	$3.8\cdot10^{5}$	107 h
0.50	$7.1(4)\cdot10^{-5}$	$6.5\cdot10^{4}$	18 h
1.00	$1.61(7)\cdot10^{-3}$	$2.86\cdot10^{3}$	48 min
1.50	$1.6(2)\cdot10^{-2}$	290	5 min
2.05	$9.3(4)\cdot10^{-2}$	49	49 s

H_3**L**^{2}

pH	k_{obs} [s^{-1}]	$t_{99\%}$ [s]	$t_{99\%}$
0.50	$1.51(8)\cdot10^{-5}$	$3.05\cdot10^{5}$	85 h
1.00	$2.7(2)\cdot10^{-4}$	$1.7\cdot10^{4}$	5 h
1.60	$2.9(3)\cdot10^{-3}$	$1.6\cdot10^{3}$	27 min
2.00	$7.5(5)\cdot10^{-3}$	620	10 min
2.45	$3.2(1)\cdot10^{-2}$	140	2 min

H_3nota

pH	k_{obs} [s^{-1}]	$t_{99\%}$ [s]	$t_{99\%}$
1.00	$9.5(9)\cdot10^{-6}$	$4.8\cdot10^{5}$	135 h
1.25	$5.0(2)\cdot10^{-5}$	$9.3\cdot10^{4}$	26 h
1.55	$3.0(2)\cdot10^{-4}$	$1.5\cdot10^{4}$	4 h
2.00	$2.9(2)\cdot10^{-3}$	$1.6\cdot10^{3}$	26 min
2.60	$5.2(3)\cdot10^{-2}$	88	88 s

H_3**L**^{3}

pH	k_{obs} [s^{-1}]	$t_{99\%}$ [s]	$t_{99\%}$
1.65	$7.1(4)\cdot10^{-5}$	$6.4\cdot10^{4}$	18 h
2.00	$2.8(2)\cdot10^{-4}$	$1.6\cdot10^{4}$	4 h
2.60	$2.3(2)\cdot10^{-3}$	$2.0\cdot10^{3}$	33 min
3.00	$1.2(1)\cdot10^{-2}$	380	6 min

H_3**L**^{1}

pH	k_{obs} [s^{-1}]	$t_{99\%}$ [s]	$t_{99\%}$
0.50	$8.6(3)\cdot10^{-6}$	$5.3\cdot10^{5}$	149 h
1.00	$1.47(9)\cdot10^{-4}$	$3.12\cdot10^{4}$	9 h
1.60	$1.22(6)\cdot10^{-3}$	$3.77\cdot10^{3}$	62 min
2.00	$3.5(2)\cdot10^{-3}$	$1.3\cdot10^{3}$	21 min
2.55	$1.89(4)\cdot10^{-2}$	243	4 min

H_3**L**^{4}

pH	k_{obs} [s^{-1}]	$t_{99\%}$ [s]	$t_{99\%}$
1.00	$1.9(2)\cdot10^{-5}$	$2.4\cdot10^{5}$	68 h
1.65	$1.3(1)\cdot10^{-4}$	$3.4\cdot10^{4}$	10 h
2.00	$3.4(3)\cdot10^{-4}$	$1.3\cdot10^{4}$	4 h
2.60	$2.3(2)\cdot10^{-3}$	$2.0\cdot10^{3}$	34 min
3.00	$8.2(6)\cdot10^{-3}$	560	9 min

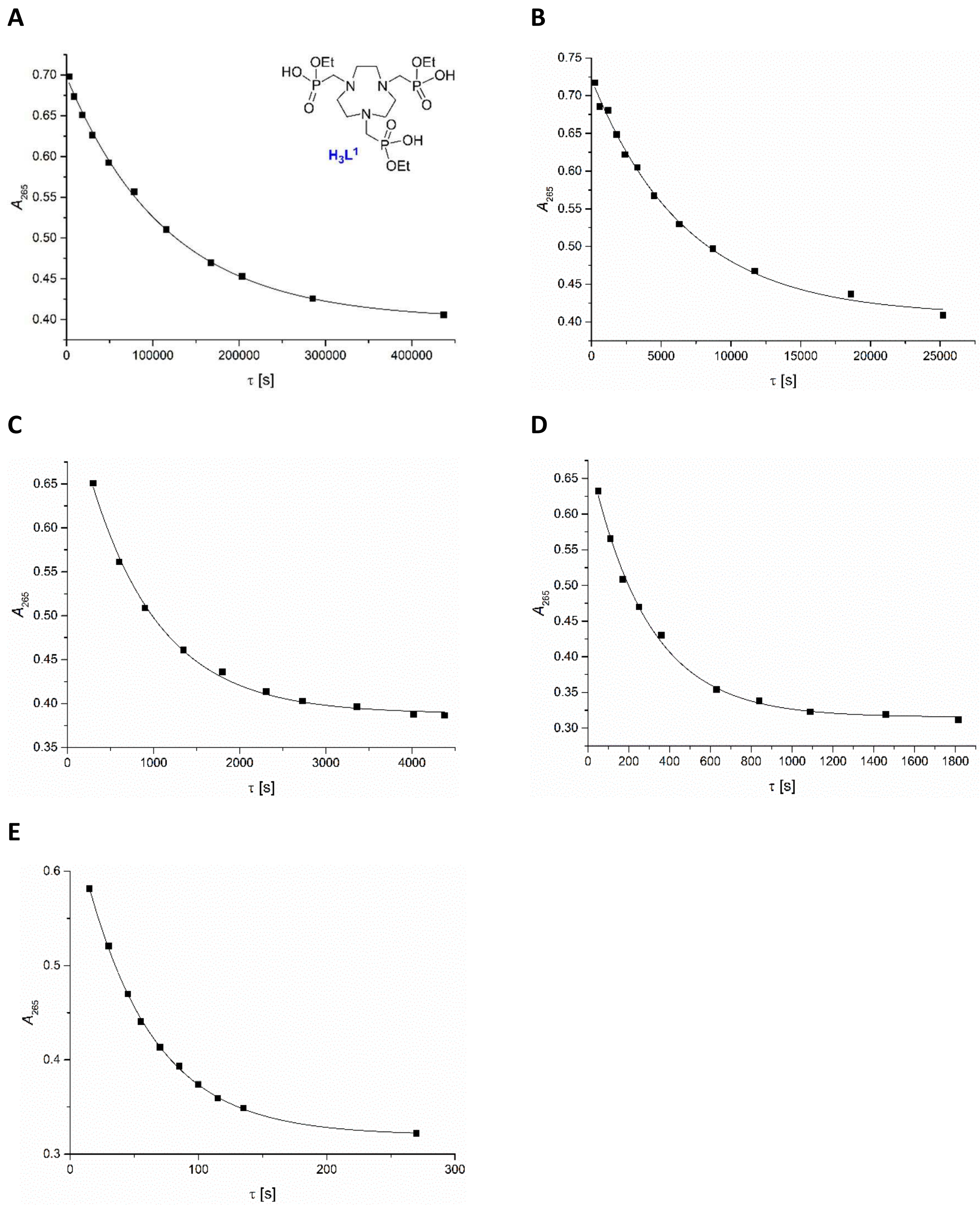

Figure S13. Change of the [Cu**L**[1]] complex absorbance at 265 nm in the course of Ga^{III} complexation experiments at pH 0.50 (**A**), 1.00 (**B**), 1.60 (**C**), 2.00 (**D**), 2.55 (**E**) as a function of time. The lines correspond to the best fit according to Equation 1 (30 °C, c_{chel} = 0.4 mᴍ, c_{Ga} = 0.2 mᴍ).

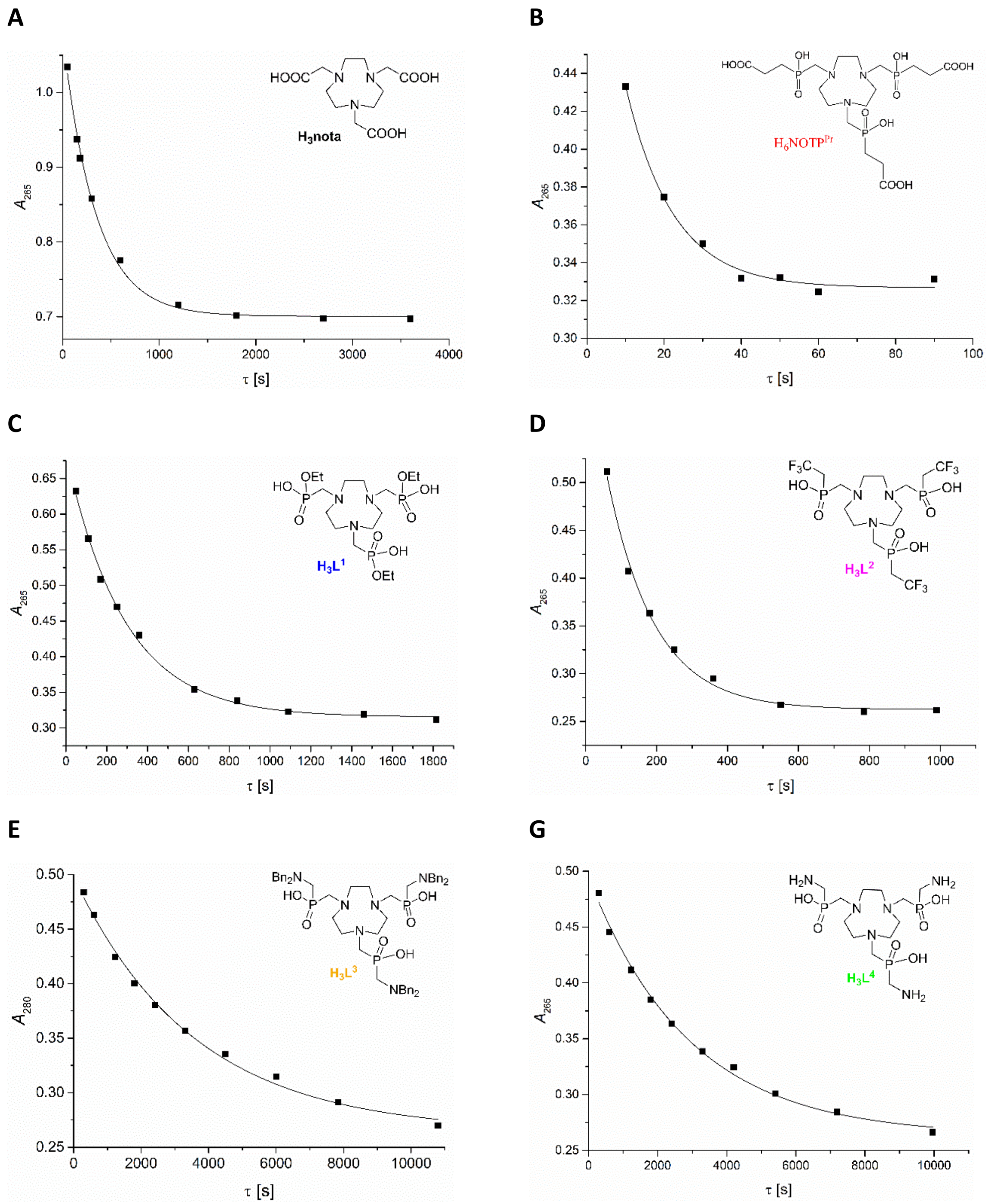

Figure S14. Change of the Cu^{II} complex absorbances at 265 nm (280 for H_3**L**^{3}) in the course of Ga^{III} complexation experiments as a function of time for H_3nota (**A**), H_6notP^{Pr} (**B**), H_3**L**^{1} (**C**), H_3**L**^{2} (**D**), H_3**L**^{3} (**E**), H_3**L**^{4} (**F**). The lines correspond to the best fit according to Equation 1 (30 °C, c_{chel} = 0.4 mM, c_{Ga} = 0.2 mM).