

Supporting Information

Acid-base modulation of a versatile heteroditopic calix[6]arene based receptor

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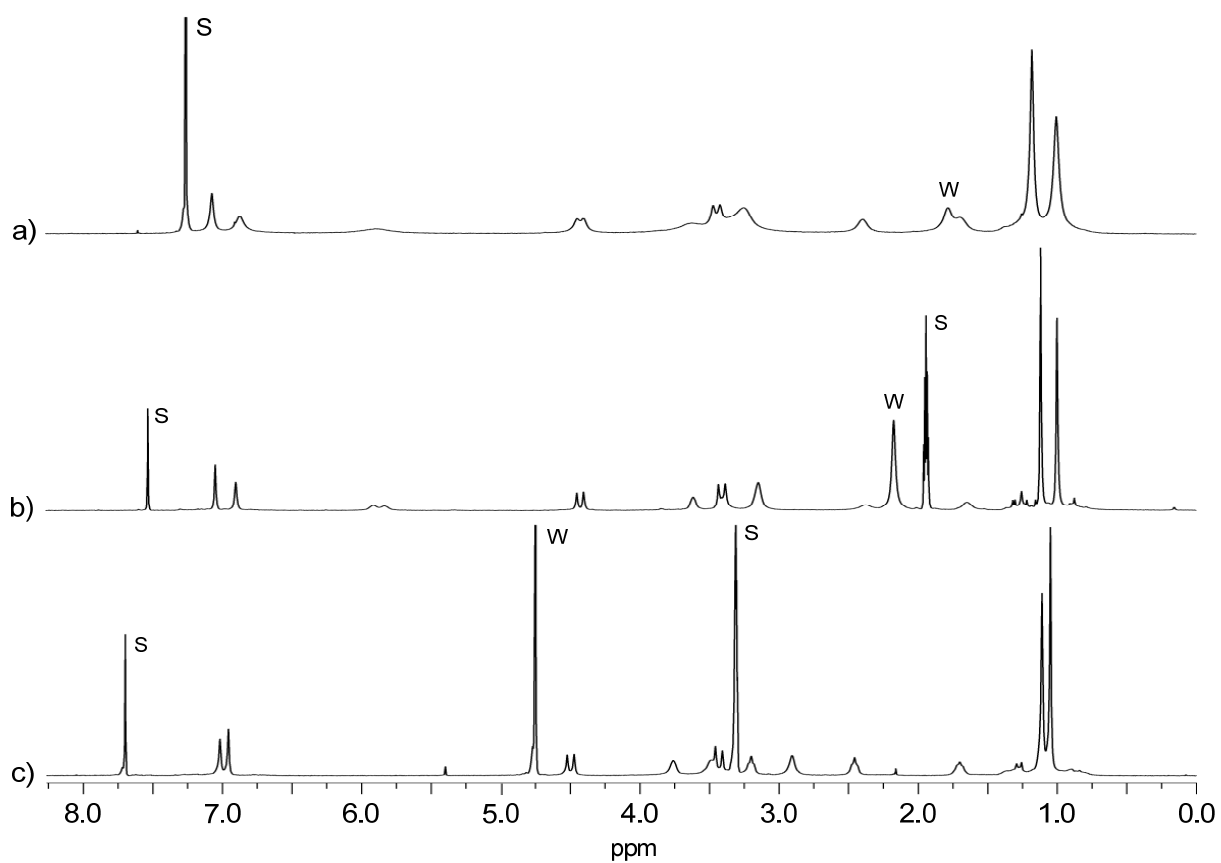
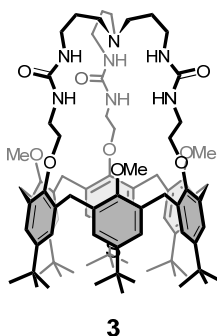
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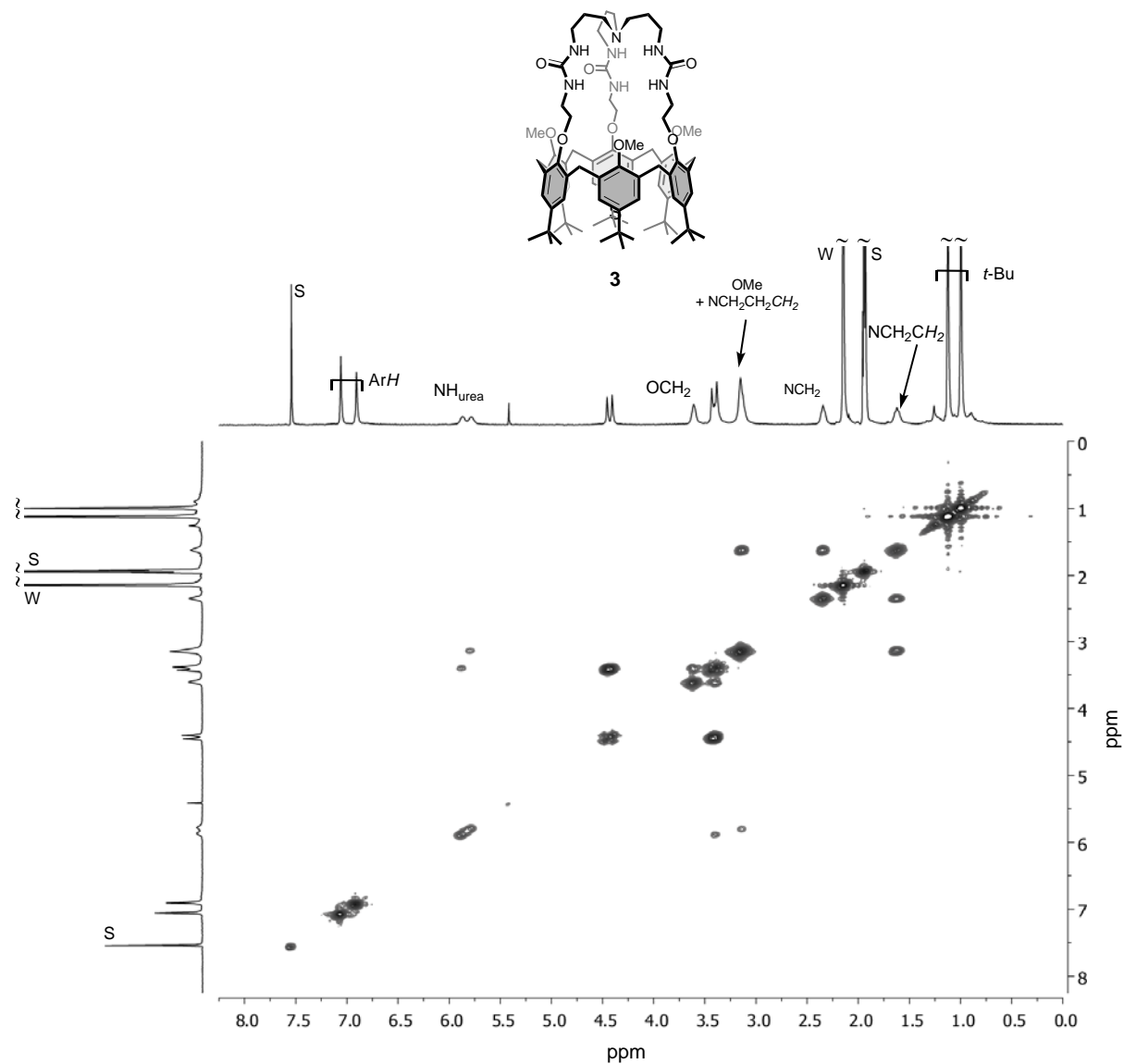
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SI1. ^1H NMR (298K, 300MHz) spectra of **3** in CDCl_3 , $\text{CD}_3\text{CN}/\text{CDCl}_3$ (7:3) and $\text{CD}_3\text{OD}/\text{CDCl}_3$ (7:3)



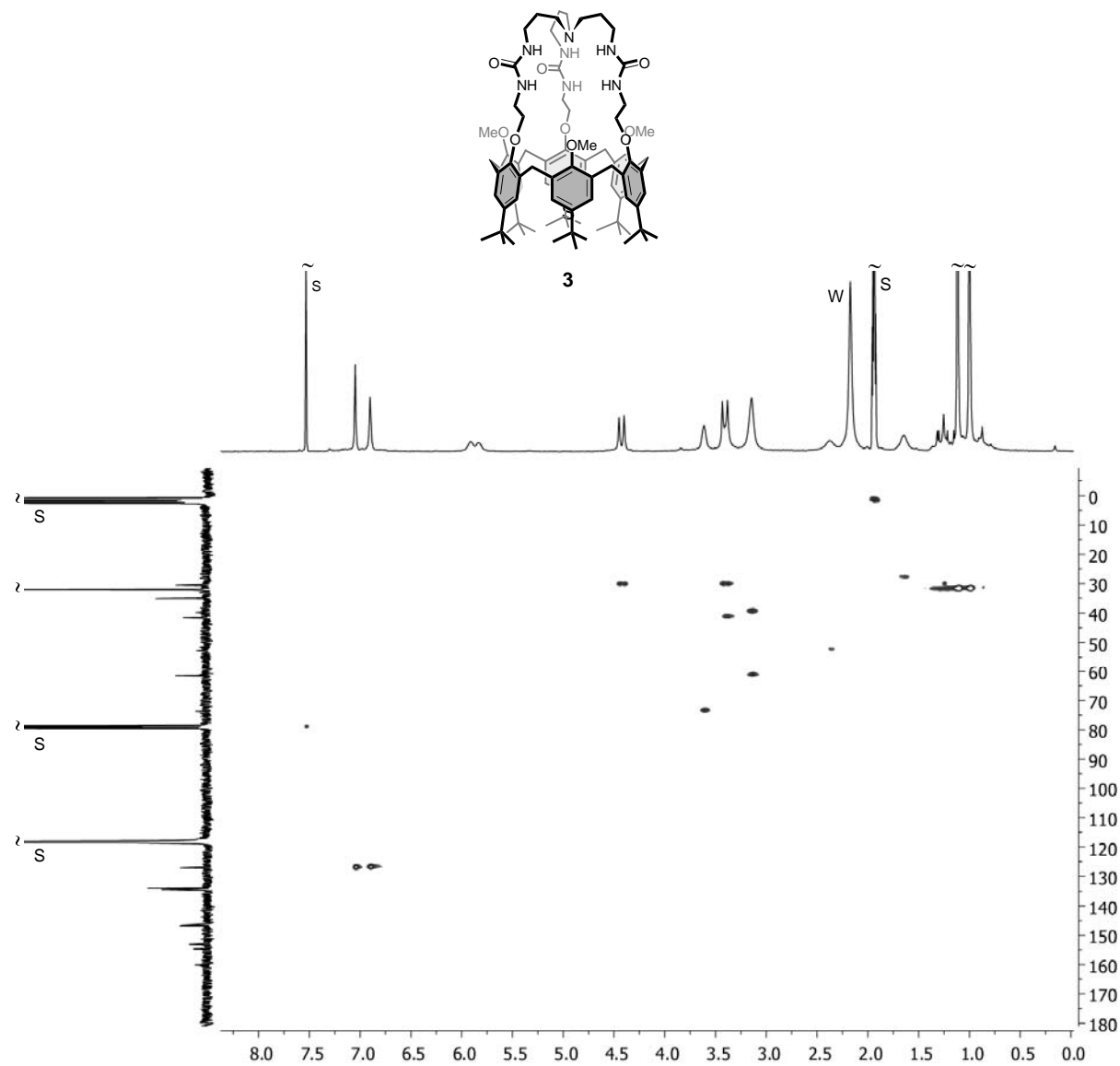
^1H NMR (298K, 300MHz) spectra of **3** in a) CDCl_3 , b) $\text{CD}_3\text{CN}/\text{CDCl}_3$ (7:3) and c) $\text{CD}_3\text{OD}/\text{CDCl}_3$ (7:3). S: solvent; W: water.

SI2. COSY (298K, 300 MHz) spectrum of **3** in CD₃CN/CDCl₃ (7:3)



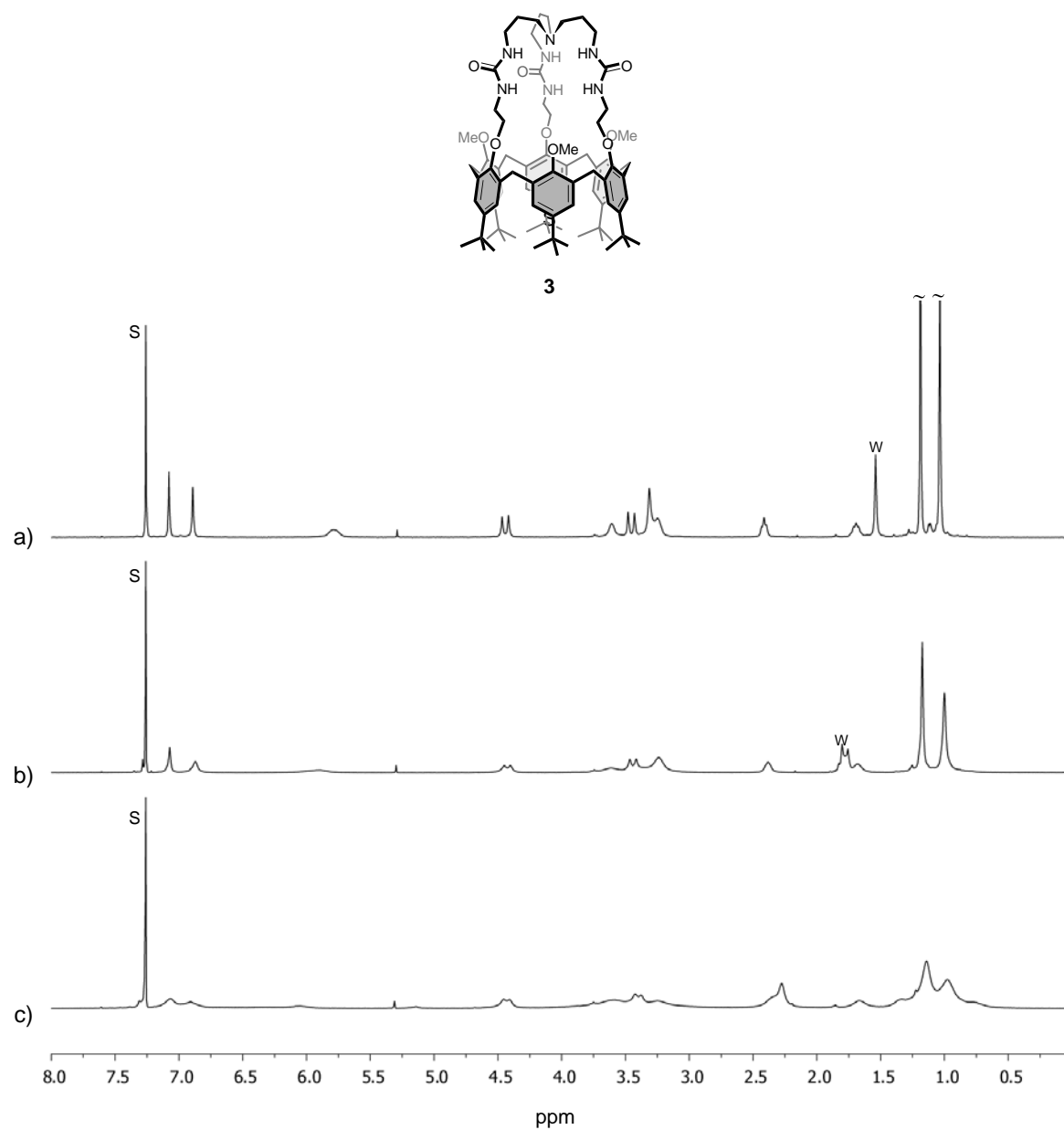
COSY (298 K, 300 MHz) spectrum of **3** in CD₃CN/CDCl₃ (7:3). S: solvent; W: water.

SI3. HSQC (298K, 300 MHz) spectrum of **3** in CD₃CN/CDCl₃ (7:3)



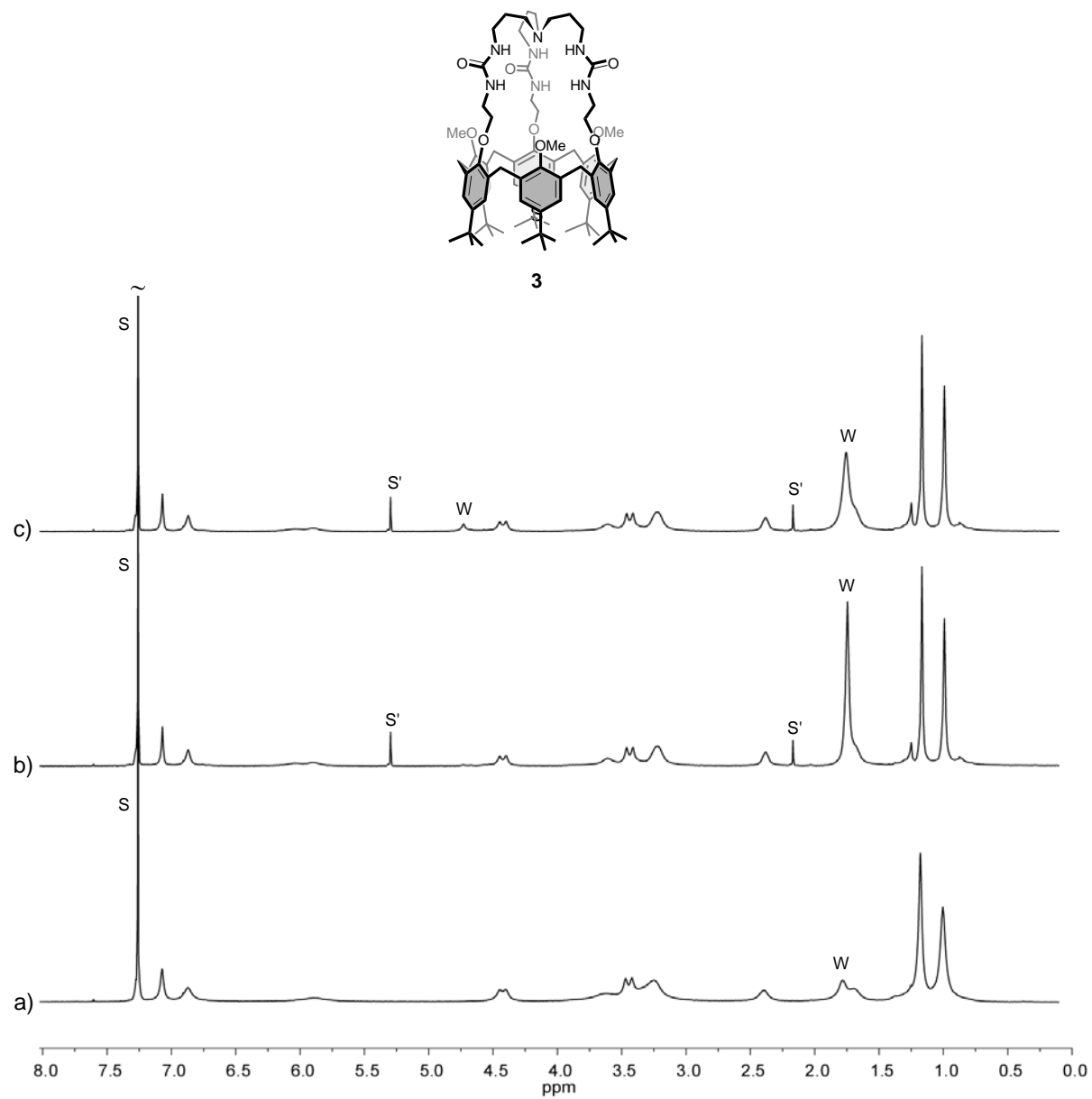
HSQC (298K, 300 MHz) spectrum of **3** in CD₃CN/CDCl₃ (7:3). S: solvent; W: water.

SI4. ^1H NMR (300 MHz) spectra of **3** in CDCl_3 at 328K, 298K and 258K



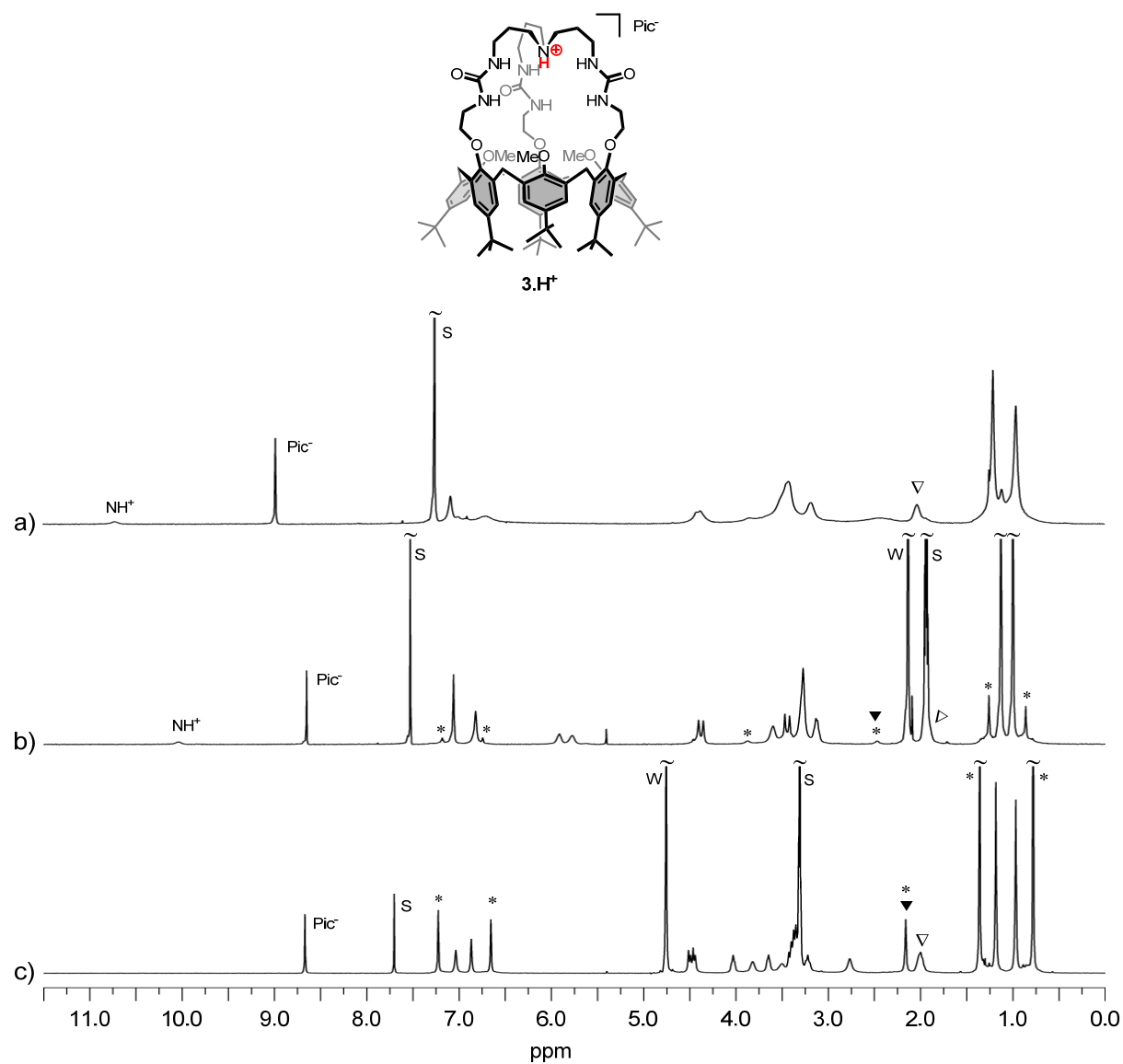
^1H NMR (300 MHz) spectra of **3** in CDCl_3 at a) 328K, b) 298K and c) 258K. S: solvent; W: water.

SI5. ^1H NMR (298K, 300 MHz) spectra of **3** in CDCl_3 with different amounts of water



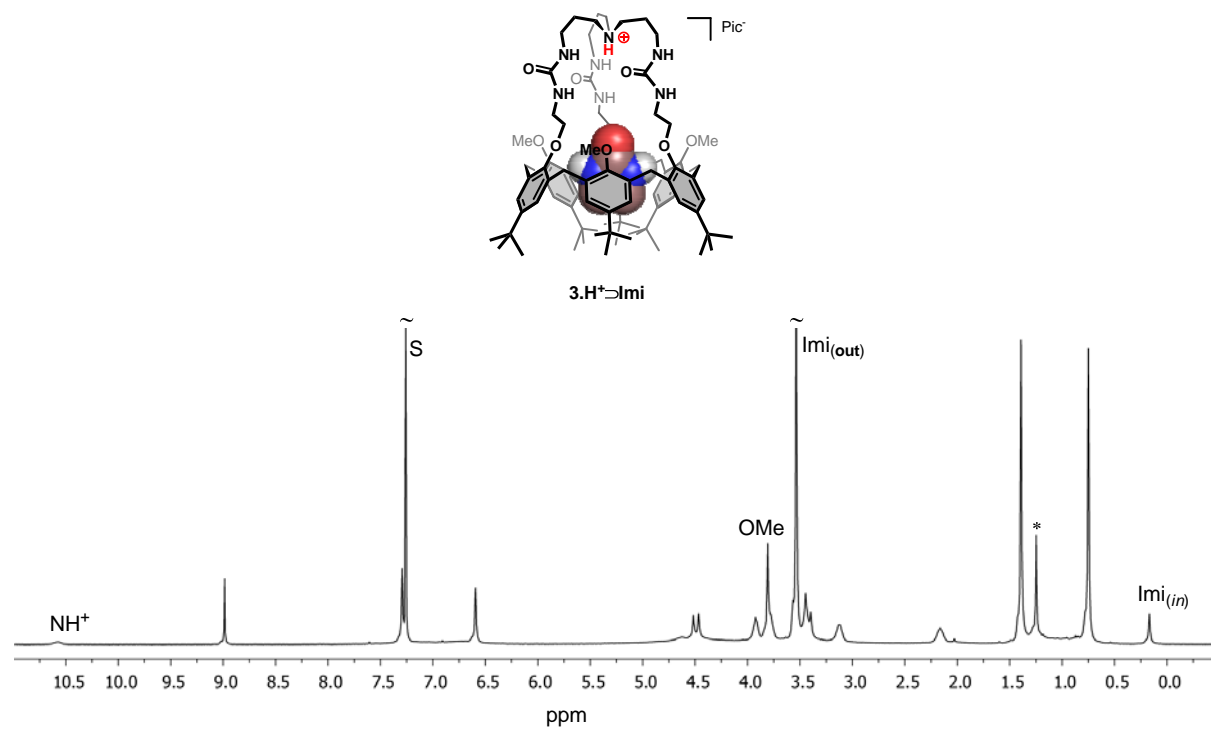
^1H NMR (298K, 300 MHz) spectra of **3** in CDCl_3 with a) 4 equiv. of H_2O , b) 26 equiv. of H_2O and c) saturated with H_2O . S: solvent; W: water, S': residual solvent.

SI6. ^1H NMR (298K, 300 MHz) spectra of $\mathbf{3.H}^+$ in CDCl_3 , $\text{CD}_3\text{CN}/\text{CDCl}_3$ (7:3) and $\text{CD}_3\text{OD}/\text{CDCl}_3$ (7:3)



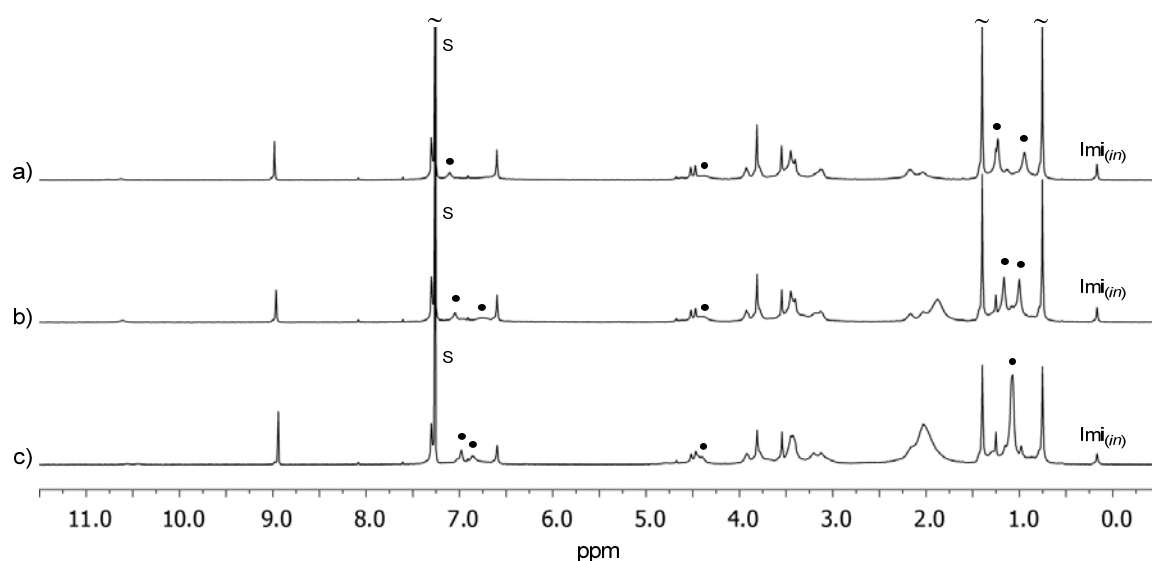
^1H NMR (298K, 300 MHz) spectra of $\mathbf{3.H}^+$ in a) CDCl_3 , b) $\text{CD}_3\text{CN}/\text{CDCl}_3$ (7:3) and c) $\text{CD}_3\text{OD}/\text{CDCl}_3$ (7:3). S: solvent; W: water; *: C_{3v} symmetrical flattened cone conformation; \blacktriangledown : $\text{OMe}_{(in)}$; ∇ : $\text{NH}^+\text{CH}_2\text{CH}_2$

SI7. ^1H NMR (298K, 300 MHz) spectrum of $\mathbf{3.H}^+\text{Imi}$ in CDCl_3



^1H NMR (298K, 300MHz) spectrum of $\mathbf{3}$ with PicH (1.6 eq) and Imi (8.5eq) in CDCl_3 . S: solvent; W: water; *: residual grease.

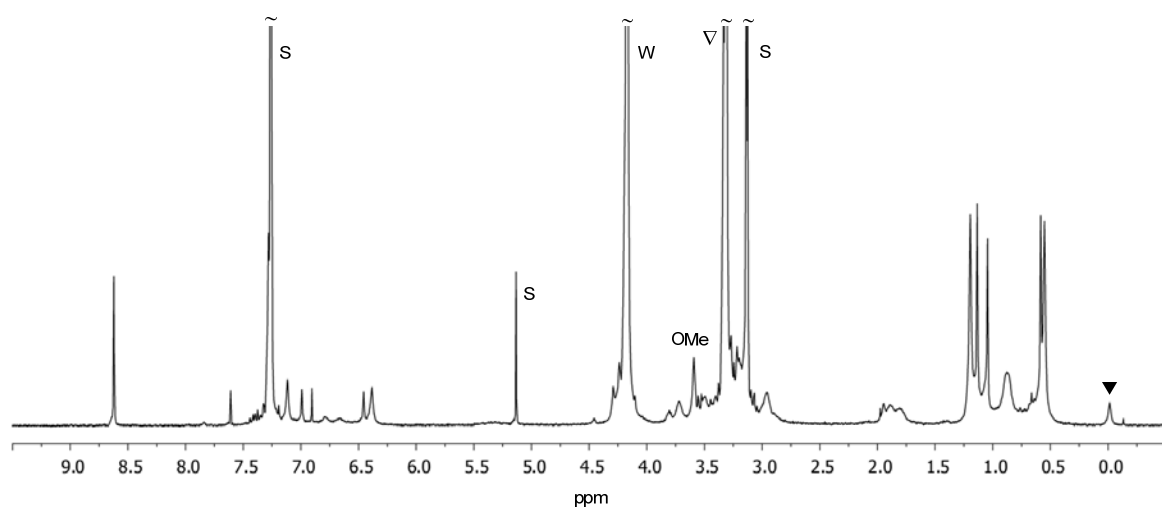
SI8. ^1H NMR (298K, 300 MHz) complexation studies of Imi in CDCl_3 in presence of water



^1H NMR (298K, 300MHz) spectra of $3.\text{H}^+$ with Imi (1.6 equiv.) in CDCl_3 in the presence of a) 3 equiv.; b) 10 equiv.; c) 19 equiv.; S: solvent; W: water; ●: mixture of $3.\text{H}^+$ and $3.\text{H}^+ \supset n\text{H}_2\text{O}$.

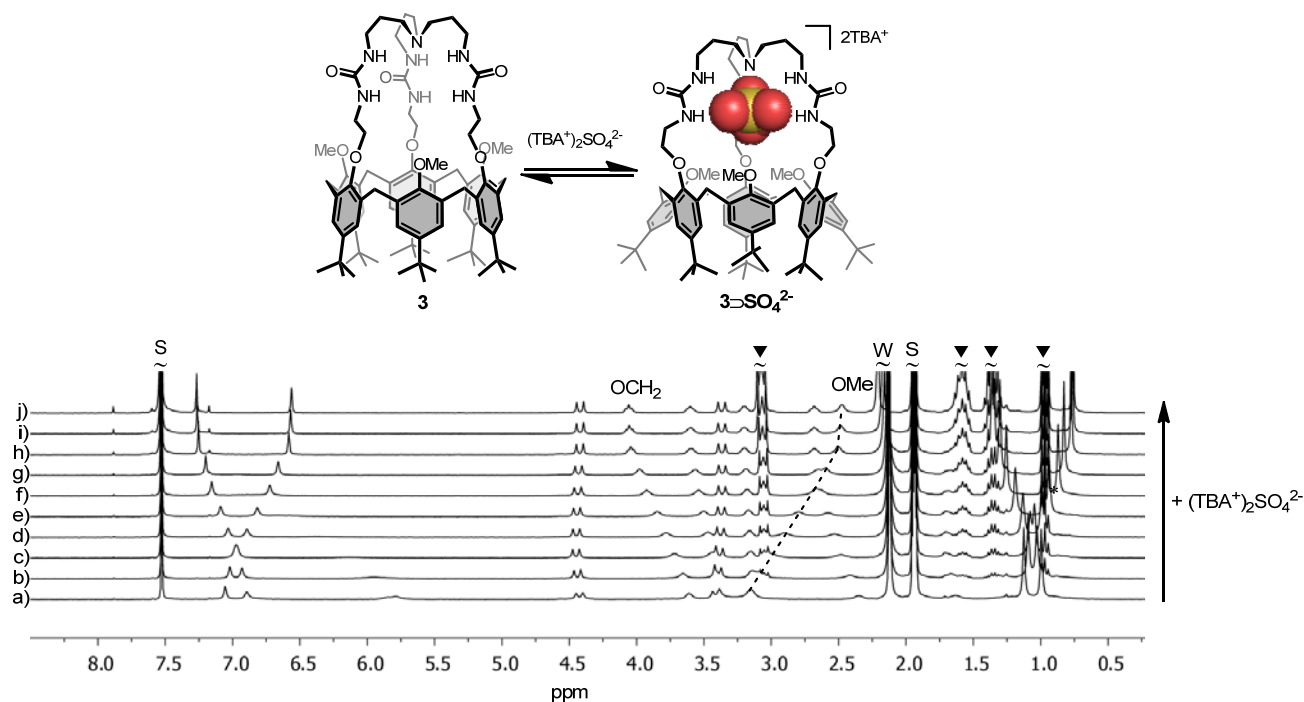
This NMR study clearly shows that $3.\text{H}^+$ bounds water. Note that the chemical shifts of the NMR signals corresponding to the protonated calixarene species that do not include Imi (i.e.: ●) are modified upon the addition of water. This result can be rationalized by the fact that these signals correspond to a mixture of $3.\text{H}^+$ and $3.\text{H}^+ \supset n\text{H}_2\text{O}$, the exchange process between these two species being fast on the NMR time scale.

SI9. ^1H NMR (298K, 300 MHz) spectrum of $\mathbf{3.H}^+$ with Imi in $\text{CD}_3\text{OD}/\text{CDCl}_3$ (1:2)



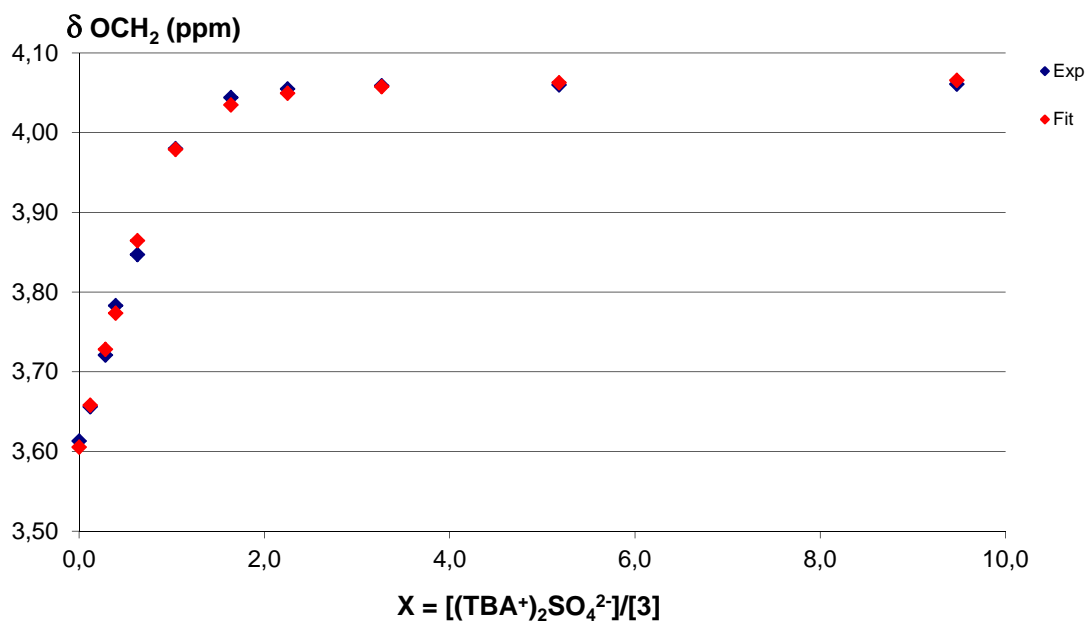
^1H NMR (298K, 300 MHz) spectrum of $\mathbf{3.H}^+$ with Imi (38 equiv.) in $\text{CD}_3\text{OD}/\text{CDCl}_3$ (1:2). S: solvent; W: water; ▼: Imi in; ∇: Imi out.

SI10. ^1H NMR (298K, 300 MHz) spectra of titration of **3** with SO_4^{2-} in $\text{CD}_3\text{CN}/\text{CDCl}_3$ (7:3)

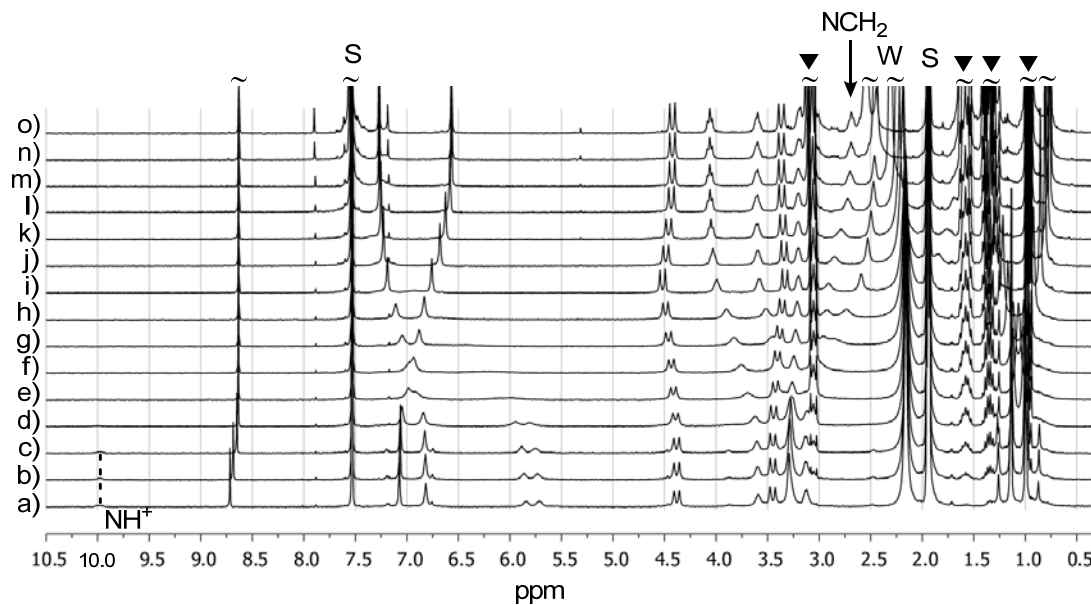


^1H NMR (298K, 300 MHz) spectra in $\text{CD}_3\text{CN}/\text{CDCl}_3$ (7:3) of a) **3** (1 mM) with b) 0.12 equiv.; c) 0.29 equiv.; d) 0.40 equiv.; e) 0.63 equiv.; f) 1.04 equiv.; g) 2.25 equiv.; h) 3.27 equiv.; i) 5.18 equiv.; j) 9.47 equiv. of $(\text{TBA}^+)_2\text{SO}_4^{2-}$. S: solvent; W: water; ▼: TBA⁺.

SI11. ^1H NMR (298K, 300 MHz) titration curve of **3** with SO_4^{2-} in $\text{CD}_3\text{CN}/\text{CDCl}_3$ (7:3)

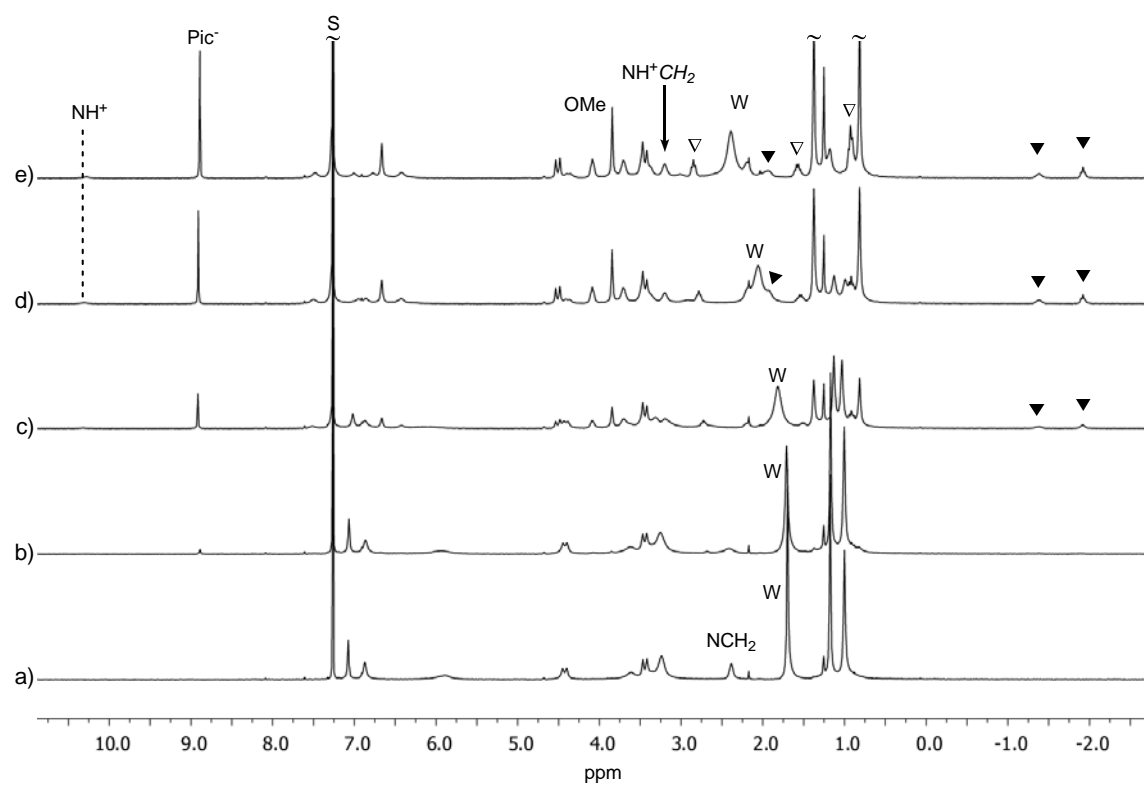


SI12. ^1H NMR (298K, 300 MHz) spectra of $3\cdot\text{H}^+$ with SO_4^{2-} in $\text{CD}_3\text{CN}/\text{CDCl}_3$ (7:3)



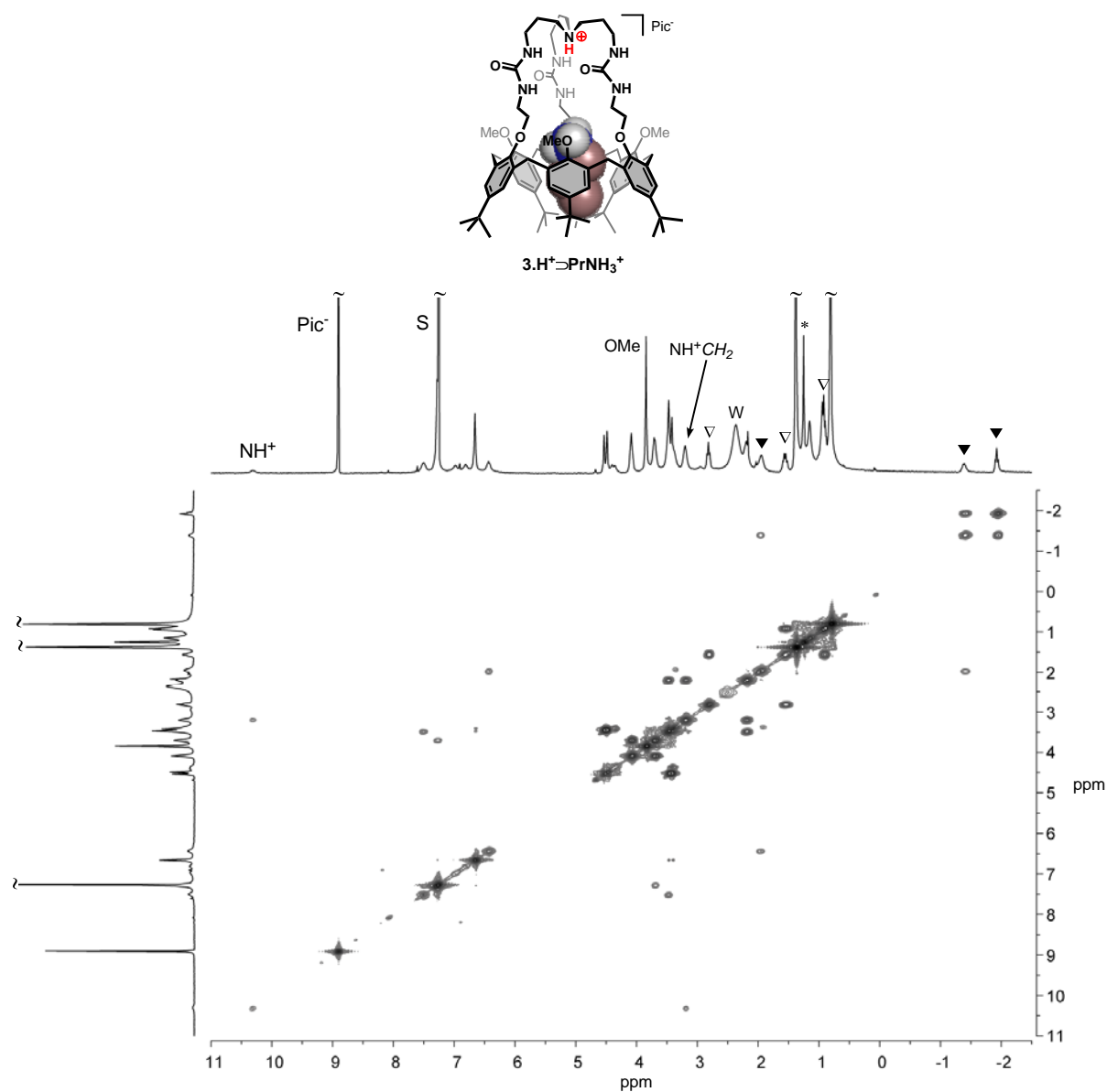
^1H NMR (298K, 300MHz) spectra in $\text{CD}_3\text{CN}/\text{CDCl}_3$ (7:3) of a) $3\cdot\text{H}^+$ (1 mM) with b) 0.15 equiv.; c) 0.28 equiv.; d) 0.43 equiv.; e) 0.62 equiv.; f) 0.81 equiv.; g) 0.98 equiv.; h) 1.17 equiv.; i) 1.58 equiv.; j) 1.96 equiv.; k) 2.59 equiv.; l) 3.38 equiv.; m) 5.02 equiv.; n) 9.24 equiv.; o) 12.86 equiv. of $(\text{TBA}^+)_2\text{SO}_4^{2-}$. S: solvent; W: water.

SI13. ^1H NMR (298K, 300 MHz) spectra of **3** with $\text{PrNH}_3^+\text{Pic}^-$ in CDCl_3



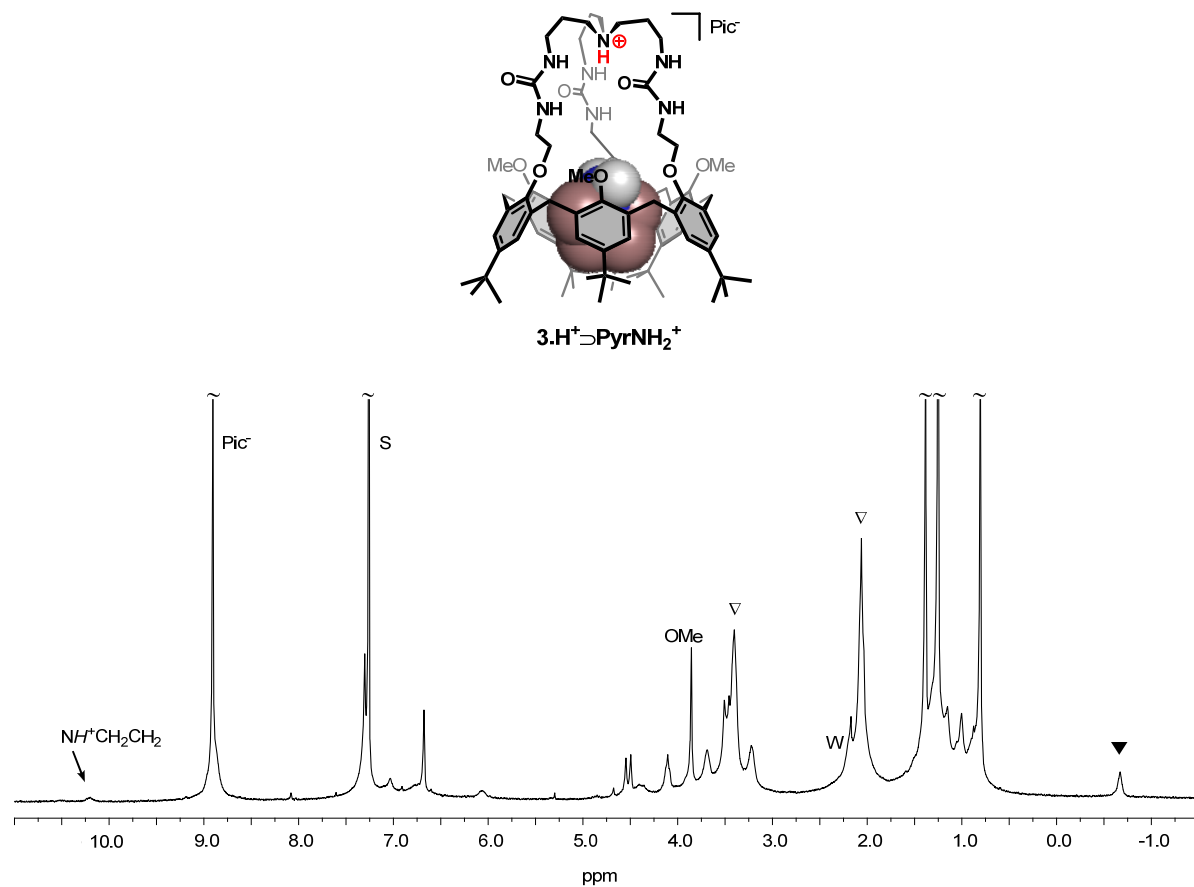
^1H NMR (298K, 300 MHz) spectra in CDCl_3 of a) **3** with b) 0.2 equiv.; c) 1.2 equiv.; d) 2.3 equiv.; e) 2.7 equiv. of $\text{PrNH}_3^+\text{Pic}^-$. S: solvent; W: water; ▼: PrNH_3^+ in; ▽: PrNH_3^+ out.

SI14. COSY (298K, 300 MHz) spectrum of $3.H^+ \supset PrNH_3^+$ in $CDCl_3$



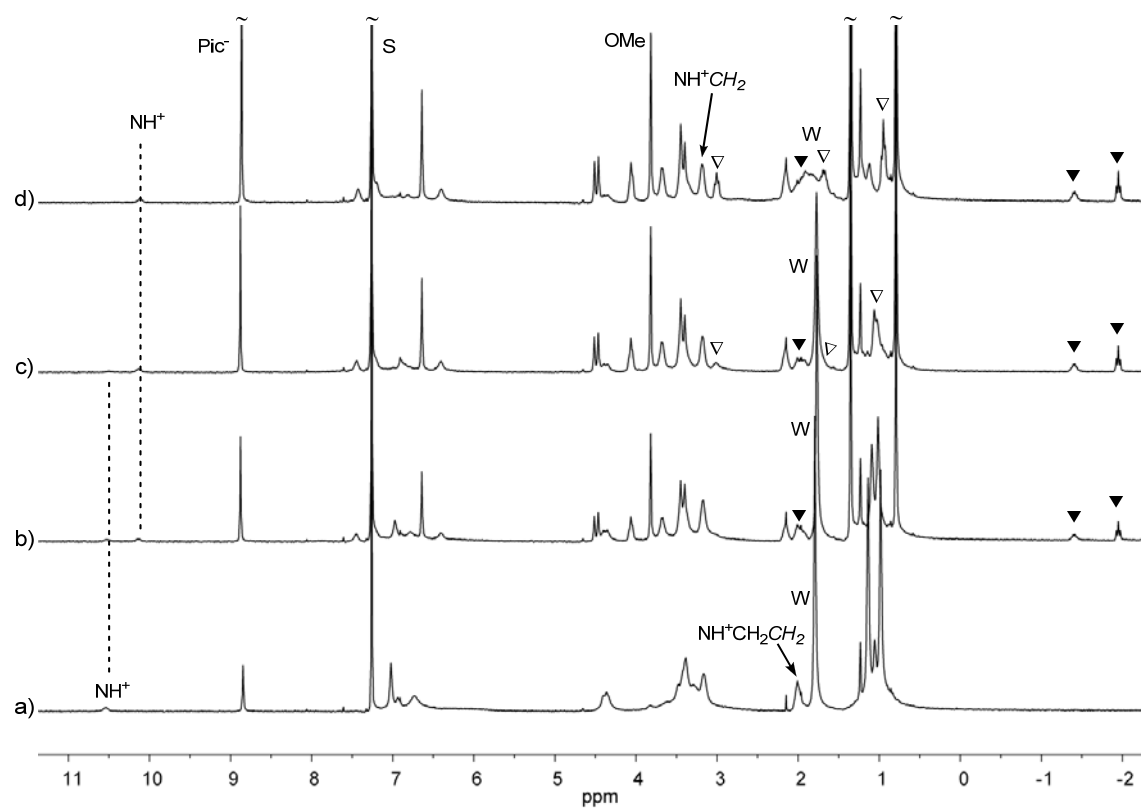
COSY (298K, 300 MHz) spectrum of **3** with $PrNH_3^+Pic^-$ (2.7 equiv.) in $CDCl_3$. S: solvent; W: water; ▼: $PrNH_3^+$ in; ▽: $PrNH_3^+$ out; *: residual grease.

SI15. ^1H NMR (298K, 300 MHz) spectrum of $3\cdot\text{H}^+\supset\text{PyrNH}_2^+$ in CDCl_3



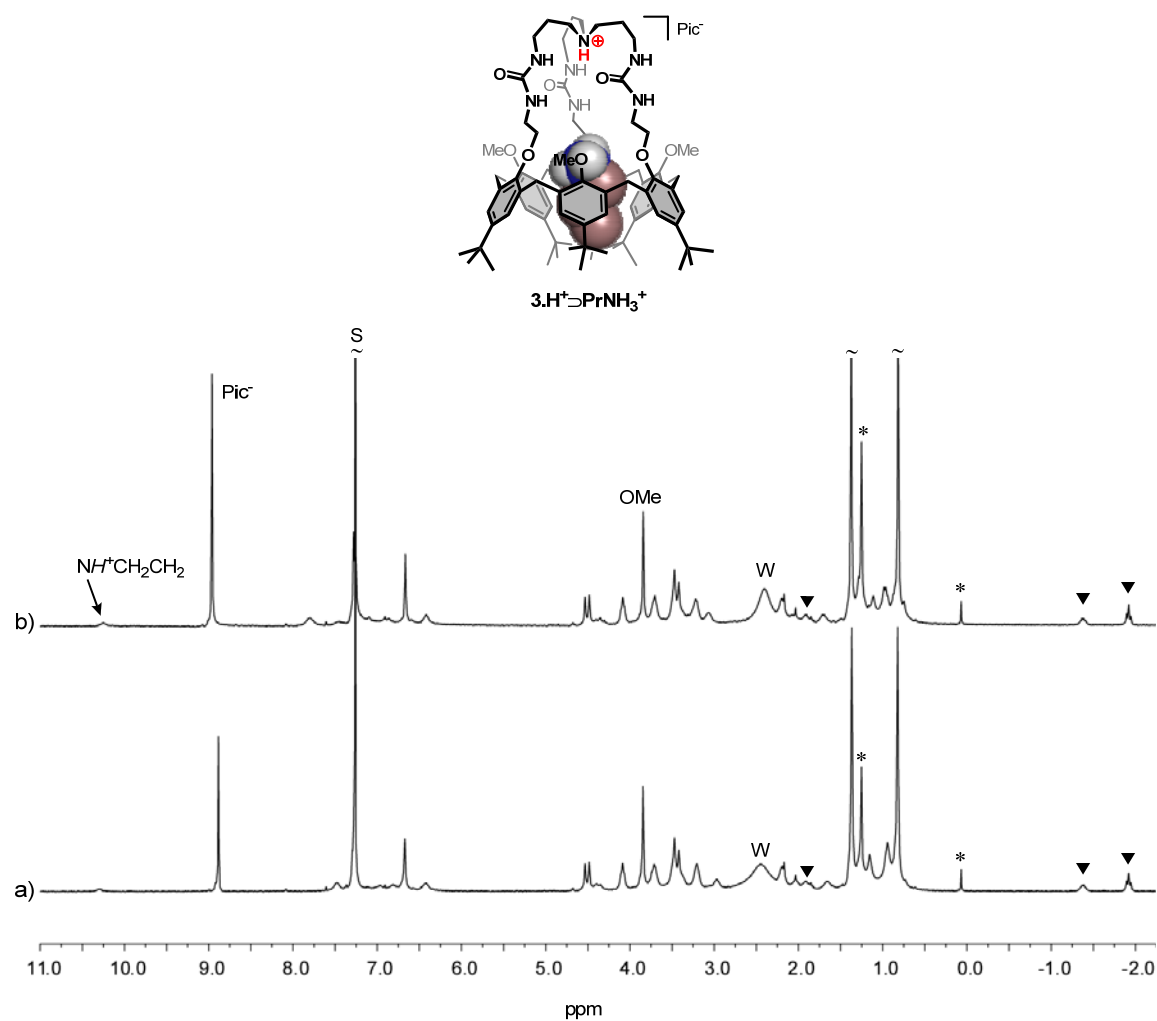
^1H NMR (298K, 300 MHz) spectrum of **3** with PicH (ca. 5 equiv.) and $\text{PyrNH}_2^+\text{Pic}^-$ (ca. 8 equiv.) in CDCl_3 . S: Solvent; W: water; ▼: PyrNH_2^+ in; ∇: PyrNH_2^+ out.

SI16. ^1H NMR (298K, 300 MHz) spectra of $\mathbf{3.H}^+$ with $\text{PrNH}_3^+\text{Pic}^-$ in CDCl_3



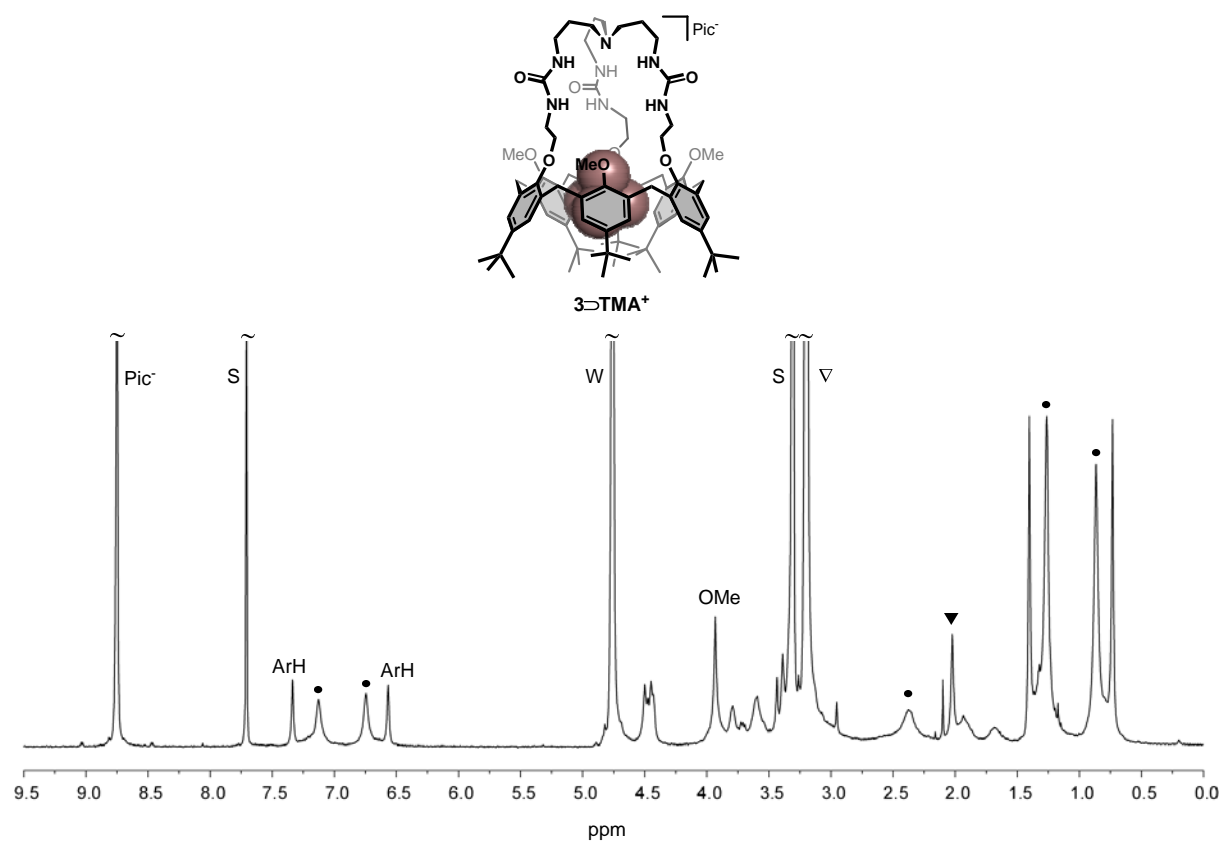
^1H NMR (298K, 300 MHz) spectra of $\mathbf{3}$ in CDCl_3 with a) PicH (1.2 equiv.); b) 0.4 equiv.; c) 1 equiv.; d) 2.2 equiv. of $\text{PrNH}_3^+\text{Pic}^-$. S: solvent; W: water; \blacktriangledown : PrNH_3^+ in; ∇ : PrNH_3^+ out.

SI17. ^1H NMR (298K, 300 MHz) spectra of $3\cdot\text{H}^+\supset\text{PrNH}_3^+$ in CDCl_3 upon addition of PicH



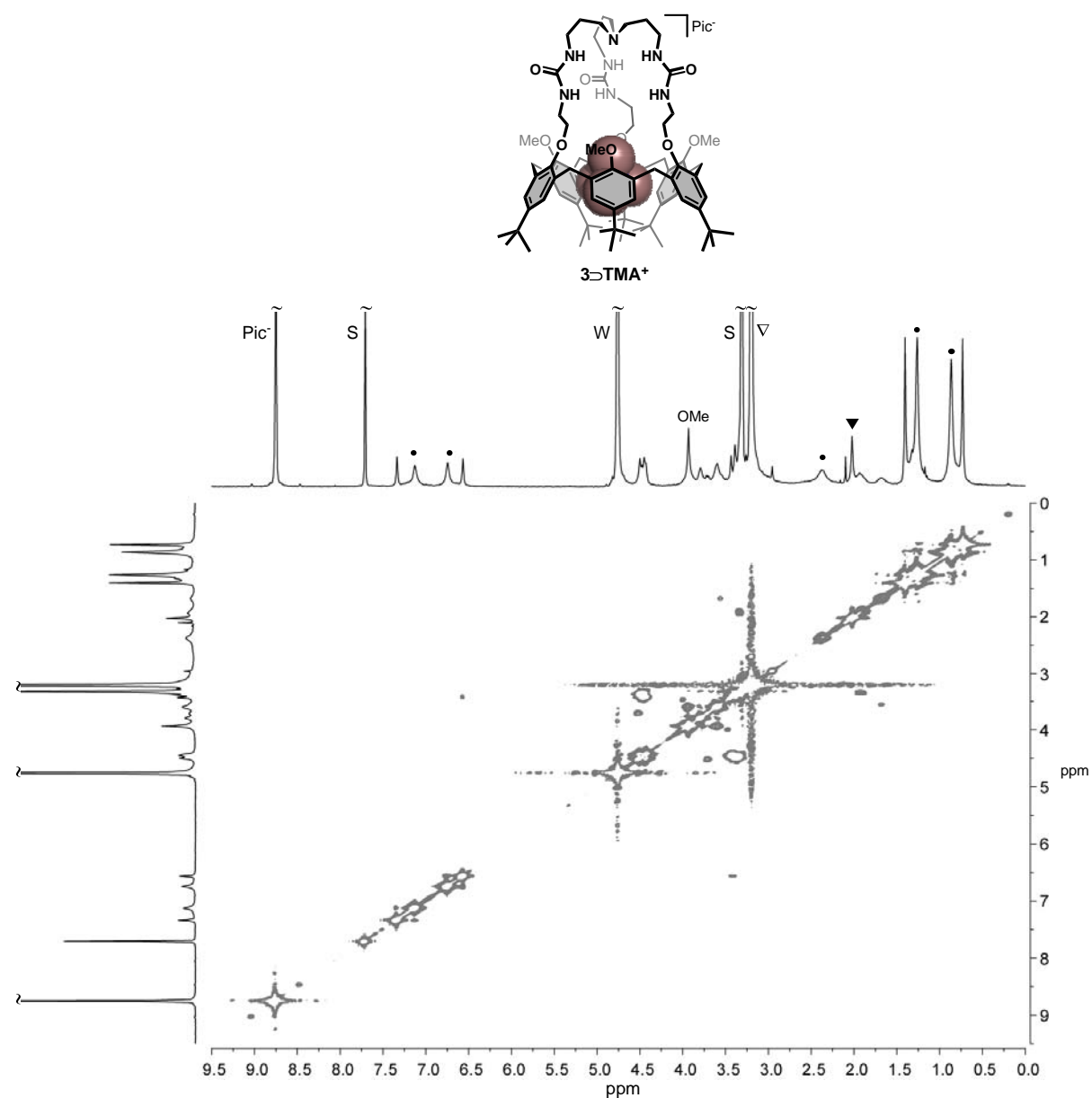
^1H NMR (298K, 300 MHz) spectra of a) $3\cdot\text{H}^+\supset\text{PrNH}_3^+$ in CDCl_3 ; b) after addition of PicH (1.9 equiv.). S: solvent; W: water; *: residual grease; ▼: PrNH_3^+ in.

SI18. ^1H NMR (298K, 300 MHz) spectra of 3TMA^+ in $\text{CD}_3\text{OD}/\text{CDCl}_3$ (7:3)



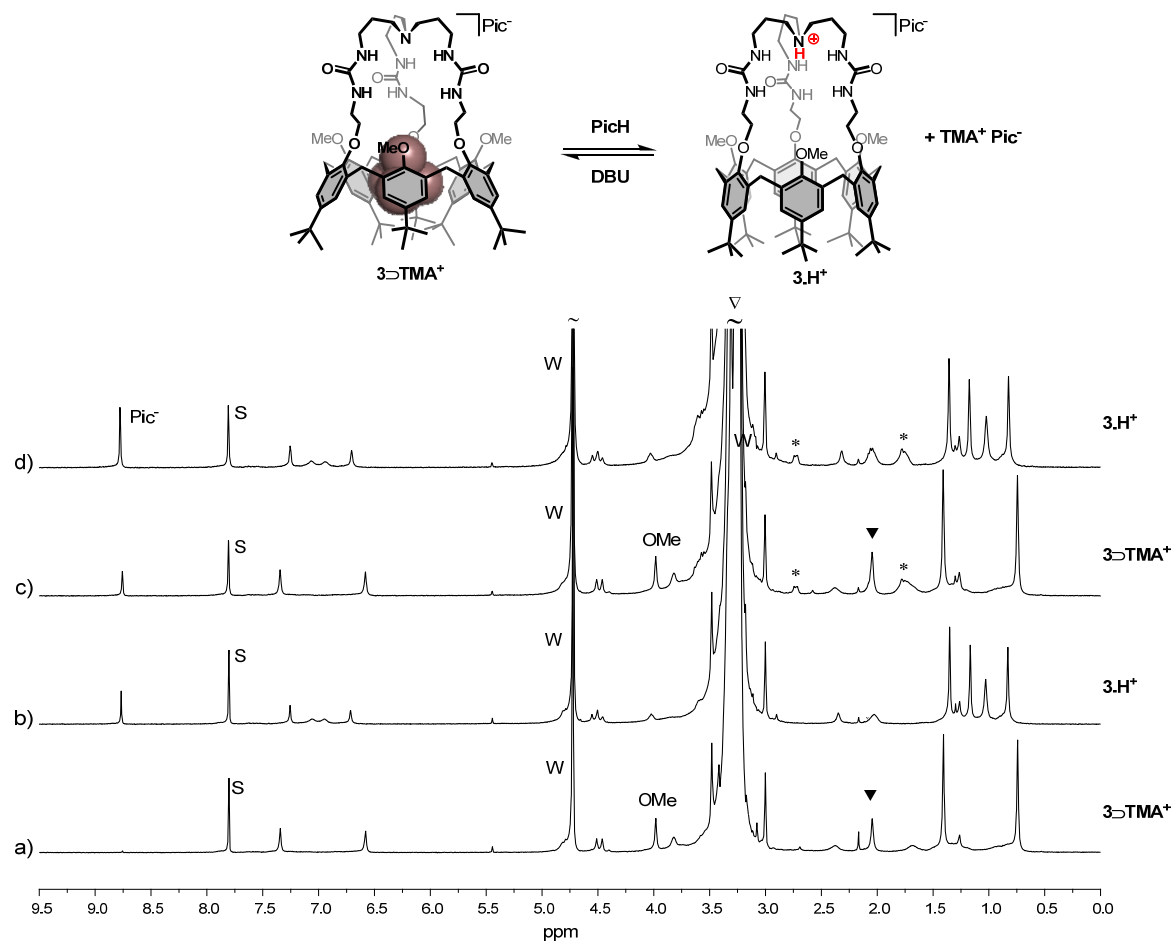
^1H NMR (298K, 300 MHz) spectra of **3** with TMA^+Pic^- (7.8 equiv.) in $\text{CD}_3\text{OD}/\text{CDCl}_3$ (7:3).
S: solvent; W: water; ▼ TMA^+ in; ▽ TMA^+ out; ●: **3**.

SI19. COSY (298K, 300 MHz) spectrum of **3**⊃TMA⁺ in CD₃OD/CDCl₃ (7:3)



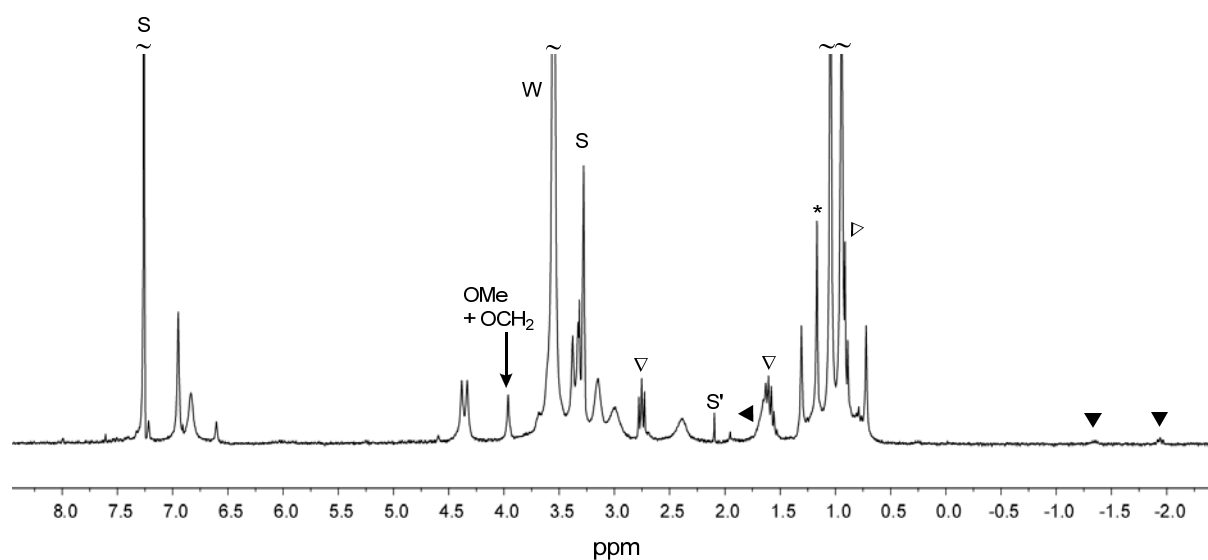
COSY (298K, 300 MHz) spectrum of **3** with TMA⁺Pic⁻ in CD₃OD/CDCl₃ (7:3). S: solvent; W: water; ▼TMA⁺ in; ▽: TMA⁺ out; ●: **3**.

SI20. Interconversion between $3\supset\text{TMA}^+$ and $3\cdot\text{H}^+$ in $\text{CD}_3\text{OD}/\text{CDCl}_3$ (7:3) monitored by ^1H NMR



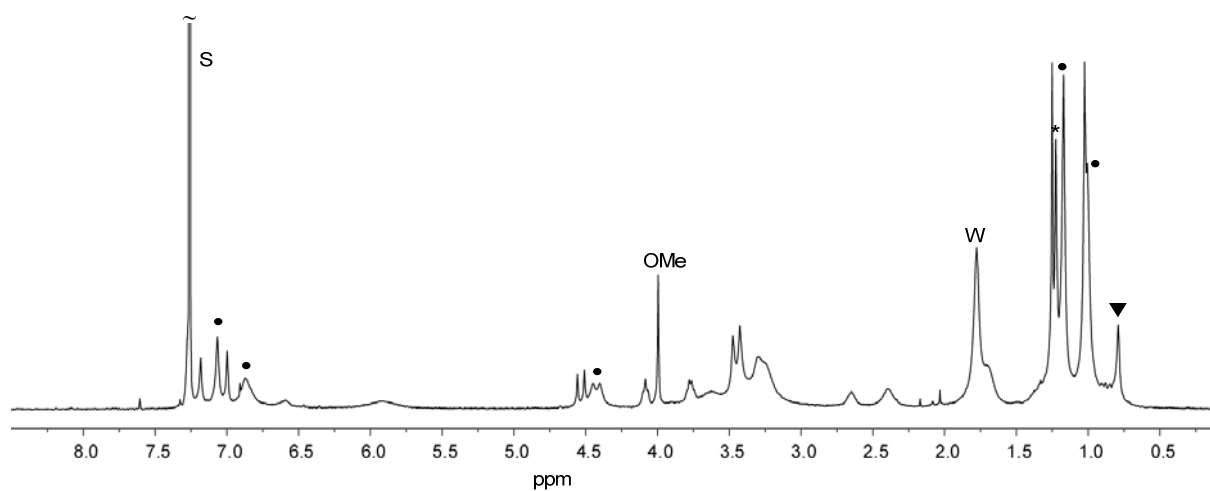
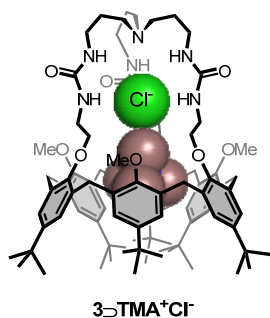
^1H NMR (298K, 300 MHz) spectra of **3** in $\text{CD}_3\text{OD}/\text{CDCl}_3$ (7:3) with a) TMA^+Cl^- (ca. 200 equiv.); b) after addition of PicH (1.5 equiv.); c) after addition of DBU (1.5 equiv.); d) after addition of PicH (3.5 equiv.). S: solvent; W: water; *: DBU ; ▼: TMA^+ in; ∇: TMA^+ out.

SI21. ^1H NMR (298K, 300 MHz) spectrum of **3** with $\text{PrNH}_3^+\text{Cl}^-$ in $\text{CD}_3\text{OD}/\text{CDCl}_3$ (1:9)



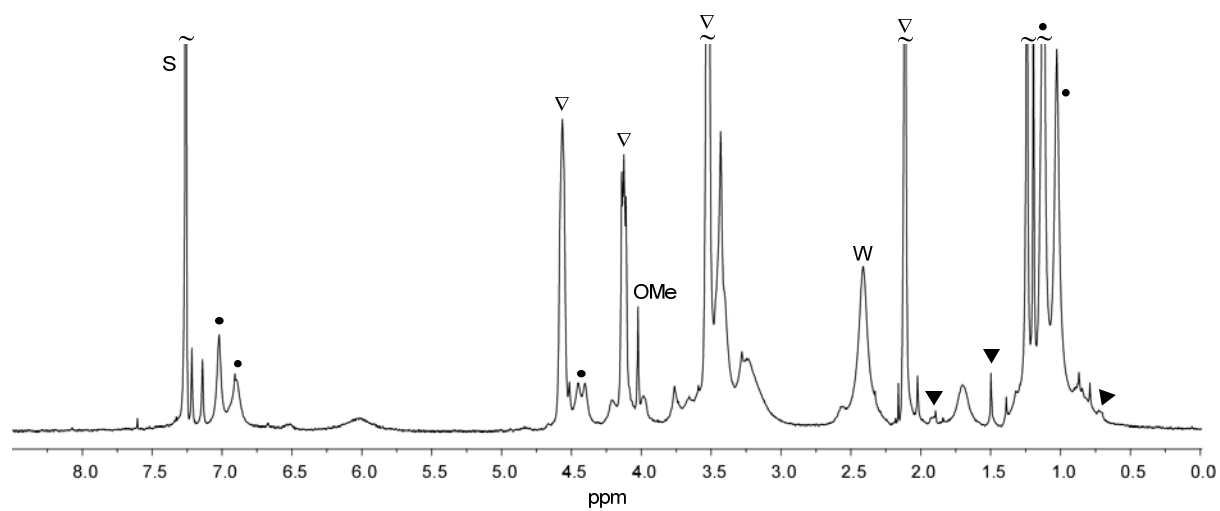
^1H NMR (298K, 300 MHz) spectrum of **3** with $\text{PrNH}_3^+\text{Cl}^-$ (1.3 equiv.) in $\text{CD}_3\text{OD}/\text{CDCl}_3$ (1:9). S: solvent; S': residual acetone; W: water; \blacktriangledown : PrNH_3^+ in; ∇ : PrNH_3^+ out; *: residual grease.

SI22. ^1H NMR (298K, 300 MHz) spectrum of **3** in CDCl_3 saturated with TMA^+Cl^-



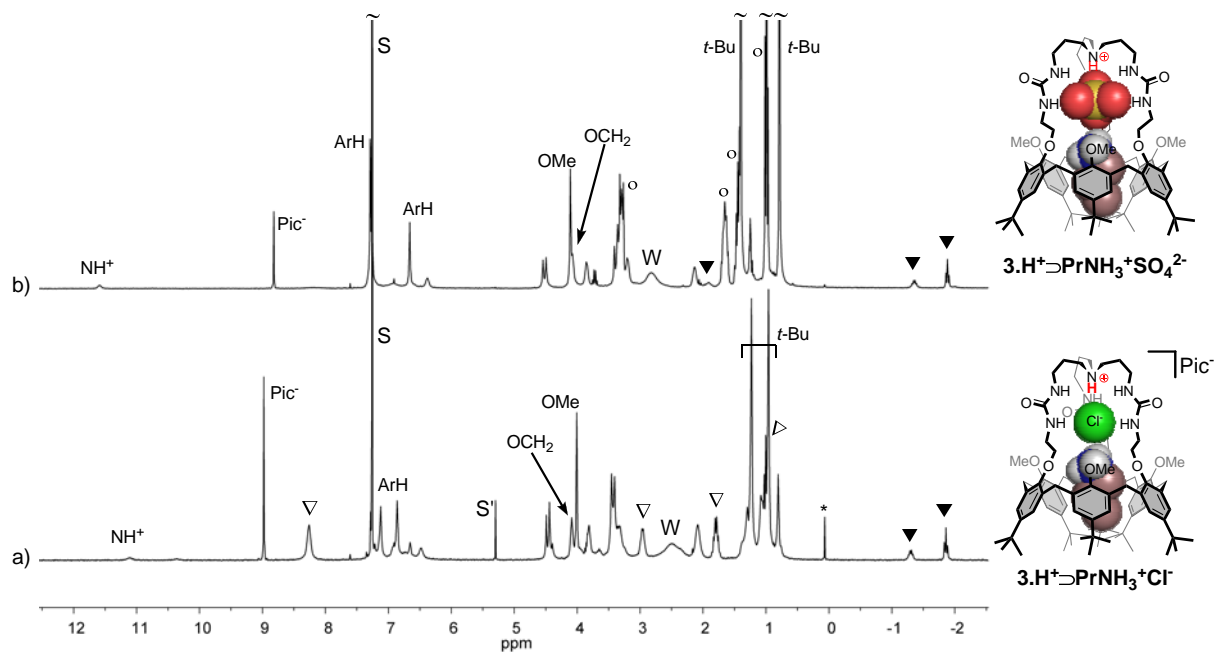
^1H NMR (298K, 300 MHz) spectrum of **3** in CDCl_3 saturated with TMA^+Cl^- . S: solvent; W: water; ▼: TMA^+ in; ●: **3**; *: residual grease.

SI23. ^1H NMR (298K, 300 MHz) spectrum of **3** with Ach^+Cl^- in CDCl_3



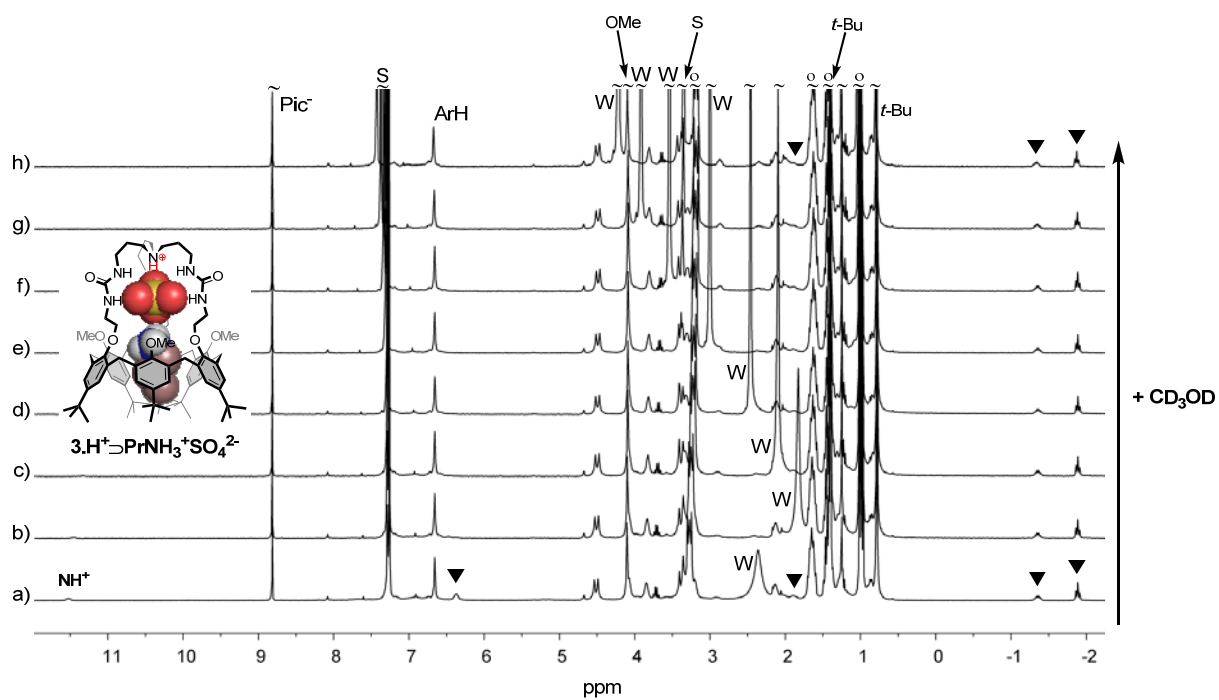
^1H NMR (298K, 300 MHz) spectrum of **3** with Ach^+Cl^- (10.6 equiv.) in CDCl_3 . S: solvent; W: water; ▼: Ach^+Cl^- in; ∇: Ach^+Cl^- out; ●: **3**.

SI24. ^1H NMR (298K, 300 MHz) spectra of $3\cdot\text{H}^+\text{PrNH}_3^+\text{SO}_4^{2-}$ and $3\cdot\text{H}^+\text{PrNH}_3^+\text{Cl}^-$ in CDCl_3



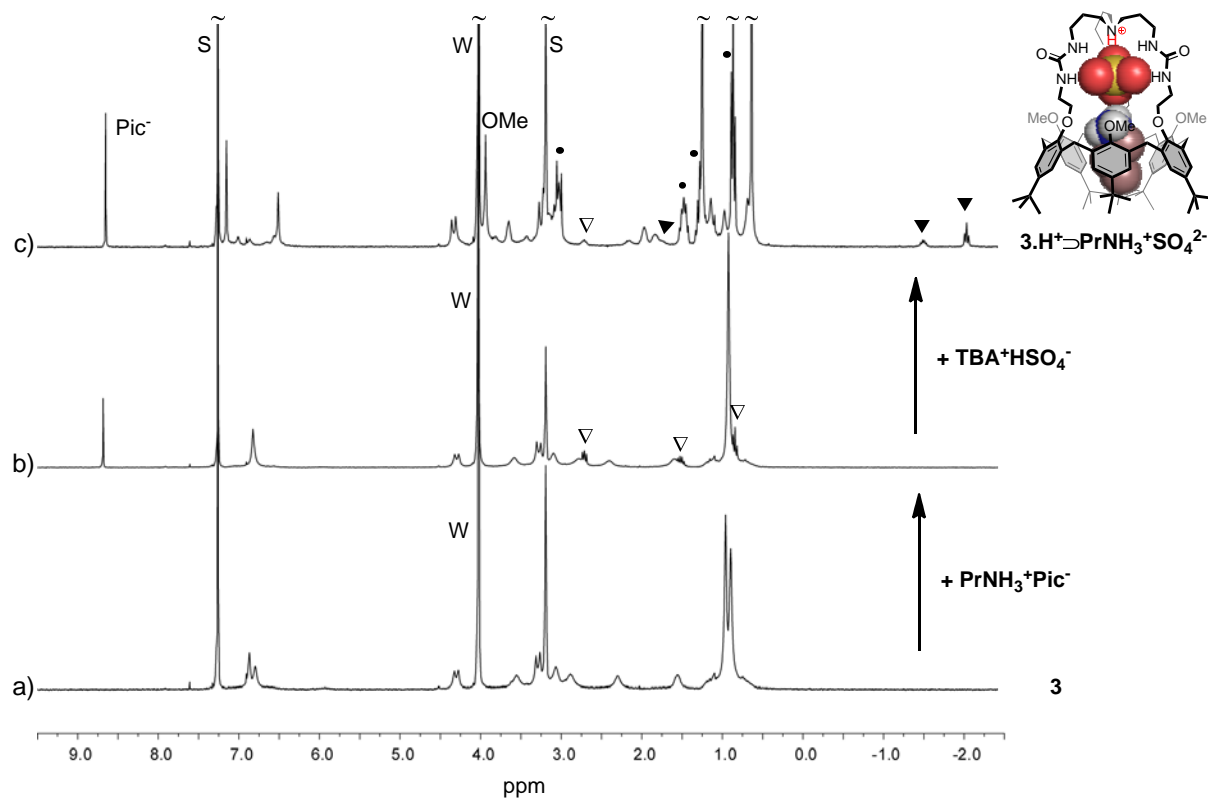
^1H NMR (298K, 300 MHz) spectra of a) **3** with PicH (3 equiv.) and $\text{PrNH}_3^+\text{Cl}^-$ (2.8 equiv.) and b) **3** with PicH (1 equiv.) and $\text{TBA}^+\text{PrNH}_3^+\text{SO}_4^{2-}$ (2 equiv.) in CDCl_3 . S: solvent; S' : dichloromethane; W: water; \blacktriangledown : PrNH_3^+ in; ∇ : PrNH_3^+ out; o: TBA^+ ; *: residual grease.

SI25. ^1H NMR (298K, 300 MHz) spectra of $3\cdot\text{H}^+\text{TBA}^+\text{PrNH}_3^+\text{SO}_4^{2-}$ in CDCl_3 upon addition of CD_3OD



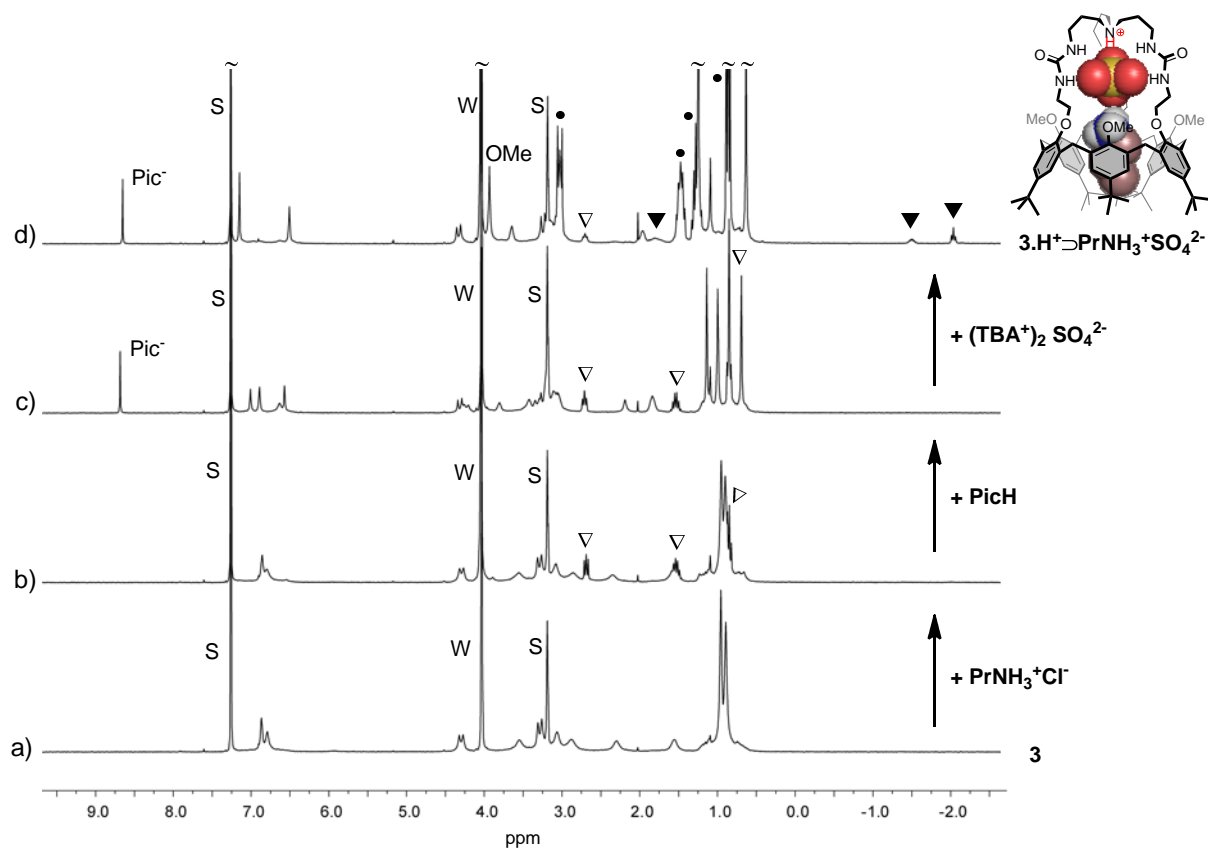
^1H NMR (298K, 300 MHz) spectra of a) **3** with PicH (1.3 equiv.) and $\text{TBA}^+\text{PrNH}_3^+\text{SO}_4^{2-}$ (2.4 equiv.) in CDCl_3 ; b) 5 μL ; c) 15 μL ; d) 25 μL ; e) 45 μL ; f) 85 μL ; g) 145 μL ; h) 245 μL of CD_3OD . S: solvent; W: water; \blacktriangledown : PrNH_3^+ in; o: TBA^+ .

SI26. ^1H NMR (298K, 300 MHz) spectra of **3** with $\text{PrNH}_3^+\text{Pic}^-$ and $\text{TBA}^+\text{HSO}_4^-$ in $\text{CD}_3\text{OD}/\text{CDCl}_3$ (1:3)



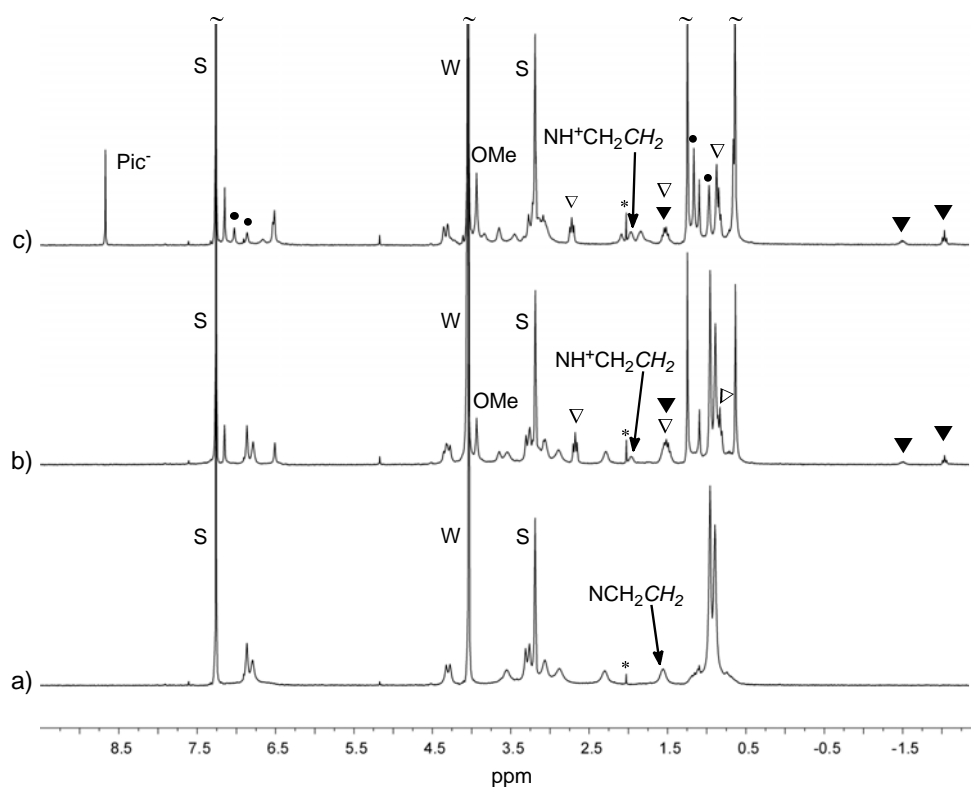
^1H NMR (298K, 300 MHz) spectra in $\text{CD}_3\text{OD}/\text{CDCl}_3$ (1:3) of a) **3**; b) after addition of $\text{PrNH}_3^+\text{Pic}^-$ (1.1 equiv.); c) after the subsequent addition of $\text{TBA}^+\text{HSO}_4^-$ (1.2 equiv.). S: solvent; W: water; \blacktriangledown : PrNH_3^+ in; ∇ : PrNH_3^+ out; \bullet : TBA^+ .

SI27. ^1H NMR (298K, 300 MHz) spectra of **3** with $\text{PrNH}_3^+\text{Cl}^-$, PicH and $(\text{TBA}^+)_2\text{SO}_4^{2-}$ in $\text{CD}_3\text{OD}/\text{CDCl}_3$



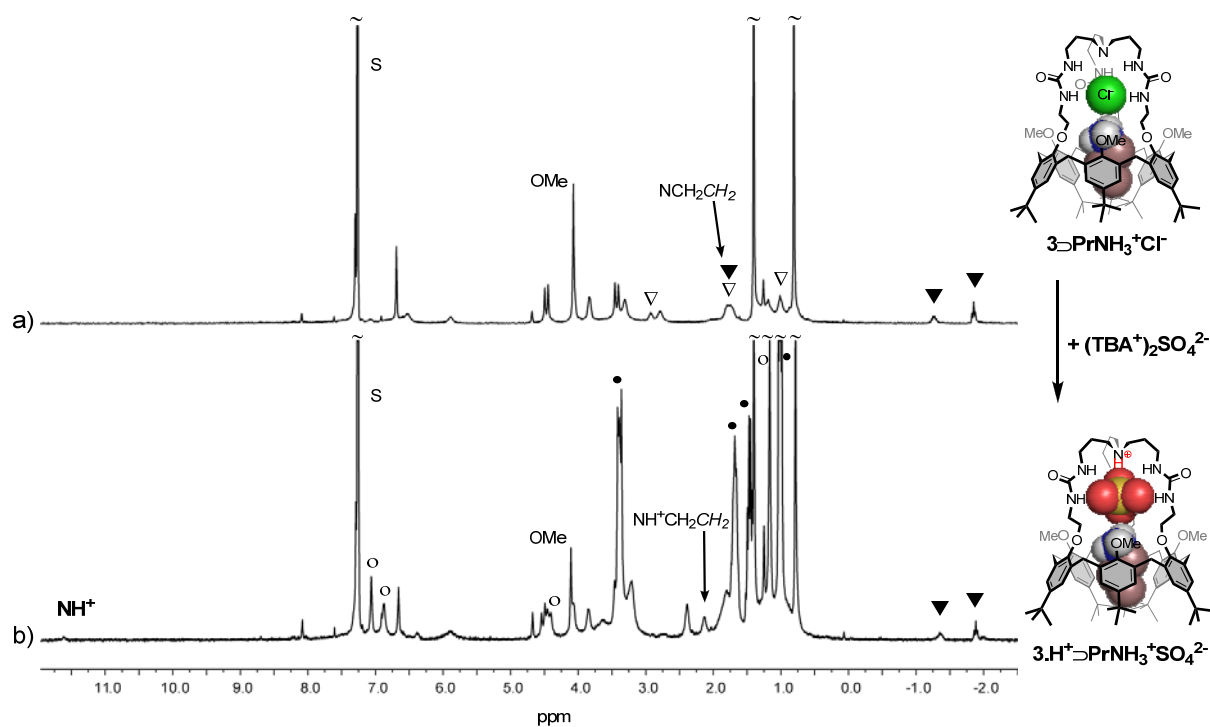
^1H NMR (298K, 300 MHz) spectra in $\text{CD}_3\text{OD}/\text{CDCl}_3$ (1:3) of a) **3**; b) after addition of $\text{PrNH}_3^+\text{Cl}^-$ (2 equiv.); c) after the subsequent addition of PicH (1 equiv.) and d) after the subsequent addition of $(\text{TBA}^+)_2\text{SO}_4^{2-}$ (2 equiv.). S: solvent; W: water; ∇ : PrNH_3^+ in; \triangleright : PrNH_3^+ out; \bullet : TBA^+ .

SI28. ^1H NMR (298K, 300 MHz) spectra of **3** with $(\text{PrNH}_3^+)_2\text{SO}_4^{2-}$ and PicH in $\text{CD}_3\text{OD}/\text{CDCl}_3$ (1:3)



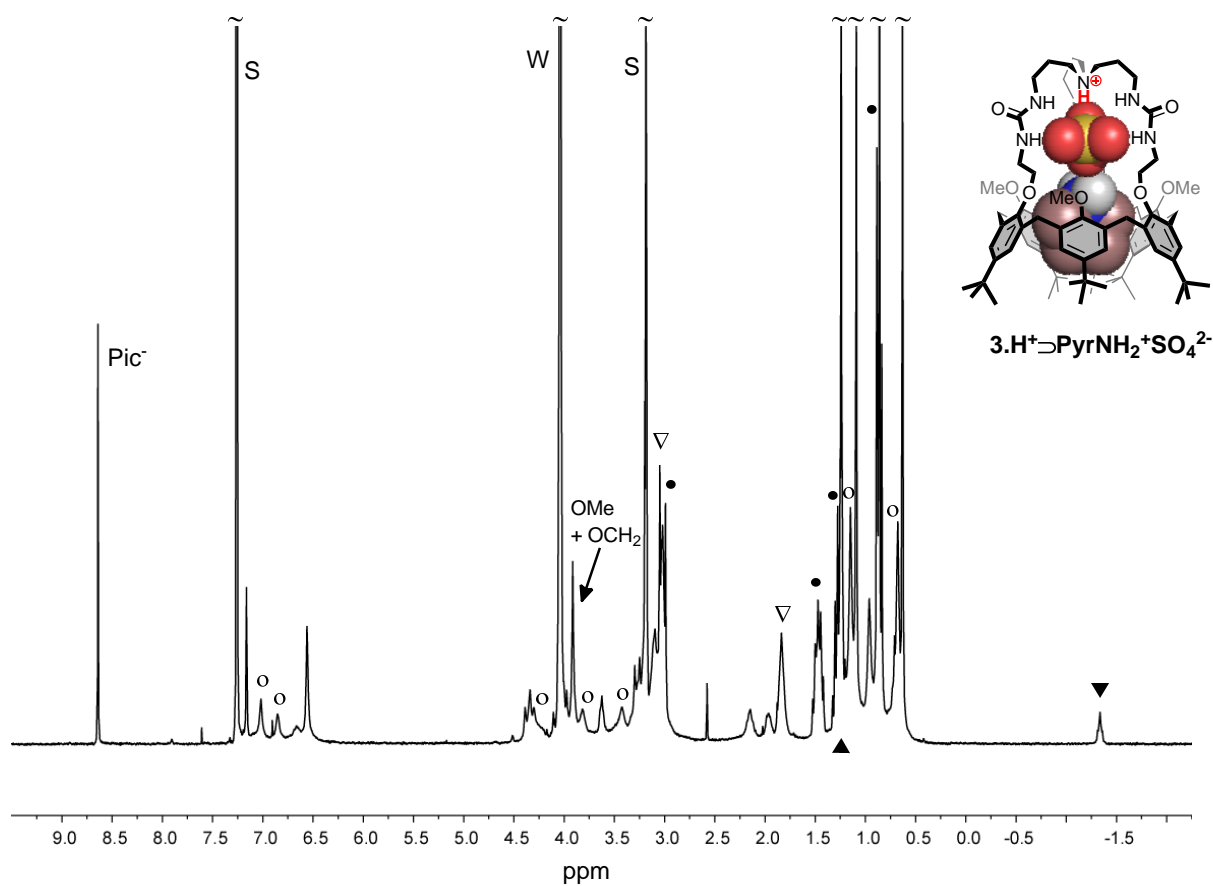
^1H NMR (298K, 300 MHz) spectra in $\text{CD}_3\text{OD}/\text{CDCl}_3$ (1:3) of a) **3**; b) after addition of $(\text{PrNH}_3^+)_2\text{SO}_4^{2-}$ (2.6 equiv.); c) after the subsequent addition of PicH (1.3 equiv.). S: Solvent; W: water; \blacktriangledown : PrNH_3^+ in; ∇ : PrNH_3^+ out; \bullet : $\mathbf{3.H}^+$; *: residual acetone.

SI29. ^1H NMR (298K, 300 MHz) spectra of **3** with $\text{PrNH}_3^+\text{Cl}^-$ in CDCl_3 and after addition of $(\text{TBA}^+)_2\text{SO}_4^{2-}$



^1H NMR (298K, 300 MHz) spectra of **3** in CDCl_3 with a) $\text{PrNH}_3^+\text{Cl}^-$ (2 equiv.) and b) after addition of $(\text{TBA}^+)_2\text{SO}_4^{2-}$ (ca. 1.7 equiv.). S: solvent; \blacktriangledown : PrNH_3^+ in; ∇ : PrNH_3^+ out; o: $3 \cdot \text{H}^+$; \bullet : TBA^+ .

SI30. ^1H NMR (298K, 300 MHz) spectrum of $3\cdot\text{H}^+\supset\text{PyrNH}_2^+\text{SO}_4^{2-}$ in $\text{CD}_3\text{OD}/\text{CDCl}_3$ (1:3)



^1H NMR (298K, 300 MHz) spectrum of **3** in $\text{CD}_3\text{OD}/\text{CDCl}_3$ (1:3) with $\text{PyrNH}_2^+\text{Pic}^-$ (1.2 equiv.) and $\text{TBA}^+\text{HSO}_4^-$ (1.2 equiv.). S: solvent; W: water; ▼: PyrNH_2^+ in; ▽: PyrNH_2^+ out; ●: TBA^+ ; o: $3\cdot\text{H}^+$.