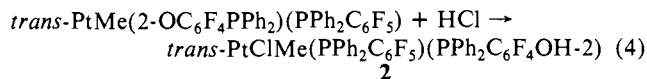
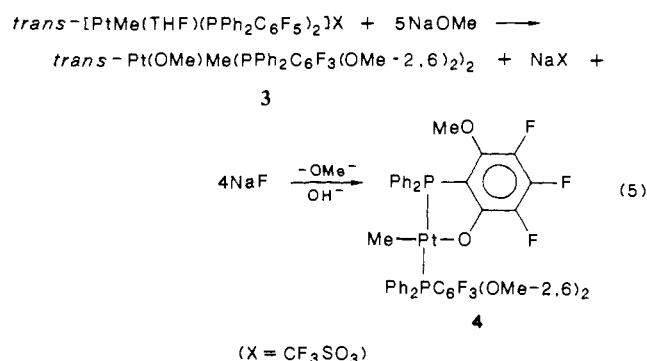


clometalated product results from nucleophilic attack by OH⁻ at the ortho carbon of a pentafluorophenyl ring. No reaction occurs between uncomplexed PPh₂C₆F₃ and aqueous KOH. The ortho substitution in complex **1** is therefore induced by platinum coordination. Two mechanistic pathways are plausible, each of which involves nucleophilic attack by hydroxide at the ortho carbon of the pentafluorophenyl ring (Scheme 1). The first pathway involves an agostic interaction which induces ortho selectivity by the external nucleophile; the second pathway involves prior complexation of the hydroxide with platinum.⁸ We presently have no conclusive evidence to differentiate between intramolecular or external attack at the ortho carbon by the hydroxyl nucleophile. Complex **1** is protonated by HCl to give the ring-opened complex *trans*-PtClMe(PPh₂C₆F₃)(PPh₂C₆F₄OH-2) (**2**) (eq 4).



Methoxide ion (excess NaOMe in methanol) substitutes the fluorines at the ortho carbon atoms of the pentafluorophenyl ring in *trans*-[PtMe(THF)(PPh₂C₆F₃)₂]CF₃SO₃ to give *trans*-Pt(OMe)Me(PPh₂C₆F₃(OMe-2,6)₂) (**3**) in 82% yield. Complex **3** reacts with NaOH to give *trans*-PtMe(2-OC₆F₃(OMe-6)-PPh₂)(PPh₂C₆F₃(OMe-2,6)₂) (**4**) (eq 5).⁹ The conversion of **3**



to **4** involves C-O bond cleavage.¹⁰ These reactions involve the conversion of a strong C-F bond into a weaker C-O bond. The formation of platinum alkoxide bonds in both **3** and **4** provides some driving force to the reaction, but solvation effects and the higher lattice energy of NaF as compared to NaOMe provide the dominant advantage.

Acknowledgment. We thank the Louisiana Board of Reagents for support and Mark Fink for helpful discussions.

Supplementary Material Available: Tables of positional pa-

(8) Although we have no direct evidence for an agostic interaction, precedents exist for both organohalide complexation and C-F cleavage and oxidative addition, see: Richmond, T. G.; Osterberg, C. E.; Arif, A. M. *J. Am. Chem. Soc.* **1987**, *109*, 8091-8092. Crabtree, R. H.; Faller, J. W.; Mellea, M. F.; Quirk, J. M. *Organometallics* **1982**, *1*, 1361-1366. Crabtree, R. H.; Mellea, M. F.; Quirk, J. M. *J. Am. Chem. Soc.* **1984**, *106*, 2913-2917. Gross, M. E.; Johnson, C. E.; Maroney, M. J.; Troglor, W. C. *Inorg. Chem.* **1984**, *23*, 2968-2973. For nucleophilic substitution of fluoroaromatics see: Tatlow, J. C. *Endeavour* **1963**, *22*, 89-95. Allen, J. G.; Burdon, J.; Tatlow, J. C. *J. Chem. Soc.* **1965**, 1045-1051. Banks, R. E. *Fluorocarbons and their Derivatives*, 2nd ed.; MacDonald: London, 1970; pp 218-221. Attack by external nucleophile is favored by the observation that no reaction occurs with NaOH instead of KOH, but prior hydroxyl coordination better explains the ortho selectivity. An S_{RN}1 mechanism fails to explain the selectivity, and furthermore **1** is not formed in the reaction between *trans*-[PtMe(THF)(PPh₂C₆F₃)₂]X and sodium naphthalenide.

(9) ¹H, ³¹P{¹H}, and ¹⁹F NMR data for **3**: δ(CH₃) 0.23 t; ³J(PH) = 6.4 Hz. δ(OCH₃) 3.32 d (12 H); ²J(HF) = 2.4 Hz. δ(OCH₃) 3.14 s (3 H); ³J(PH) = 23 Hz. δ(P) 16.7 s; ¹J(PIP) = 3527 Hz. δ(CF) -151.6 t (2 F); -155.8 d (4 F); ³J(FF) = 20.3 Hz. **4**: δ(CH₃) 0.83 dd; ³J(PH) = 7.0 Hz, ³J(PH) = 5.5 Hz. δ(OCH₃) 3.23 d (6 H); ²J(HF) = 2.5 Hz. δ(OCH₃) 3.00 d (3 H); ²J(HF) = 2.7 Hz. δ(P) 33.8 d, 20.7 d; ²J(PP) = 442 Hz. δ(CF) -150.7 t (1 F); -152.1 t (1 F); -155.6 d (2 F); -163.7 d (1 F); -169.6 d (1 F); ³J(FF) = 20.5 Hz.

(10) A similar C-O cleavage reaction has been published, see: Jones, C. E.; Shaw, B. L.; Turtle, B. L. *J. Chem. Soc., Dalton Trans.* **1974**, 992-999.

rameters, bond distances, bond angles, general displacement parameters, and torsion angles (13 pages); listing of observed and calculated structure factors (40 pages). Ordering information is given on any current masthead page.

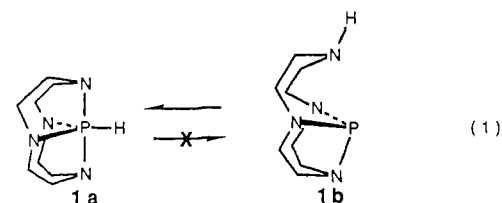
First Structural Evidence for Transannular P-N Bonding in the Phosphine Form of Cyclenphosphorane: An Open Tautomer?

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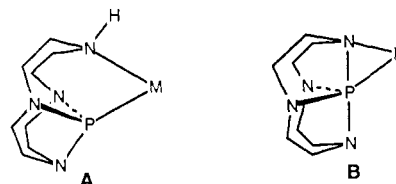
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Received December 12, 1988

Evidence has shown that cyclenphosphorane (cyclenPH) exists only in the "closed" tautomer **1a** in solution as well as in the solid



and gas phases.¹ Attempts to isolate the "open" form **1b** by coordination to transition metals have, thus far, been unsuccessful, except in the rare cases where it is forced into the bidentate structure A.² Reactions of cyclenPH with transition metals usually give the pentacoordinate structure B.³ It has been sug-



gested that this is due to the constraint of the 12-membered cyclen ring which stabilizes the trigonal-bipyramidal (tbp) geometry around phosphorus.^{3,4} We herein report the synthesis and X-ray crystal structure of the first monodentate P-bound transition-metal complex of **1b**. The structure of this complex reveals a P-N transannular interaction, which yields a unique geometry for a phosphine ligand, and provides the first structural confirmation of the tbp constraining "bite" of the cyclen ring about phosphorus. Moreover, the geometry explains why this complex undergoes a

[†] Present address: Chemistry Department, Vanderbilt University, Nashville, TN.

(1) (a) Atkins, T. J.; Richman, J. E. *Tetrahedron Lett.* **1978**, 5149. (b) Richman, J. E.; Atkins, T. J. *Tetrahedron Lett.* **1978**, 4333.

(2) (a) Burns, E. G.; Chu, S. S. C.; de Meester, P.; Lattman, M. *Organometallics* **1986**, *5*, 2383. (b) Khasnis, D. V.; Lattman, M.; Siriwardane, U. *Inorg. Chem.* **1989**, *28*, 681.

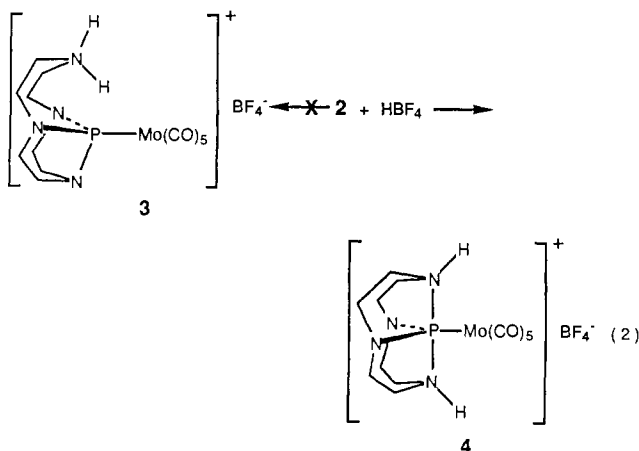
(3) (a) Lattman, M.; Chopra, S. K.; Burns, E. G. *Phosphorus Sulfur* **1987**, *30*, 185. (b) Lattman, M.; Burns, E. G.; Chopra, S. K.; Cowley, A. H.; Arif, A. M. *Inorg. Chem.* **1987**, *26*, 1926. (c) Lattman, M.; Chopra, S. K.; Cowley, A. H.; Arif, A. M.; *Organometallics* **1986**, *5*, 677. (d) Lattman, M.; Olmstead, M. M.; Power, P. P.; Rankin, D. W.; Robertson, H. E. *Inorg. Chem.* **1988**, *27*, 3012.

(4) (a) Dupart, J.-M.; Pace, S.; Riess, J. G. *J. Am. Chem. Soc.* **1983**, *105*, 1051. (b) Dupart, J.-M.; Le Borgne, G.; Pace, S.; Riess, J. G. *J. Am. Chem. Soc.* **1985**, *105*, 1202. (c) Bouvier, F.; Dupart, J.-M.; Riess, J. G. *Inorg. Chem.* **1988**, *27*, 427. (d) Bouvier, F.; Vierling, P.; Dupart, J.-M. *Inorg. Chem.* **1988**, *27*, 1099.

surprising protonation reaction.

Treatment of cyclenPH with $\text{Mo}(\text{CO})_6$ in refluxing toluene yields air-stable crystals of $\text{HcyclyenPMo}(\text{CO})_5$, **2**, in which cyclenPH is coordinated to the metal (through the phosphorus) in the open form **1b**.^{5,6} The proposed geometry of the product is supported by the ^{31}P chemical shift of +116 ppm, which is about 100–150 ppm further downfield than either cyclenPH itself, or the pentacoordinate cyclenP metal derivatives and is indicative of a lower coordination number for phosphorus.^{2,3} The N–H appears as a broad resonance in the ^1H NMR spectrum at δ 1.47 and a weak band in the ν_{NH} region of the IR spectrum at 3400 cm^{-1} . A direct P–Mo bond is supported by the observation of two-bond PC coupling to the carbonyl carbons in the $^{13}\text{C}\{^1\text{H}\}$ NMR spectrum.⁶ In addition, four resonances appear in the ^{13}C spectrum in the methylene region. Isolation of this geometry of cyclenPH is most likely due to the fact that the $\text{Mo}(\text{CO})_5$ fragment has only one vacant coordination site.

Since nitrogens attached to phosphorus usually show reduced basicity,⁷ the N–H nitrogen in **2** would be expected to be the most reactive site toward Lewis acids. However, treatment of **2** with HBF_4 yields a species with a ^{31}P chemical shift at δ +35, which is 81 ppm upfield from **2**. The CO region in both the IR and ^{13}C NMR spectra are very similar to **2**, suggesting that the $\text{Mo}(\text{CO})_5$ fragment is intact. Moreover, the ^{13}C NMR spectrum shows only two resonances in the methylene region, which indicates the presence of only two types of carbons. These spectra are consistent not with the simple ammonium salt formation product **3** but rather with a pentacoordinate phosphorus with both axial nitrogens protonated, $[(\text{H}_2\text{cyclenP})\text{Mo}(\text{CO})_5]\text{BF}_4$, **4**.^{8–10}



The unexpected product obtained by protonation led us to examine the structure of **2** more closely to see if it might give insights into the observed reactivity. The X-ray crystal structure

(5) Synthesis of **2** (inert atmosphere, all solvents dried and deoxygenated). A solution of cyclenPH (0.20 g, 1.0 mmol) and $\text{Mo}(\text{CO})_6$ (0.30 g, 1.1 mmol) were refluxed in toluene (5 mL) for 4 h. The volatiles were then pumped off, and the residue was recrystallized from hot hexanes (10 mL), yielding **2** as an off-white, air-stable, crystalline solid (0.41 g, 95%): mp 110–112 °C. Anal. ($\text{C}_{13}\text{H}_{17}\text{MoN}_4\text{O}_5\text{P}$) C, H, N.

(6) Spectroscopic data for **2**: ^1H NMR (CDCl_3) δ 1.47 (br, 1 H), 2.3–3.3 (comp m, 16 H); $^{31}\text{P}\{^1\text{H}\}$ NMR (CDCl_3) δ 116; $^{13}\text{C}\{^1\text{H}\}$ NMR ($\text{THF}-d_6$) δ 49.3 (CH_2), 50.6 (CH_2), 50.9 (CH_2), 52.5 (CH_2 , d, $^2J_{\text{PC}} = 22$ Hz), 207.4 (CO, d, $^2J_{\text{PC}} = 13$ Hz), 212.0 (CO, d, $^2J_{\text{PC}} = 32$ Hz); IR (hexanes, cm^{-1}) ν_{CO} 1945 (vs), 2060 (w); ν_{NH} (KBr) 3400 (vw).

(7) Verkade, J. G. *Coord. Chem. Rev.* **1972**/3, 9, 1, and references therein.

(8) Synthesis of **4** (inert atmosphere, all solvents dried and deoxygenated). A stirred solution of **2** (135 mg, 0.309 mmol) in hexanes (3 mL) was treated dropwise with 85% $\text{HBF}_4 \cdot \text{O}(\text{C}_2\text{H}_5)_2$ (48 μL , 0.28 mmol). After stirring for 8 h, the resulting precipitate was filtered, washed with hexanes and ether, and pumped dry to yield **4** as a white, air-stable, solid (144 mg, 90%): dec 185–187 °C.

(9) Spectroscopic data for **4**: ^1H NMR (CD_3CN) δ 2.3–3.3 (comp m, 16 H), 4.86 (br, 2 H); $^{31}\text{P}\{^1\text{H}\}$ NMR (CD_3CN) δ 35; $^{13}\text{C}\{^1\text{H}\}$ NMR (CD_3CN) δ 45.3 (CH_2 , d, $^2J_{\text{PC}} = 2$ Hz), 45.4 (CH_2 , d, $^2J_{\text{PC}} = 2$ Hz), 206.1 (CO, d, $^2J_{\text{PC}} = 13$ Hz), 211.0 (CO, d, $^2J_{\text{PC}} = 41$ Hz); IR (CH_3CN , cm^{-1}) ν_{CO} 1937 (vs), 2065 (w).

(10) This $\text{H}_2\text{cyclenP}$ geometry has been observed before. See ref 3b.

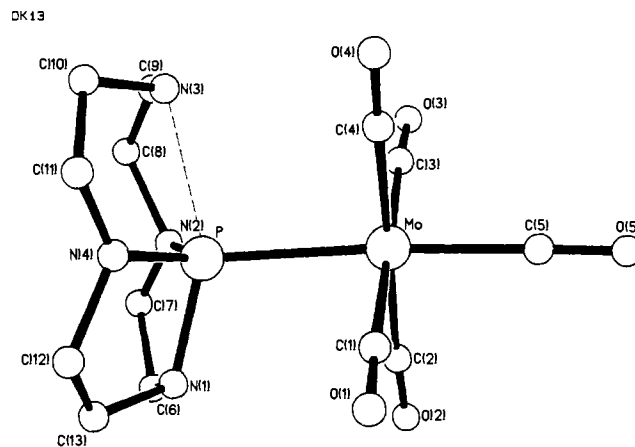


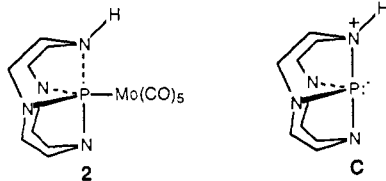
Figure 1. Computer-generated drawing of $\text{HcyclyenPMo}(\text{CO})_5$, **2**. Hydrogen atoms omitted for clarity. Selected interatomic distances (\AA) are as follows: Mo–P = 2.533 (5); P–N(1) = 1.809 (20); P–N(2) = 1.749 (20); P–N(3) = 2.356 (23); P–N(4) = 1.666 (20). Angles (deg) are as follows: Mo–P–N(1) = 107.7 (7); Mo–P–N(2) = 117.6 (9); Mo–P–N(3) = 98.6 (9); Mo–P–N(4) = 120.4 (8); N(1)–P–N(2) = 82.8 (11); N(1)–P–N(3) = 153.5 (13); N(1)–P–N(4) = 90.7 (9); N(2)–P–N(3) = 82.0 (12); N(2)–P–N(4) = 120.8 (12); N(3)–P–N(4) = 78.8 (13).

of **2** was obtained¹¹ and is illustrated in Figure 1, along with selected atomic distances and angles. The geometry about the phosphorus is unique for a phosphine bound to a metal: instead of being close to tetrahedral, the phosphorus is a distorted tbp. The Mo, N(2), and N(4) atoms are at the equatorial positions of the phosphorus, while N(1) occupies one axial position. The other axial site is occupied by N(3), which interacts with P through its lone pair of electrons. Although the P–N(3) distance of 2.356 (23) \AA is about 0.4 \AA longer than other P–N axial bonds in related cyclenP-metal derivatives,^{2,3} it is well within the sum of the van der Waals radii. More importantly, the phosphorus lies almost in the plane of the Mo, N(2), and N(4) atoms [sum of equatorial angles about P is 359 (2)°]. The N–P–N equatorial and axial angles of 120.8 (12)° and 153.5 (13)°, respectively, are typical for other tbp cyclenPX derivatives in which all four nitrogens show “normal” bond distances to phosphorus. The cyclenP unit adopts a staggered conformation with respect to the Mo–C–O bonds cis to the phosphorus, presumably to minimize steric interactions. It is noted that there is no significant difference between the solution and solid-state structures because the MAS ^{31}P chemical shift of **2** appears at δ +109, only 7 ppm shifted from the solution value.^{12,13}

(11) X-ray structure determination and refinement. Suitable colorless, cube-shaped crystals of **2** were grown from a solution of hot hexanes. Data were collected at room temperature on a Nicolet R_{3m}/V diffractometer using $\text{MoK}\alpha$ radiation. $\text{C}_{13}\text{H}_{17}\text{N}_4\text{O}_5\text{Mo}$, orthorhombic, space group $Pbca$, $a = 12.201$ (16) \AA , $b = 13.432$ (15) \AA , $c = 21.48$ (2) \AA , $V = 3520$ (7) \AA^3 , $Z = 8$, and $d_{\text{calcd}} = 1.65$ g cm^{-3} . A total of 3750 reflections were collected in the range $3.0^\circ \leq 2\theta \leq 50.0^\circ$. Data were corrected for decay (~2%), Lorentz polarization, and absorption. The structure was solved by direct methods using SHELXTL-PLUS (Sheldrick, G. M. *Structure Determination Software Programs*, Nicolet Instrument Corp., 1988) and subsequent difference Fourier methods. Final full-matrix least-squares refinement using 1892 observed reflections based on $F > 6.0\sigma(F)$ converged to $R = 0.062$ and $R_w = 0.069$; $\text{GOF} = 2.27$, $(\Delta/\sigma)_{\text{max}} = 0.10$, $\Delta\rho_{\text{max, min}} = 0.63, -0.82$ $\text{e}/\text{\AA}^3$, the function minimized being $\sum w(|F_o| - |F_c|)^2$, the weight used being $w^{-1} = \sigma(F)^2 + 0.0013F^2$. All non-hydrogen atoms were refined anisotropically; hydrogens on carbon atoms were included in calculated positions with a riding model with fixed isotropic thermal parameters and were included in the final refinement. Scattering factors for C, H, N, O, P, and Mo used were those stored in SHELXTL-PLUS.

(12) The ^{31}P chemical shift of **2** does not, at first, suggest a high coordination for phosphorus because of the far downfield position. However, a possible model for comparison would be $(\text{Me}_2\text{N})_3\text{PMo}(\text{CO})_5$, a species where no increased coordination of the phosphorus is possible. The ^{31}P shift of this compound is δ +145 (Andrews, G. T.; Colquhoun, I. J.; McFarlane, W.; Grim, S. O. *J. Chem. Soc., Dalton Trans.* **1982**, 2353), about 30 ppm downfield of **2**; this difference may reflect somewhat of an upfield shift of the phosphorus in **2** due to the interaction of the nitrogen lone pair with phosphorus. However, see ref 13.

The X-ray structure of **2** shows that the cyclen ring does have the correct bite for a tbp geometry around phosphorus and indeed adopts that orientation via a P-N transannular interaction. This provides the first direct structural evidence for this often-suggested ability.^{1-3,14} Moreover, in view of the geometry about phosphorus, the electronics of cyclenP might be best described as a zwitterionic phosphoranide^{3d} ligand C.



Acknowledgment. We thank the Robert A. Welch Foundation for generous financial support. D.V.K. thanks Prof. Narayan S. Hosmane for helpful discussions. We thank Prof. Robert H. Neilson for obtaining the ¹³C NMR spectrum of **4**.

Supplementary Material Available: Tables of summary of X-ray analysis, atomic coordinates, anisotropic thermal parameters, bond distances, bond angles, and hydrogen atom coordinates for **2** (6 pages); tables of observed and calculated structure factors for **2** (11 pages). Ordering information is given on any current masthead page.

(13) As an alternative explanation to that in ref 12, the ³¹P chemical shift may not indicate any transannular interaction since (Me₂N)₃PMo(CO)₅ may not be a suitable comparison standard. The upfield position of **2** compared to (Me₂N)₃PMo(CO)₅ may be due simply to incorporation of the phosphorus into two five-membered rings. We thank a referee for pointing out this possibility.

(14) Richman, J. E.; Kubale, J. J. *J. Am. Chem. Soc.* **1983**, *105*, 749.

Gas-Phase Ion Chemistry of the Acetic Acid Enolate Anion [CH₂CO₂H]⁻

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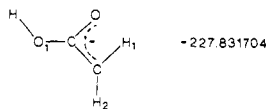
Received November 14, 1988

Deprotonation of acetic acid forms mainly the acetate anion CH₃CO₂⁻ [$\Delta G^\circ_{\text{acid}}(\text{CH}_3\text{CO}_2\text{H}) = 341.5 \text{ kcal mol}^{-1}$].² The isomeric enolate ion [CH₂CO₂H]⁻³ has not been studied in the gas phase, although it is implicated in condensed phase reactions.⁴ We wish to report that in our tandem flowing afterglow-selected

(1) (a) On leave at Boulder from the University of Adelaide. (b) Boulder. (c) Adelaide.

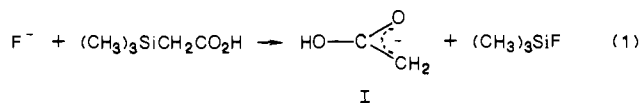
(2) Cumming, J. B.; Kebabian, P. *Can. J. Chem.* **1978**, *58*, 56.

(3) (a) For early ab initio calculations, see: Wagner, H.-U.; Boche, G. Z. *Naturforsch.* **1982**, *37b*, 1339; *Helv. Chim. Acta* **1983**, *66*, 842. (b) Ab initio calculations on [CH₂CO₂H]⁻ give the geometry (RHF/6-31+G*) and energy (MP2/6-31+G**/6-31+G*) indicated below (GAUSSIAN 82, Release H—Frisch, M.; Binkley, J. S.; Schlegel, H. B.; Raghavachari, K.; Martin, R.; Stewart, J. J. P.; Bobrowicz, F.; DeFrees, D.; Seeger, R.; Whiteside, R.; Fox, D.; Fluder, E.; Pople, J. A. Carnegie Mellon University). Results are as follows (hartrees, Å, deg): HO₁ (0.048), O₁C (1.392), CO₂ (1.244), CC (1.374), CH₁ (1.075), CH₂ (1.075), HO₁C (103.68), O₁CC (114.94), O₂CC (130.68), CCH₂ (119.36), CCH₁ (120.96), planar.

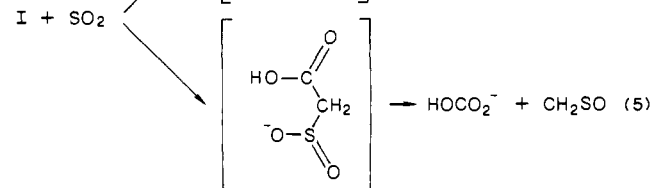
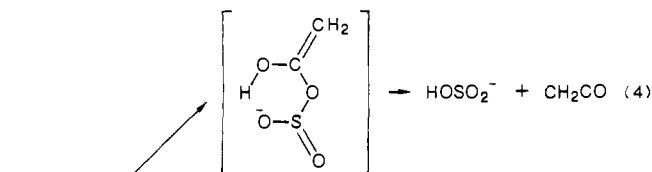
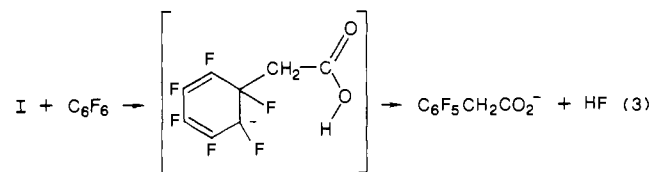
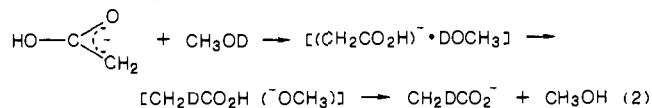


(4) Angelo, M. B. C. R. *Acad. Sci. Paris, C* **1973**, 293. Nesmeyanov, A. N.; Surkov, B. A.; Sazonova, V. A.; Zaimovskaya, T. A. *Dokl. Akad. Nauk. SSSR* **1974**, *219*, 614.

ion flow tube (FA-SIFT),⁵ the acetic acid enolate anion can readily be prepared by the reaction shown in eq 1.⁶



Enolate ion I deprotonates acetone [$\Delta G^\circ_{\text{acid}} = 361.9 \text{ kcal mol}^{-1}$]⁷ but not methyl acetate [$\Delta G^\circ_{\text{acid}} = 365.1 \text{ kcal mol}^{-1}$];⁷ this brackets $\Delta G^\circ_{\text{acid}}(\text{CH}_3\text{CO}_2\text{H})$ at $363 \pm 3 \text{ kcal mol}^{-1}$. Ion I undergoes quite different reactions from that of its isomer the acetate anion II. For example, (i) I (*m/z* 59) reacts readily with CH₃OD to form *m/z* 60 (eq 2);⁸ the acetate anion undergoes no deuterium incorporation under these conditions;⁹ (ii) I undergoes the characteristic nucleophilic aromatic substitution with C₆F₆¹⁰ shown in eq 3;¹¹ and (iii) I may act as an ambident nucleophile with SO₂ as shown in eq 4 and 5.¹²



We have shown that thermalized ions I and II are discrete species with quite different reactivities. However, if enolate I is excited (for example, by collisional activation), will it convert to the more stable acetate anion by 1,3 proton transfer?¹⁴ This

(5) Van Doren, J. M.; Barlow, S. E.; DePuy, C. H.; Bierbaum, V. M. *J. Am. Chem. Soc.* **1987**, *109*, 4412.

(6) (a) The generation of gas-phase anions from trimethylsilyl compounds is reported by the following: DePuy, C. H.; Bierbaum, V. M.; Flippin, L. A.; Grabowski, J. J.; King, G. K.; Schmitt, R. J.; Sullivan, S. A. *J. Am. Chem. Soc.* **1980**, *102*, 5012. (b) The (M-H⁺)⁻ ion is also a product of the reaction between F⁻ and Me₃SiCH₂CO₂H (branching ratio 0.10). (c) Me₃SiCH₂CO₂H is a commercial product.

(7) Bartmess, J. E.; McIver, R. T. *The Gas Phase Acidity Scale*. In *Gas Phase Ion Chemistry*; Bowers, M. T., Ed.; Academic Press: New York, 1979; Vol. 2, p 99. Lias, S. G.; Bartmess, J. E.; Liebman, J. F.; Holmes, J. L.; Levin, R. D.; Mallard, W. G. *J. Phys. Chem. Ref. Data* **1988**, *17* (Suppl. 1).

(8) (a) The ion [(CH₂CO₂H)⁻ + CH₃OD] is also detected in this experiment. (b) Anion I undergoes slow incorporation (one deuterium) with D₂O at high D₂O flows.

(9) (a) The acetate ion is made by the reaction F⁻ + (CH₃)₃SiOCOCH₃ → CH₃CO₂⁻ + (CH₃)₃SiF. (b) The only detectable product of the reaction between CH₃CO₂⁻ and CH₃OD is [CH₃CO₂⁻ + CH₃OD].

(10) For other nucleophilic aromatic substitution reactions of perfluorobenzenes, see: Ingemann, S.; Nibbering, N. M. M.; Sullivan, S. A.; DePuy, C. H. *J. Am. Chem. Soc.* **1982**, *104*, 6520.

(11) (a) The ion [(CH₂CO₂H)⁻ + C₆F₆] is also noted: branching ratio [(CH₂CO₂H)⁻ + C₆F₆]:C₆F₅CH₂CO₂⁻ = 1:2. (b) CH₃CO₂⁻ reacts with C₆F₆ to give only [CH₃CO₂⁻ + C₆F₆].

(12) (a) The ion [(CH₂CO₂H)⁻ + SO₂] is also noted: branching ratio [(CH₂CO₂H)⁻ + SO₂]:HOSO₂⁻:HOCO₂⁻ = 4:4:1. (b) CH₃CO₂⁻ reacts with SO₂ to give only [CH₃CO₂⁻ + SO₂].

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