nicating his results prior to publication.

Registry No. (OMN)Cr(CO)$_3$, 79391-56-3; (OMN)Mo(CO)$_3$, 79391-57-4; (OMN)W(CO)$_3$, 79391-58-5; (OMN)Cr(CO)$_2$(PPh$_3$), 79391-59-6; (*endo*)-[OMN·MA]Cr(CO)$_3$, 79391-60-9; (*exo*)-[OMN·MA]Cr(CO)$_3$, 79434-50-7; (*endo*)-OMN·MA, 36744-72-6; (*exo*)-OMN·MA, 36744-73-7; Cr(CO)$_3$(P(OMe)$_3$)$_3$, 17764-72-6; Cr(CO)$_6$, 13007-92-6; (CH$_3$CN)$_3$Mo(CO)$_3$, 15038-48-9; (CH$_3$CN)$_3$W(CO)$_3$, 16800-47-8; MA, 108-31-6.

Supplementary Material Available: Listings of the observed and calculated structure factors used in the crystallographic analyses (21 pages). Ordering information is given on any current masthead page.

Further Studies on the Molecular Dynamics of the Four-Electron Bridging Carbonyl

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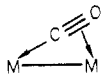
Both Mn$_2$(CO)$_6$(dpm)$_2$, which contains only terminal carbonyls, and Mn$_2$(CO)$_5$(dpm)$_2$, which contains one μ:η^2 (four-electron donor) carbonyl, are shown to be fluxional by ^{13}C NMR spectroscopy. Scrambling in the hexacarbonyl occurs over both metal atoms with E_a = 10.2 kcal/mol and log A = 12.1, while that in pentacarbonyl involves only a wagging motion which results in disruption of the Dewar–Chatt portion of the four-electron donor carbonyl with E_a = 17.0 kcal/mol and log A = 15.0. By selective ^{31}P decoupling experiments, the chemical shift of the four-electron donor carbonyl is shown to fall in the chemical shift region normally attributed to terminal carbonyls. Coupling of ^{13}C to ^{31}P is small (<5 Hz) through the Dewar–Chatt portion of this type of carbonyl.

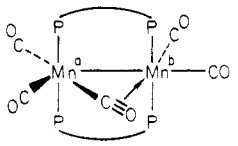
Introduction

The four-electron-donor carbonyl bridge, depicted formally as I, is an organometallic structural unit of relatively



I

recent vintage. The first example, contained in Mn$_2$(CO)$_5$(dpm)$_2$, II (dpm = bis(diphenylphosphino)methane,

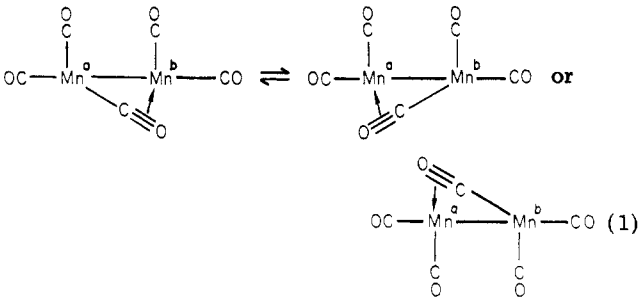


II

Ph$_2$PCH$_2$PPh$_2$), was reported in 1975 by Colton, Commons, and Hoskins.[1] The five carbonyls in this molecule are coplanar. Subsequent reports include Cp$_2$NbMo(CO)$_3$Cp,[2] Cp$_2$Zr(OC)(OCMe)Mo(CO)Cp,[3] and (C$_5$Me$_5$)$_2$ZrCo(CO)$_2$(C$_5$H$_5$).[4] A cluster-bound analogue occurs in HFe$_4$(CO)$_{13}^-$, where one of the carbonyl ligands donates a total of four electrons to all four iron atoms in Fe$_4$(CO)$_{13}$H$^-$.[5] Finally an extreme example of carbonyl Lewis basicity is found in Cp$_3$Nb$_3$(CO)$_7$, where one CO ligand lies obliquely over the Nb$_3$ triangle and donates via the carbon lone pair and *both* filled C≡O π orbitals.[6]

Carbon monoxide assumes the μ_2:η^2 functionality in ligand-deficient situations; indeed, this structural unit is generally formed by thermal or photochemical processes which expel ligands (e.g., CO or CH$_4$). Since such ligand-deficient situations are precisely those found on lightly loaded metal surfaces, molecular examples of multipoint attachment of CO represent an important opportunity to examine the dynamics and reactivity of a catalytically relevant moiety by use of spectroscopic methods.

Several years ago, we reported the results of a ^{31}P NMR study of Mn$_2$(CO)$_5$(dpm)$_2$ which indicated that the migrational processes depicted in eq 1 (bridging dpm ligands



(1)

are omitted for simplicity) are *not* facile.[7] The observed inequivalence (at 30 °C) of the phosphorus nuclei attached to different manganese atoms allowed us to set a lower limit of 15.6 kcal/mol for the activation energy of eq 1. This result is compatible with the notion that multipoint carbonyl binding inhibits the characteristically facile migrations of two-electron donor carbonyls.

We were therefore somewhat surprised by our more recent result that *reorientation* of the six-electron donor carbonyl in Cp$_3$Nb$_3$(CO)$_7$ (eq 2) occurs with an activation energy, E_a, of 17 kcal/mol.[8] In order to examine this situation more critically, we have returned to perhaps the

(1) (a) Commons, C. J.; Hoskins, B. F. *Aust. J. Chem.* **1975**, *28*, 1663. (b) Colton, R.; Commons, C. J. *Ibid.* **1975**, *28*, 1673.
(2) Pasynskii, A. A.; Skripkin, Yu. V.; Eremenko, I. L.; Kalinnikov, V. T.; Aleksandrov, G. G.; Andrianov, V. G.; Struchkov, Yu. T. *J. Organomet. Chem.* **1979**, *165*, 49.
(3) Longato, B.; Norton, J. R.; Huffman, J. C.; Marsella, J. A.; Caulton, K. G. *J. Am. Chem. Soc.* **1981**, *103*, 209.
(4) Barger, P. T.; Bercaw, J. E. *J. Organomet. Chem.* **1980**, *201*, C39.
(5) Manassero, M.; Sanasoni, M.; Longoni, G. *J. Chem. Soc., Chem. Commun.* **1976**, 919.
(6) Herrmann, W. A.; Biersack, H.; Ziegler, M. L.; Weidenhammer, K.; Siegel, R.; Rehder, D. *J. Am. Chem. Soc.* **1981**, *103*, 1692.
(7) Caulton, K. G.; Adair, P. *J. Organomet. Chem.* **1976**, *114*, C11.
(8) Lewis, L. N.; Caulton, K. G. *Inorg. Chem.* **1980**, *19*, 3201.

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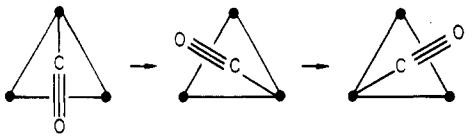


(2)

• = $CpNb(CO)_2$

simplest example, $Mn_2(CO)_5(dpm)_2$. This time, we have examined the migrating nuclei directly using ^{13}C NMR. This provides information which complements, but does not duplicate, our earlier ^{31}P NMR study. Of equal importance, this study yields unexpected information about the spectroscopic characteristics of the four-electron donor carbonyl.

Experimental Section

The compound $Mn_2(CO)_5(dpm)_2$ was synthesized according to the published procedure.[1b] Carbon-13 enrichment was achieved by stirring a suspension of the complex under 0.5 atm of enriched ^{13}CO (70%) at 140 °C in a mixture of xylenes for 3 days. The resulting orange solution was then degassed, and heating was continued for 1 day under 1 atm of N_2 (closed system) to yield enriched $Mn_2(CO)_5(dpm)_2$ as a red precipitate. From the orange filtrate was obtained enriched $Mn_2(CO)_6(dpm)_2$. The purity and identity of these two complexes were confirmed by ^{31}P NMR spectroscopy.[7]

NMR spectra were obtained on a Varian XL 100 spectrometer operating at 25.206 MHz for carbon and equipped with ^{31}P decoupling capability. Methylene chloride solvent was used for all spectra obtained at 30 °C and below. For high-temperature spectra (>30 °C), 1,2-dichloroethane was used. Samples were approximately 50% enriched, based on the relative intensities of the μ-CO bands at 1645 (^{12}CO) and 1605 cm^{-1} (^{13}CO) of $Mn_2(CO)_5(dpm)_2$. NMR solutions were approximately 30 mM in manganese complex and 10 mM in $Cr(acac)_3$. None of the spectra showed significant broadening by the quadrupolar manganese nuclei. Temperatures were measured by means of a thermometer inserted into the sample probe.

Dynamic NMR spectra were simulated with the program DNMR.[8] Activation parameters for $Mn_2(CO)_6(dpm)_2$ were derived from spectra in the range −55 to −20 °C, while those for the pentacarbonyl employed spectra in the range 5 to 75 °C. These parameters were evaluated from a least-squares fit of the derived rate constants.

Results

The poor solubility of $Mn_2(CO)_5(dpm)_2$ necessitates ^{13}CO enrichment in order to obtain reliable data on ligand migration. This enrichment was effected by taking advantage of the equilibrium[9] in eq 3. The forward and

$$Mn_2(CO)_5(dpm)_2 + CO \rightleftharpoons Mn_2(CO)_6(dpm)_2 \quad (3)$$

reverse steps of this reaction have been carried out at 25 and 140 °C, respectively.[1,7] The enrichment proceeds by the agitation of $Mn_2(CO)_5(dpm)_2$ under ^{13}CO at 140 °C in xylene.

The $^{13}C\{^1H\}$ NMR spectrum of $Mn_2(CO)_5(dpm)_2$ in the carbonyl region at −52 °C consists of a complex series of overlapping resonances (Figure 1a). The coupling to phosphorus represents an obstacle to assigning the spectrum. We therefore recorded the *broad-band* ^{31}P-decoupled ^{13}C spectrum (Figure 1d). While no proton decoupling was employed, this caused no significant broadening of the carbonyl resonances. The $^{13}C\{^{31}P\}$ NMR spectrum of $Mn_2(CO)_5(dpm)_2$ at −52 °C shows a closely spaced cluster of five lines in the region from 240 to 225 ppm. None of these lines is due to $Mn_2(CO)_6(dpm)_2$ impurity (see below).

(9) $Mn_2(CO)_5(dpm)_2$ adds p-$CH_3C_6H_4NC$ irreversibly in refluxing xylene, subsequently displacing CO to give (μ-η^1:η^2-$CH_3C_6H_4NC$)Mn_2-$(dpm)_2(CO)_4$. Benner, L. S.; Olmstead, M. M.; Balch, A. L. *J. Organomet. Chem.* 1977, *159*, 289.

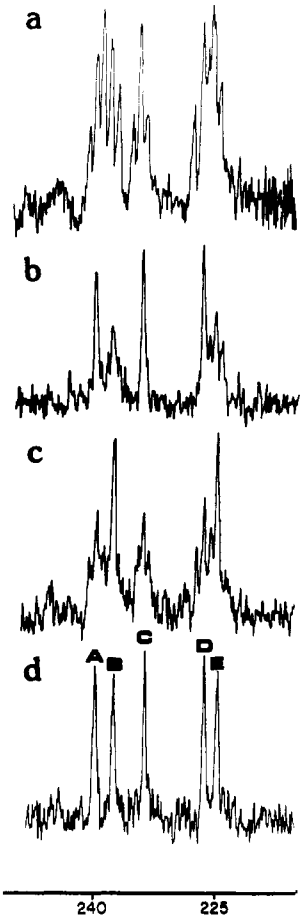


Figure 1. Carbonyl region ^{13}C NMR spectra of $Mn_2(CO)_5(dpm)_2$ at −52 °C. (a) No ^{31}P decoupling. (b) Selective decoupling of the 75.9-ppm ^{31}P resonance. (c) Selective decoupling of the 59.5-ppm ^{31}P resonance. (d) Broad-band ^{31}P decoupling.

While this spectrum is in accord with the solid-state structure, it is remarkable in that the four-electron donor carbonyl exhibits a chemical shift in the "terminal carbonyl region" and not further downfield in the region typical of normal μ_2:η^1 bridging carbonyls.[10]

Selective ^{31}P decoupling experiments make it possible to assign most of this spectrum. Irradiation of the 75.9-ppm ^{31}P resonance frequency (i.e., with the 59.5-ppm phosphorus nuclei coupling to carbon) leaves two of the carbonyl signals (B and E) as triplets (Figure 1b). These carbonyls are therefore assigned as bonded to Mn^b in II. Irradiation of the other (59.5 ppm) phosphorus frequency yields triplet patterns for lines A, C, and D. Thus, no carbon couples significantly to both types of phosphorus. These lines are then assigned to carbonyls bonded to Mn^a;[11,12] one of these three is then the resonance of the four-electron-donor carbonyl. This permits the conclusion that carbon in the μ_2:η^2-CO structural unit couples selectively to the phosphorus to which it dative bonds through carbon but that coupling to phoshorus through the π-donor orbital is small (<5 Hz).

The course of the ligand migration process is best observed in the completely ^{31}P decoupled spectrum (Figure

(10) Todd, L. J.; Wilkinson, J. R. *J. Organomet. Chem.* 1974, *77*, 1.

(11) This assignment of resonances A, C, and D to carbons bound to Mn^a in II is not arbitrary, nor is it based simply on arguments about the magnitude of J(P–C). The nature of the nuclear permutation deduced under Discussion uniquely leads to this assignment.

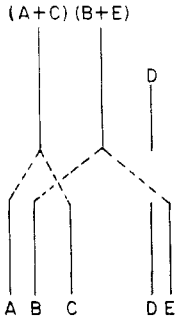
(12) These experiments also indicate that the 75.9-ppm phosphorus nuclei are bonded to Mn^a and the 59.5-ppm phoshorus nuclei reside on Mn^b.

Table I. Carbonyl Ligand ^{13}C Chemical Shifts in $Mn_2(CO)_5(dpm)_2$

resonance	chemical shift (ppm)
A	239.8
B	237.5
C	233.8
D	226.8
E	224.9
(A + C)[a]	237.4
(B + E)[a]	231.5

[a] Observed position above coalescence temperature.

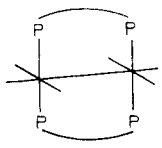
2). As the temperature is raised, resonances A, B, C, and E (see Figure 1d for labels) broaden and *selectively* coalesce, while resonance D remains sharp. The selective character of the coalescence lies in the fact that lines A, B, C, and E coalesce to *two* lines. On the basis of the averaged chemical shifts, we can show that lines A and C merge to one line, while B and E merge to a second line. Differential line broadening is evident in the spectra in the range 30–75 °C, but this is caused by the fact that resonances A and C are separated by a smaller gap (133 Hz at −75 °C, 152 Hz at −30 °C) than B and E (320 Hz) (see Table I).



Line-shape analysis (see below) shows that a single kinetic process (one rate constant) is sufficient to reproduce this differential line broadening.

By +75 °C, resonances A and C have coalesced to a singlet (broad band ^{31}P decoupled) which is nearly as sharp as (unchanged) resonance D. The slower coalescence of lines B and E leaves their merged resonance broader at +75 °C. The coalesced pattern approximates the expected 2:2:1 intensity ratios for the assignment (reading upfield) (A + C), (B + E), and D. Selective ^{31}P decoupling at +75 °C permits independent confirmation of the above conclusion that, within any pair of interchanging carbonyls, the two nuclei are bound to the same metal atom. Thus, decoupling at the 75.9-ppm ^{31}P frequency broadens only the central resonance (relative to the broad-band ^{31}P-decoupled spectrum), which was assigned as B + E (both on Mn^b). Decoupling at the 59.5-ppm phosphorus resonance yields triplets for the resonance assigned as (A + C) and D (both on Mn^a); the (B + E) resonance is unaffected. The connectivity and site-exchange required of these data are contained in the following: [Mn^a: P(75.9 ppm); (A + C); D] [Mn^b: P(59.5 ppm); (B + E)].

For a number of reasons, it was deemed useful to examine the ^{13}C NMR of $Mn_2(^{13}CO)_6(dpm)_2$ (III).[1b] Curi-



III

ously, the $^{13}C\{^1H\}$ spectrum of this compound at 30 °C

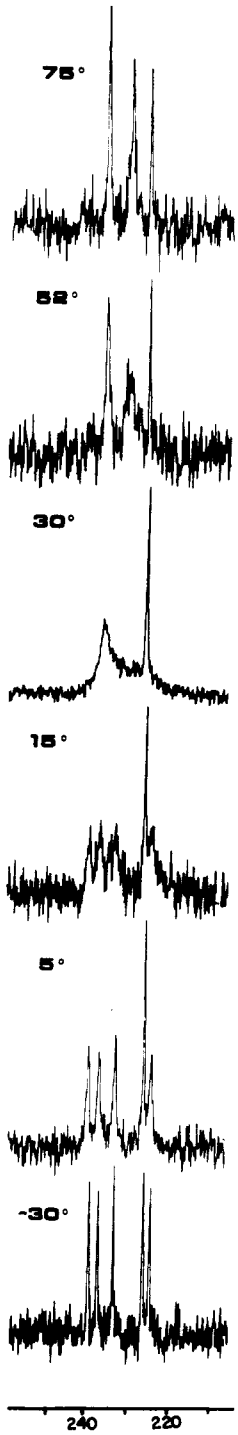


Figure 2. Variable-temperature ^{13}C NMR spectra (carbonyl region) of $Mn_2(CO)_5(dpm)_2$ under conditions of broad-band ^{31}P decoupling.

shows only a quintet resonance in the carbonyl region (δ 232.5), due to coupling to phosphorus (J = 10.3 Hz). Both the single apparent chemical shift and the apparently equivalent coupling to all four phosphorus nuclei speak for a fluxional molecule. No single structural alternative to III could account for these observations. At −75 °C, the $^{13}C\{^{31}P\}$ NMR spectrum of $Mn_2(CO)_6(dpm)_2$ consists of two resonances, 234.8 and 226.5 ppm, of relative intensity approximately 2:1. In the phosphorus-coupled spectrum, each resonance is broadened ($\nu_{1/2}$ = 30 Hz) sufficiently to be consistent with unresolved coupling to ^{31}P; the $^{13}C\{^{31}P\}$ broad-band NMR spectrum at −75 °C (Figure 3) is considerably sharper ($\nu_{1/2}$ = 10 Hz).[13] This confirms that

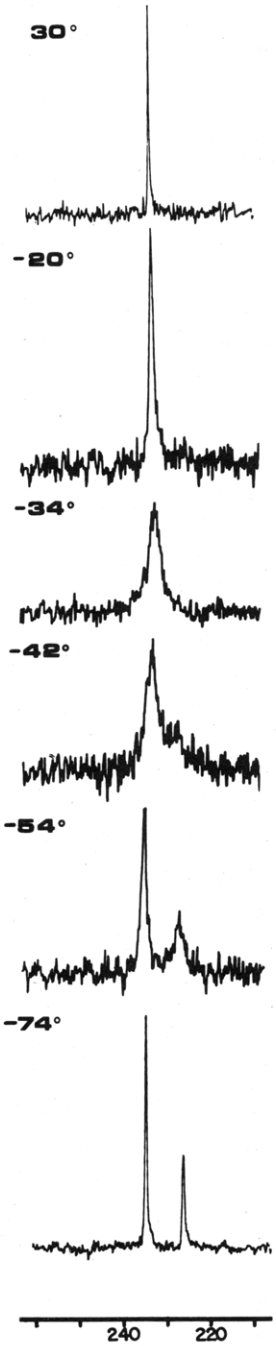


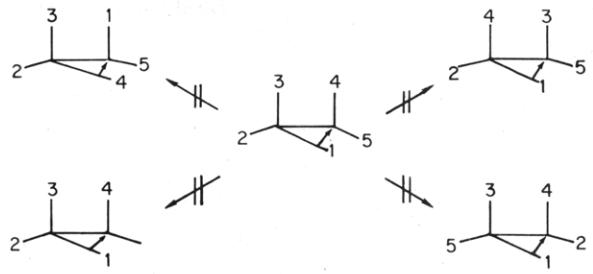
Figure 3. Variable-temperature ^{13}C NMR spectra (carbonyl region) of $Mn_2(CO)_6(dpm)_2$ under conditions of broad-band ^{31}P decoupling.

$Mn_2(CO)_6(dpm)_2$ exhibits global intramolecular carbonyl scrambling and provides a useful standard for the energetics of the rearrangement of the four-electron donor carbonyl. In retrospect, it is clear that CO scrambling between the two inequivalent sites in $Mn_2(CO)_6(dpm)_2$ is essential to the *random* enrichment which we seek in eq 3.

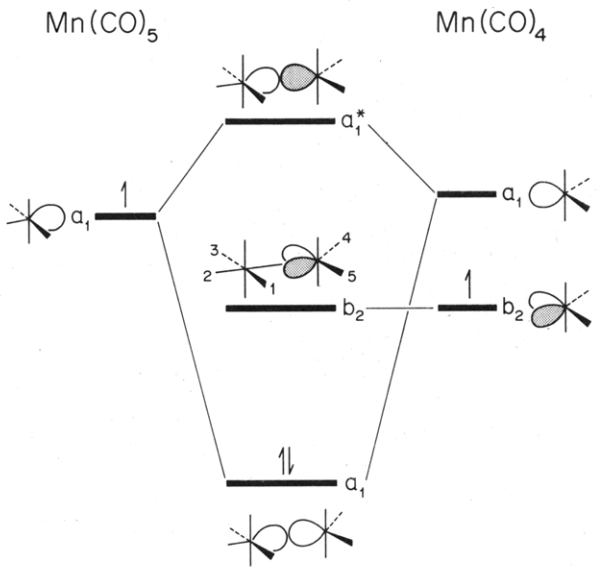
Discussion

We have detected a facile intramolecular (P–C coupling is retained) rearrangement of the four-electron-donor carbonyl in $Mn_2(CO)_5(dpm)_2$. The rearrangement is of limited, not global, scope: it does not result in equivalence of the two metal atoms in the molecule, and in this regard it is consistent with our earlier ^{31}P NMR results.[7] The rearrangement creates a time-averaged molecular mirror plane containing the metal–metal bond and the four phosphorus nuclei but no mirror plane relating the two metal atoms. Furthermore, the data show clearly that, during the progress of the rearrangement, *no* carbonyl ligand migrates to a terminal position on the second metal (for example, see Scheme I). All such processes would lead to quintets due to ^{31}P coupling.

Scheme I

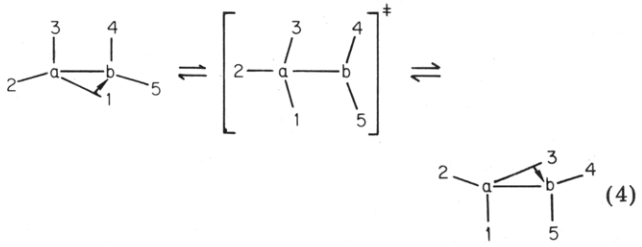


Scheme II



The limited character of the fluxional behavior of II contrasts with the global migration observed in $Fe_2(CO)_5[(EtO)_2POP(OEt)_2]_2$.[14] The structure of the iron complex differs from that of II in that it contains a symmetrical bridging carbon monoxide ligand. The very facile process (coalescence temperature ~ −108 °C) in the symmetrically bridged iron complex involves all CO's moving to *both* metal centers.

The simplest mechanism which accomplishes the observed coalescence is the limited but concerted wagging process shown in eq 4 and Figure 4. This mechanism



(4)

(13) The room-temperature $^{13}C\{^{31}P\}$ spectrum is considerably sharper, with $\nu_{1/2} \sim 3$ Hz. At −75 °C, the fluxional processes are not completely frozen, and the resulting broadening (or viscosity broadening) prevents resolution of P–^{13}C coupling.

(14) Cotton, F. A.; Haines, R. J.; Hanson, B. E.; Sekutowski, J. C. *Inorg. Chem.* **1978**, *17*, 2010.

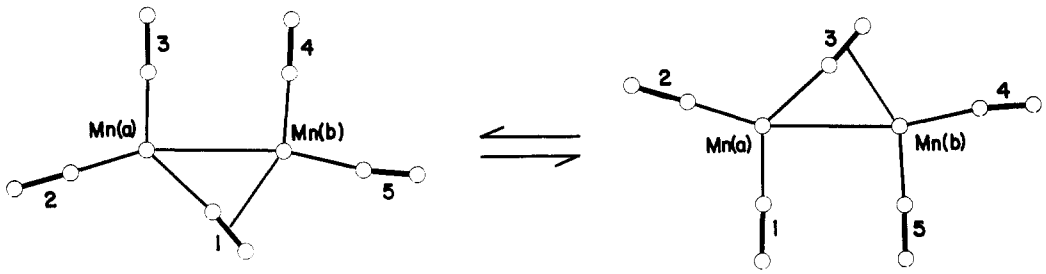
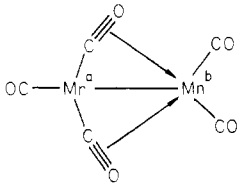


Figure 4. ORTEP drawings of the fluxional motion occurring in $Mn_2(CO)_5(dpm)_2$.

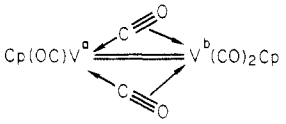
equivalences the two carbonyls bound to Mn^b, as is required by the phosphorus-coupled ^{13}C NMR data. It also requires that resonances A and C are due to environments 3 and 1, *or the reverse*; a unique assignment cannot be made with the available data, but this has no influence on the conclusions drawn. Most importantly, the temperature invariance of resonance D (now assigned to environment 2) arises in an unusual (but not unique) manner. While this quasi-axial carbonyl undergoes a spatial movement (Figure 4), it remains in an equivalent environment after such rearrangement and, therefore, exhibits no lifetime broadening.

The rearrangement mechanism in eq 4 appears to sacrifice the CO π-donor portion of the four-electron donor unit during the process. The proposed transition state has a geometry similar to that of $Re_2Cl_5(dpm)_2$.[15] It is not possible to achieve an 18-electron configuration at Mn^b by drawing a Mn=Mn double (covalent) bond in this structure. However, this transition state might reasonably employ bond making concurrent with bond breaking (IV).



IV

Such behavior is wholly analogous to that shown in the ground-state structure of $Cp_2V_2(CO)_5$[16] (V), where the net



V

result of two "semibridging" carbonyls is the formal donation of a total of only two electrons to V^b. It is this proposed compensatory nature of the rearrangement in $Mn_2(CO)_5(dpm)_2$ which lowers the activation energy of an otherwise unfavorable 18-electron → 16-electron transformation. Line-shape analysis of the observed spectra gives an E_a of 10.2 kcal/mol (log A = 12.1) for $Mn_2(CO)_6(dpm)_2$ and E_a = 17.0 kcal/mol (log A = 15.0) for $Mn_2(CO)_5(dpm)_2$. Consequently, rearrangement of the four-electron-donor carbonyl is found to cost only 6.8 kcal/mol more than that of a more conventional carbonyl complex. Combining the frontier orbitals of the fragments $Mn(CO)_5$ and $Mn(CO)_4$,[17] as shown in Scheme II, reveals that the LUMO of the C_{2v} $Mn_2(CO)_9$ transition state resides on the $Mn(CO)_4$ fragment and is of the proper symmetry (b_2) to accept from one filled π orbital of each of the two carbonyls in question. The requisite empty orbital is thus available for the interaction depicted in IV. Comparison of the activation energy in $Mn_2(CO)_5(dpm)_2$ with that in $Fe_2(CO)_5[(EtO)_2POP(OEt)_2]_2$ is also warranted since the b_2 orbital of this proposed intermediate is filled in the latter compound. The iron compound exhibits intramolecular carbonyl exchange at over 10^3 s^{-1} at 100 °C. The difference in ground-state structure tends to frustrate any more detailed comparison, however.

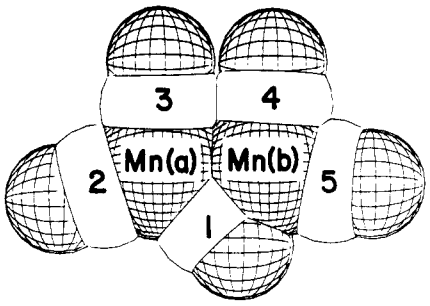
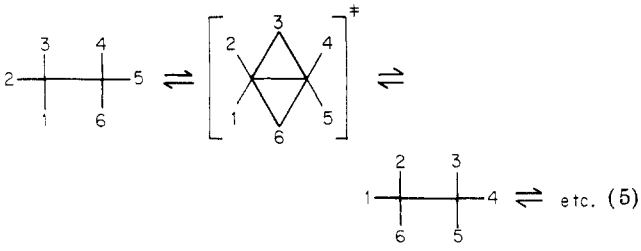


Figure 5. Space-filling scale model of the $Mn_2(CO)_5$ unit in $Mn_2(CO)_5(dpm)_2$.

Figure 5 shows a scale view of the $Mn_2(CO)_5$ plane with all atoms drawn at their van der Waals radii. This space-filling model reveals that the clockwise motion of the four-electron-donor carbonyl which initiates the rearrangement in eq 4 will displace all other carbonyls in the direction shown. The synchronous motion of all five carbonyls is assured in particular by the close contact between carbonyls 3 and 4, which flank the metal–metal bond on different metal atoms.

The carbonyl migration in $Mn_2(CO)_6(dpm)_2$ is most readily accomplished by the merry-go-round mechanism shown in eq 5. Our DNMR result shows that the bridged



carbonyl complex lies less than or equal to 10.2 kcal/mol above the all-terminal ground state. While carbonyls symmetrically bridging two manganese atoms are rare, an example has been reported recently.[18] The key question, and the origin of our surprise at the fluxionality of $Mn_2(CO)_6(dpm)_2$, is why this compound differs so much from $Mn_2(CO)_{10}$, which appears stereochemically rigid at 30 °C by ^{13}C NMR and up to 130 °C by ^{17}O NMR.[19] We suggest

(15) Cotton, F. A.; Shive, L. W.; Stults, B. R. *Inorg. Chem.* **1976**, *15*, 2239.
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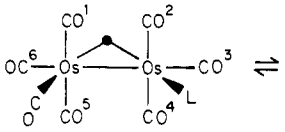
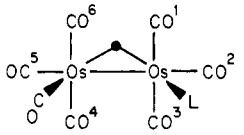
that conformational differences around the Mn–Mn single bond contribute to this difference.[20] $Mn_2(CO)_{10}$ is staggered. $Mn_2(CO)_6(dpm)_2$ is, of course, eclipsed. While this has not been established crystallographically for $Mn_2(CO)_6(dpm)_2$, the $Ph_2PCH_2PPh_2$ linkage is too short to span a staggered metal–metal bond 2.9–3.0 Å long. Eclipsed conformations are found in $Re_2Cl_5(dpm)_2$,[15] $Mo_2Cl_4(dpm)_2$,[21a] and the many M–M single bonded species $M_2(dpm)_2X_n$ (M = Rh, Pt, Pd).[21b] An interesting corollary of this argument is that the $Ph_2PCH_2CH_2PPh_2$-bridged analogue, $Mn_2(CO)_6(dppe)_2$, is predicted to have a higher barrier to carbonyl scrambling. $Re_2Cl_4(dppe)_2$,[22] $Mo_2Br_2(Ph_2PCH_2CH_2AsPh_2)$,[23] and $W_2Cl_4(dppe)_2$[24] are all staggered.

Although we believe the steric consequences of the phosphine bridge to be the most important consideration, it should be noted that the stereochemical rigidity of $Os_3(CO)_{12}$ is diminished upon phosphine substitution. Thus, $Os_3(CO)_{12}$ is only fluxional above 100 °C, while $Os_3(CO)_{11}P(Et)_3$ (VI) shows two-center carbonyl fluxionality at room temperature (eq 6).[20] On the other hand,



VI



etc. (6)

• = $Os(CO)_4$; L = $P(C_2H_5)_3$

axial $Mn_2(CO)_9(PPh_3)$, like $Mn_2(CO)_{10}$, is rigid.[19c]

Conclusion

Fluxional processes operate in both $Mn_2(CO)_6(dpm)_2$ and $Mn_2(CO)_5(dpm)_2$. These are in contrast to the nonfluxional nature of the parent carbonyl complex. The chemical shift of the μ_2 carbonyl in $Mn_2(CO)_5(dpm)_2$ is in the "normal" terminal carbonyl region. This result is consistent with the observation of resonances at 229.9 and 227.8 ppm for the two carbonyl ligands in $Cp_2Zr(\mu\text{-}C(O)Me)(\mu\text{-}CO)Mo(CO)Cp$[3] and suggests that ^{13}C NMR is *not* diagnostic of four-electron donor carbonyl ligands. Coupling constants from phoshorus to the carbonyl carbons in $Mn_2(CO)_n(dpm)_2$ (n = 5, 6) are in the range of values (9–25 Hz) observed previously for cis geometry.[10] Carbon in the four-electron donor carbonyl exhibits little coupling through metals to which the C–O π-donor bond is formed. This is a feature which it shares with the typical Dewar–Chatt bond to ethylene in $Os(PPh_3)_2NO(CO)C_2H_4^+$ ($J_{P\text{-}CO}$ is observed, while $J_{P\text{-}C_2H_4}$ is unresolved).[25]

At the beginning of this paper, we proposed that the four-electron bridging carbonyl might be a common structural unit on lightly loaded metal surfaces. In all probability, just such an example already exists in the literature. A study[26] of Mn_2 dimers in CO-doped low-temperature matrices has produced a species of composition Mn_2CO which exhibits a stretching frequency of 1683 cm^{-1}. We suggest that this is not simply a carbon-bonded bridging carbonyl but rather a four-electron donor, I. The generality of this binding mode makes it an attractive model for studies of dissociative chemisorption of CO.

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Registry No. $Mn_2(CO)_5(dpm)_2$, 56665-73-7; $Mn_2(CO)_6(dpm)_2$, 57403-90-4.

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