half-power beam width was approximately 48 minutes of arc. The transistor amplifier receiver yielded a system noise of about 700°K. We analyzed the frequency-switched signal with a 100-channel filter bank, using 10-khz filters. The observed upper limits on the line antenna temperature and the expected values for the sources observed are given in Table 1.

Table 1. Observational upper limits and predicted line antenna temperatures computed by means of the following hypotheses: Hypothesis A, prediction made from the $1_{10} \leftarrow 1_{11}$ transition in $H_2C^{12}O$; hypothesis B, prediction made from the $1_{10} \leftarrow 1_{11}$ transition in $H_2C^{13}O$; hypothesis C, prediction made from the $2_{11} \leftarrow 2_{12}$ transition in $H_2C^{12}O$ with a microwave background temperature of 5.0°K; and hypothesis D, prediction made from the $2_{11} \leftarrow 2_{12}$ transition in $H_2C^{12}O$ with a microwave background temperature of 2.7°K. Equal relative populations have been assumed in all cases.

Source	Predicted ΔT_A (°K)				Observational limit ΔT_A (°K)
	Hypothesis A	Hypothesis B	Hypothesis C	Hypothesis D	
Sgr B2	0.058	0.78	0.24	0.71	≤ 0.08
Sgr A	0.040	0.23	0.06	0.19	≤ 0.05
W 12 (NGC2024)	0.019				≤ 0.10
W 43	0.016				≤ 0.16
W 49	0.004				≤ 0.15
W 51	0.027	0.041	0.031	0.089	≤ 0.16

Clouds which may contain H_2CS lie in front of bright sources of continuum radiation. The depth of the absorption line we expect to see depends not only upon the optical depth of the H_2CS, but also upon the brightness temperature of the continuum and the angular sizes of the H_2CS cloud and the antenna beam. The expected values for the live antenna temperatures were calculated with the following approximate formula:

$$\frac{\Delta T_A(H_2CS)}{\Delta T_A(X)} = \frac{F(H_2CS)}{F(X)} \frac{T_B(1046\text{ Mhz})}{T_B(\nu_X)} \frac{\tau(H_2CS)}{\tau(X)}$$

where X is the transition in $H_2C^{12}O$ or $H_2C^{13}O$ used for comparison, T_B is the source brightness temperature at the respective frequencies, and F is the beam-filling factor for the respective beams. The observations of the $1_{10} \leftarrow 1_{11}$ and $2_{11} \leftarrow 2_{12}$ transitions in $H_2C^{12}O$ and of the $1_{10} \leftarrow 1_{11}$ transition in $H_2C^{13}O$ were used as comparisons. In all cases, we have used the theoretical ratios, $\tau(H_2CS)/\tau(X)$, computed under the assumptions stated above, so that the only factor for which observational data have been used directly is $\Delta T_A(X)$. A ν^{-2} dependence of T_B was assumed for H II regions and spectral indices of −0.25 and −0.20 were used for the fluxes of Sagittarius A and Sagittarius B2, respectively. For the $1_{10} \leftarrow 1_{11}$ transitions the beam-filling factor is taken as the average of the factors for source sizes of 4 to 10 minutes of arc, over which range the factor varies by ± 20 percent. The results given in Table 1 for the $2_{11} \leftarrow 2_{12}$ transition were calculated on the basis of a source size of 6 minutes of arc. If the source size is 3 minutes of arc, then the expected line antenna temperatures are decreased by about a factor of 2. These values are meant simply to be representative of the range of possible cloud sizes.

All predictions discussed above were based on the assumption that the cosmic abundance of H_2CS relative to that of H_2CO is 1/40, the same as that of sulfur relative to oxygen. The failure to detect H_2CS in its expected abundance provides some evidence for the chemical and excitation processes involved. Mechanisms which establish the H_2CO level populations are not well understood and may yield quite different distributions for H_2CS. This might be true, for example, if these mechanisms involved resonant radiative pumping, but it is less likely if collision mechanisms dominate. If the species of interest are formed through reactions involving CS and CO, then the abundance of the diatomic molecules is relevant. Since the dissociation energy of CO is 11 ev, as compared to 7.8 ev for CS, there are roughly four times as many ultraviolet photons able to dissociate CS, if the spectrum in the ultraviolet from 912 to 1590 Å is flat and the radiation density at 1000 to 1400 Å predicted by Habing (*7*) is typical. Since photons of Lyman α radiation will dissociate CS, but not CO, the large flux of Lyman α radiation found by some observers (*8*) would tend to decrease the amount of CS relative to CO by several orders of magnitude. If H_2CO and H_2CS are formed on dust grains, then the relative stabilities of CO and CS are less important, but the abundance of H_2CS might be reduced relative to that of H_2CO because of the greater susceptibility of H_2CS to dissociation by ultraviolet radiation. Since we do not as yet know the amount of obscuration of ultraviolet radiation in the regions where most of the H_2CO exists, no good numerical estimate of such a reduction is possible at present.

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Formaldehyde Absorption Coefficients in the Vacuum Ultraviolet (650 to 1850 Angstroms)

Abstract. *The absorption spectrum of formaldehyde has been measured photoelectrically from 650 to 1850 angstroms. A broad continuum observed at wavelengths shorter than 1570 angstroms will be the major spectral feature contributing to the formaldehyde lifetime in the interstellar radiation field.*

Recently, as a result of observations made with the 190-foot (58-m) telescope at the National Radio Astronomy Observatory, Snyder *et al.* (*1*) have reported the presence in the interstellar media of the organic molecule formaldehyde (H_2CO). Formaldehyde is the first polyatomic organic molecule observed in the intersteller environment and, as such, the study of its spectral properties has become a subject of immediate importance to both astronomers and astrochemists interested in the processes of interstellar chemical evolution.

One of the major points of astronomical interest in the H_2CO spectrum is the calculation of the lifetime of the H_2CO molecule in the interstellar radiation field. The determination of the H_2CO lifetime is a complex problem involving photochemical considerations, perturbations in the interstellar radiation field induced by the presence of clouds of interstellar material (*2*), and accurate values for H_2CO total absorption coefficients as a function of wavelength in the interval from 912 to 2400 Å, the region over which the interstellar photon flux is known to be continuous. In this report we shall discuss only the latter question.

Prior to this communication no empirical data have been available to support the determination of H_2CO absorption coefficients below 1050 Å. In addition, values for H_2CO absorption coefficients below 1750 Å found in the literature (*3*) have their basis in eye estimates of the photographic darkening of spectrographic plates. There have been two earlier reports of H_2CO spectral properties in the vacuum ultraviolet. In 1935 Price (*4*) photographically observed H_2CO absorption bands down to 1050 Å. In 1959 Harrison and her co-workers (*5*), also using photographic methods, quantitatively recorded the H_2CO bands at 1750 and 1550 Å. Our measurements represent the first photoelectric recording of the H_2CO spectra in the vacuum ultraviolet and the first observations to be made below 1050 Å. We present quantitative total absorption coefficients over the wavelength interval from 650 to 1850 Å derived from the spectral data.

Above 1000 Å the background radiation used to determine the absorption spectra was obtained from a d-c discharge through hydrogen in a Hinteregger (*6*) type lamp. A pressure of 2 torr of commercial grade hydrogen was maintained in the lamp which was operated without a window in order that maximum photon fluxes at the shorter wavelengths might be obtained. The background spectra thus produced consisted of a continuum between 1850 and 1670 Å and a line spectrum superimposed on a continuum below 1670 Å. Continuum background radiation in the wavelength interval from 650 to 1000 Å was obtained from a 10-kv condensed discharge through 30 torr of helium in a windowless π-shaped lamp similar to that described by Huffman *et al.* (*7*). Before the helium entered the discharge capillary it was purified by passage through zeolite traps cooled to − 196°C.

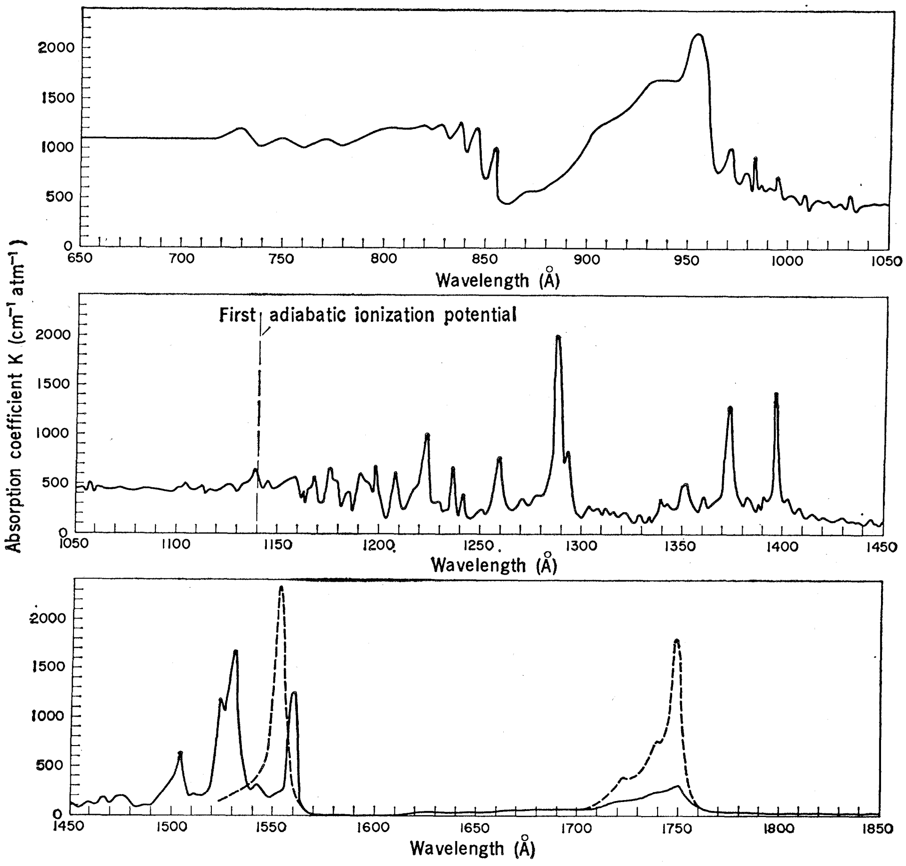

Fig. 1. Wavelength dependence of H_2CO total absorption coefficients from 650 to 1850 Å. [The dashed curve represents the work of Harrison and her co-workers (*5*).]

A 1-m normal-incidence McPherson scanning monochromator equipped with a platinum-coated grating (600 line/mm) blazed at 800 Å was used to disperse the background radiation. The entrance and exit slits of the monochromator were each 40 μm wide, thus giving the instrument a measured resolution of 1 Å. A stainless steel absorption cell 52 cm long was attached to the exit slit of the monochromator. We monitored the light passing through the cell by means of a photomultiplier tube coated with sodium salicylate. Gas pressure in the cell could be measured with a capacitance manometer (MKS Baratron) which had been calibrated against a trapped McLeod gauge.

The formaldehyde used in the experiment was prepared from the solid paraformaldehyde form by the method of Spence and Wild (*8*). Impurities in the monomeric H_2CO thus produced were monitored by mass spectrographic analysis before and after every experimental run and were maintained at less than 0.1 percent.

The experimental procedure consisted of scanning the light source before and after a known pressure of H_2CO vapor had been introduced into the absorption cell through a controlled leak valve (*9*). The resulting photomultiplier traces were then superimposed on one another and total absorption coefficients were calculated from Beer's law:

$$I(\lambda) = I_0(\lambda)e^{-K(\lambda)PL}$$

where $I_0(\lambda)$ is the incident photon intensity with no H_2CO in the cell, $I(\lambda)$ is the intensity with H_2CO in the cell, $K(\lambda)$ is the H_2CO total absorption coefficient at wavelength λ, P is the pressure of H_2CO in the absorption cell in atmospheres, and L is the path length of the absorption cell in centimeters. This equation may be solved for $K(\lambda)$ to yield

$$K(\lambda) = \frac{1}{PL} \ln \frac{I_0(\lambda)}{I(\lambda)} \text{ cm}^{-1} \text{ atm}^{-1} \quad (1)$$

Figure 1 shows the total absorption coefficient (K) as a function of wavelength over the region from 650 to 1850 Å. The absolute accuracy of the results is limited by the stability of the background source and by noise in the photomultiplier traces from which the absorption coefficients were calculated. From an analysis of dK/K as obtained from Eq. 1 we estimate the accuracy of our results to be better than 15 percent at the major absorption peaks and better than 45 percent at values of K which are less than 500. The position uncertainty of any point on the wavelength scale is ± 3 Å.

Our work is in excellent qualitative agreement with the results obtained by Price (*4, 10*). As was the case in Price's data, our results show the absorption feature at 1750 Å to be extremely diffuse and relatively less in magnitude than the absorption line at 1560 Å. Our data are in disagreement with those of Harrison (*5*) and her coworkers. Harrison's absorption coefficients (transformed into our units) are shown by the dashed lines in Fig. 1. Because of signal-to-noise considerations, in the present work we did not resolve vibrational features at 1739 and 1722 Å. There is no apparent explanation, however, for the discrepancy in the absolute magnitude of the absorption peaks at 1750 and 1559 Å (*11*).

Our data clearly show a continuum in the H_2CO absorption spectra of considerable intensity at wavelengths shorter than 1570 Å. This continuum will be the major spectral feature contributing to the determination of the H_2CO lifetime in the interstellar radiation field and will yield lifetime values which are several orders of magnitude shorter than would be inferred from previously available data (*12*). As was pointed out in the introduction, the application of these data to a meaningful lifetime calculation must also involve a reevaluation of the generalized interstellar radiation field in the local regions of space where formaldehyde is found (*2*).

Note added in proof: Recent measurements made with 0.25-Å resolution indicate closer agreement with the photographic work of Harrison and her co-workers (*5*) than is evidenced in Fig. 1. These results, which are in good agreement with Fig. 1 for $\lambda < 1700$ Å, nonetheless yield a maximum K of 1360 ± 20 cm^{-1} atm^{-1} at the 1750-Å peak.

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9. The H_2CO flowed through the absorption cell, entering through the leak valve and emerging through the exit slit of the monochromator at a rate of 20 torr liter hour^{-1}. Data were taken at several H_2CO pressures ranging between 10 and 60 μm of Hg.
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11. Harrison and her co-workers (*5*) did not estimate the absolute accuracy of their measurements. The method by which we collected data, namely, by scanning the background source before and after the H_2CO had flowed through the absorption chamber, precluded the possibility of errors due to the possible polymerization of H_2CO on the photomultiplier window.
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Amnesia Produced by Electroconvulsive Shock or Cycloheximide: Conditions for Recovery

Abstract. *Retrograde amnesia for a passive avoidance response was produced in rats by electroconvulsive shock and in mice by cycloheximide, an inhibitor of protein synthesis. One day after training the memory could be restored if a "reminder" of the original foot shock was given after the retention test on which the amnesia was demonstrated. Memory did not return if the reminder was given without the prior retention test or if the reminder and the test were separated by 23 hours.*

The most commonly accepted explanation of the time-dependent effects of electroconvulsive shock (ECS) and other amnesia-producing agents is that they interfere with the consolidation of the memory trace (*1*). According to this hypothesis, memories are initially in a labile stage, at which time they are vulnerable to destruction by a variety of agents. With the passage of time they become increasingly resistant to disruption, until a time is reached when they are said to be consolidated. This interval is a matter of controversy, with estimates ranging from a few seconds to several days (*2*). It is also commonly assumed that when retrograde amnesia (RA) is produced, it is permanent, since if fixation has been prevented, no memory should be present at any time (*3*). This aspect of the hypothesis has received considerable experimental attention. Although some studies have shown spontaneous recovery of memory after ECS (*4*), most experiments indicate that the amnesia is permanent (*5*). This conclusion has been challenged recently by several experiments which have shown that, by appropriate means, memories apparently lost after ECS can be restored (*6*). We now report a study which describes some of the conditions which determine recovery of memory after amnesia induced by ECS or by cycloheximide, an inhibitor of protein synthesis.

Subjects for our first experiment were male Holtzman rats 90 to 120 days old. The apparatus was a standard two-compartment passive avoidance box. The large compartment was 38 cm square and 44 cm high. The smaller compartment, which served as a start box, was 17 cm long, 15 cm wide, and 33 cm high. The two compartments were separated by a sliding door. The entire apparatus was constructed of ¼-inch (1 inch = 2.54 cm) clear Plexiglas, except for the floors which were made of stainless steel rods 0.24 cm in diameter, spaced 1.25 cm on centers.

A foot shock (FS) of 1.6 ma for a duration of 2 seconds was delivered to the grid floor of the large compartment from a scrambled constant-current shock source. Electroconvulsive shock (100 ma for 300 msec) was delivered through small padded alligator clips which were attached to the rat's ears before training. Intensities of FS and ECS were monitored on milliammeters and checked regularly on an oscilloscope.

On the training day, rats were put in the starting compartment with alligator clips attached. After 15 seconds the door was opened; when the rat entered the large compartment, the door was