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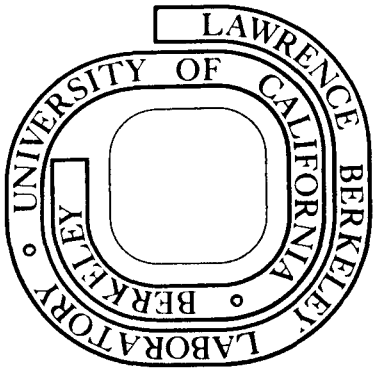

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Magnetic Scanning of Rotational Vibrational Lines of Formaldehyde Utilizing the Ag Resonance Line at 3383 A

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Formaldehyde (HCHO) is known as an intermediate in combustion processes and as a primary air pollutant. It plays an important role in photochemical chain reactions.[1,2] Formaldehyde exhibits a sharp absorption spectrum in the near U.V. region.[3] Rotational structure in the electronic transition bands of HCHO was studied by Dieke and Kistiakowsky.[4] Recently, we found that the wavelength of an Ag resonance line at 3383 A ($^2S_{1/2} - {}^2P_{1/2}$) is very close to the rotational-vibrational lines of HCHO (K"=0, J"=5,6,7) (rR-branches). These rotational lines at 29551.57 cm^{-1} show comparatively strong absorption at room temperature.[4] The Ag line at 29552.03 cm^{-1} [5,6] with gf values 0.23 [7] is one of the most intense emission lines in electric discharge radiation sources. This line from our radiation source is as strong as the mercury line at 2537 A from a mercury lamp (Pen Light, U.V. Products, Inc., Model SCT-1, 0.4A). The separation between the Ag line and the rotational lines is 0.46 cm^{-1} according to the literature.[5,7]

By scanning the wavelength of the Ag line using Zeeman effect, we measured the separation and precise line profiles of the HCHO rotational-vibrational lines. These three lines, K"=0, J"=5,6,7, could not be resolved by Dieke et al.,[4] even though a 40 feet monochromator was used. However, in this work, these lines were clearly resolved as shown in Figure 1.

The cathode of the emission source was made of a silver rod, and both D.C (110 V, 50 mA) and R.F (70 MHz, 10 W) power were simultaneously applied to the cathode.[8,9] Argon gas at 5 Torr was flowed through the source. A magnetic field from 0-25 kgauss was applied to the discharge plasma in the direction parallel to the direction of observation. The circularly polarized components were converted into linearly polarized light by a photoelastic retarder[10] and separated from each other by a Rochon prism. Formaldehyde vapor was produced from paraformaldehyde

at room temperature (25°C) and introduced into an absorption cell with path length of 25 cm. The measured vapor pressure of 5 Torr would include the vapor pressure of both paraformaldehyde and water.[11]

A monochromator with the resolving power of 10 A was used for selecting the emission line at 3383 A. At first, σ^+ and σ^- components were scanned separately. We observed three absorption peaks at 8.0, 14.3 and 17.25 kgauss for the σ^- component. There was no absorption peak from 0 to 25 kgauss for the σ^+ component. Then, to obtain the spectrum with a better S/N ratio, the linear polarized was rotated on the optical axis by a synchronous motor at 3600 r.p.m. The difference of absorption between the σ^+ and σ^- components was measured. Figure 1 shows the observed line profiles of HCHO.

We put 50 and 100 Torr of N_2 into the HCHO cell to measure the pressure broadening. The pressure broadening is small in comparison with NO lines.[14] The rotational lines remained even at atmospheric pressure. Because of the sharpness and intensity of these lines, the Ag emission source with a magnetic field will have a variety of applications in the photochemistry and optical detection of HCHO.

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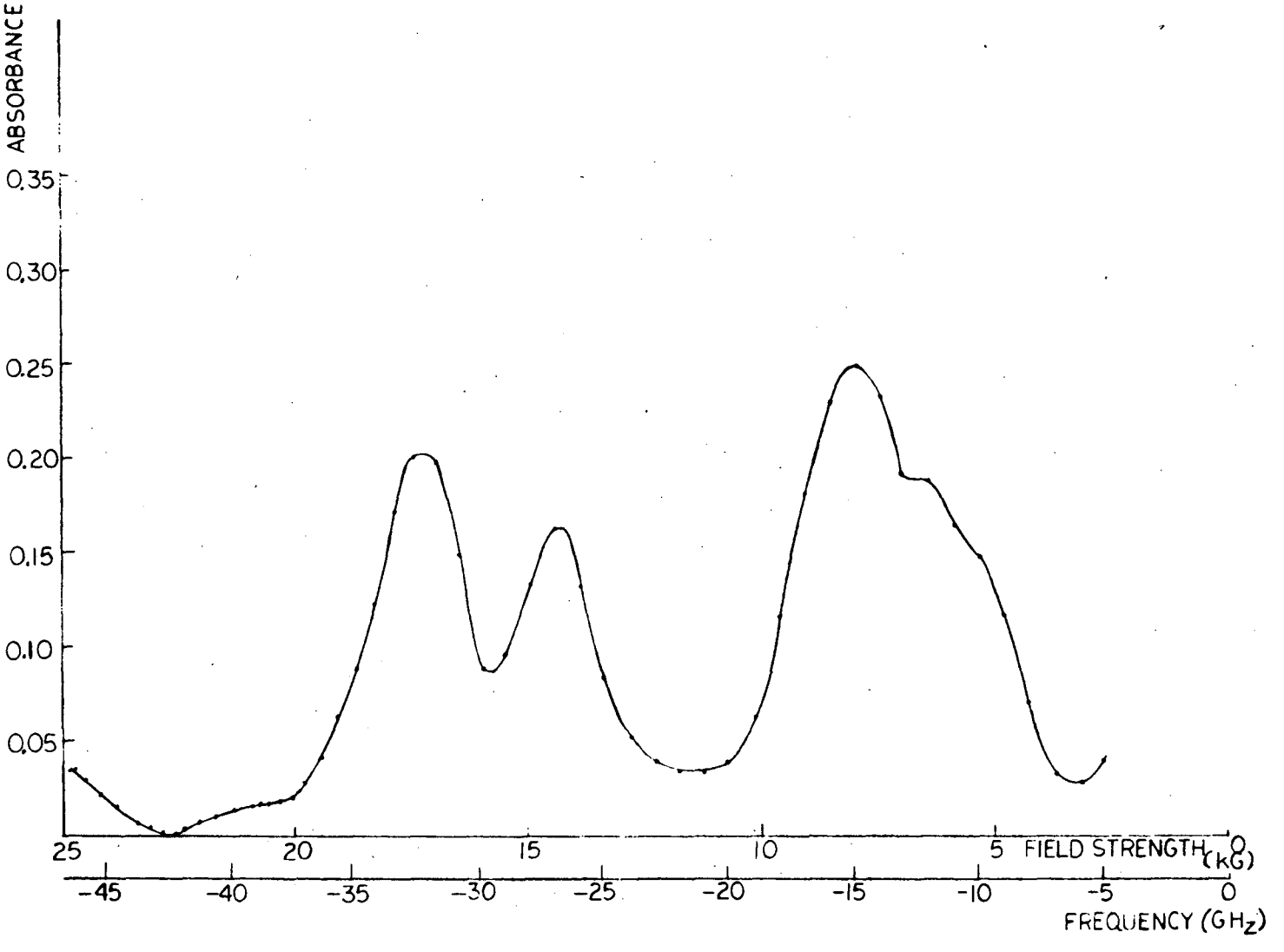
Figure Caption

Fig. 1. High resolution absorption spectrum of HCHO nearby Ag line at 3383 A observed by Zeeman scanning.



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