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MAGNETIC SCANNING OF ROTATIONAL VIBRATIONAL LINES OF FORMALDEHYDE UTILIZING THE Ag RESONANCE LINE AT 3883 A

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Hideaki Koizumi, Tetsuo Hadeishi, and Ralph D. McLaughlin

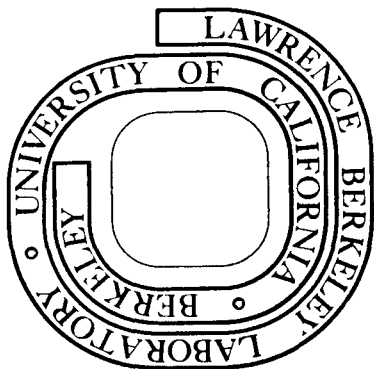
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Magnetic Scanning of Rotational Vibrational Lines of Formaldehyde  
Utilizing the Ag Resonance Line at 3383 Å

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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.<sup>1,2</sup> Formaldehyde exhibits a sharp absorption spectrum in the near U.V. region.<sup>3</sup> Rotational structure in the electronic transition bands of HCHO was studied by Dieke and Kistiakowsky.<sup>4</sup> Recently, we found that the wavelength of an Ag resonance line at 3383 Å ( $^2S_{1/2} - ^2P_{1/2}$ ) is very close to the rotational-vibrational lines of HCHO ( $K''=0, J''=5,6,7$ ) (rR-branches). These rotational lines at  $29551.57 \text{ cm}^{-1}$  show comparatively strong absorption at room temperature.<sup>4</sup> The Ag line at  $29552.03 \text{ cm}^{-1}$ <sup>5,6</sup> with gf values 0.23<sup>7</sup> 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 Å 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  $0.46 \text{ cm}^{-1}$  according to the literature.<sup>5,7</sup>

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.,<sup>4</sup> 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.<sup>8,9</sup> 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<sup>10</sup> 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.<sup>11</sup>

A monochromator with the resolving power of 10 Å was used for selecting the emission line at 3383 Å. At first,  $\sigma^+$  and  $\sigma^-$  components were scanned separately. We observed three absorption peaks at 8.0, 14.3 and 17.25 kgauss for the  $\sigma^-$  component. There was no absorption peak from 0 to 25 kgauss for the  $\sigma^+$  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  $\sigma^+$  and  $\sigma^-$  components was measured. Figure 1 shows the observed line profiles of HCHO.

We put 50 and 100 Torr of N<sub>2</sub> into the HCHO cell to measure the pressure broadening. The pressure broadening is small in comparison with NO lines.<sup>14</sup> 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.

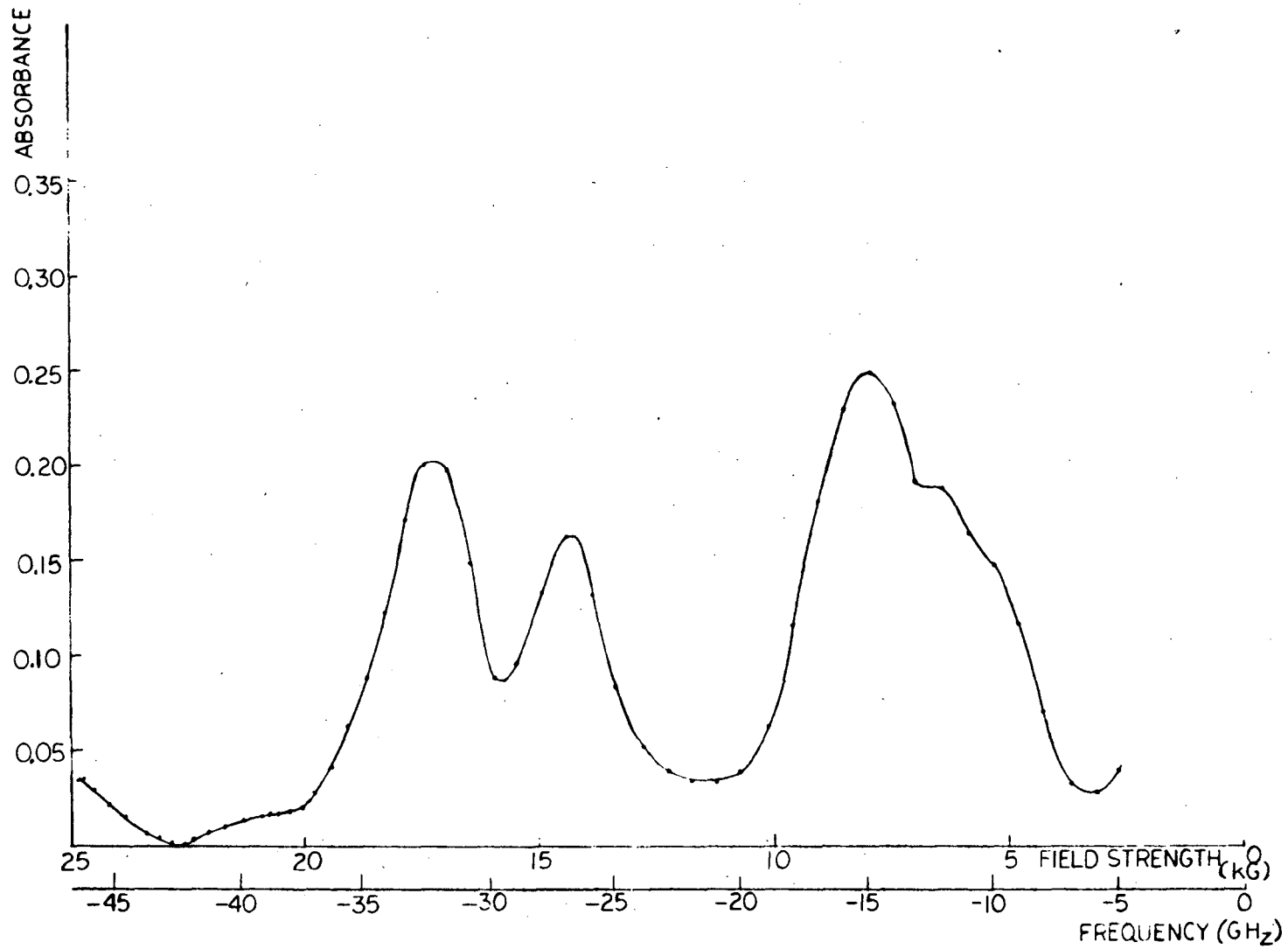
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Figure Caption

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



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