

# FORMALDEHYDE ABUNDANCES IN THE DENSE MOLECULAR CORES DR 21 AND W 3(OH)

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**ABSTRACT.** Formaldehyde absorption has been observed with the Very Large Array in both the 6 cm and 2 cm transitions towards a number of ultracompact HII regions which are embedded in the dense cores of molecular clouds. Such data have been compared with the results of radiative transfer calculations to derive the distributions of the molecular hydrogen density and of the abundance of formaldehyde relative to molecular hydrogen. Results are presented for the sources DR 21 and W 3(OH).

## 1. OBSERVATIONS AND ANALYSIS

Formaldehyde absorption has been mapped in both the 2 cm and 6 cm transitions towards the continuum sources DR 21 and W 3(OH) with the Very Large Array (VLA) of the National Radio Astronomy Observatory. An angular resolution of 2" (= .02 pc for a distance of 2 kpc) and a velocity resolution of 0.5 km/s was used for DR 21; the corresponding resolutions for W 3(OH) were 0.5" (= 0.006 pc for a distance of 2.4 kpc) and 0.76 km/s. The 6 cm observations were presented in the papers by Dickel et al. (1983, 1984); the 2 cm data will appear in forthcoming papers (Dickel et al. 1985, 1986).

The formaldehyde optical depths at 2 cm and 6 cm have been compared with the results of radiative transfer calculations using the large-velocity-gradient approximation to derive the distributions of the molecular hydrogen density and the abundance of formaldehyde relative to molecular hydrogen. Results for each source are presented.

## 2. RESULTS

### 2.1. DR 21

The distributions of the 2 cm and 6 cm optical depths towards the HII region - molecular cloud in Cygnus called DR 21 are quite similar, indicating that the molecular hydrogen densities and formaldehyde abundances are reasonably uniform. The mean values are  $8 \times 10^4/\text{cm}^3$  and  $2 \times 10^{-9}$  respectively. These quantities vary by a factor of five to six with an observational uncertainty of about a factor of 1.5. The highest formaldehyde abundance is found towards DR 21C, the ultracompact HII region (UCHII) with the most intense ultraviolet radiation field.

### 2.2. W 3(OH)

In contrast to DR 21, there are pronounced gradients in the molecular hydrogen density across the young UCHII region/OH maser source W 3(OH). The density of the material with radial velocities similar to those of the OH masers ( $V = -45$  km/s) varies from  $< 5 \times 10^3/\text{cm}^3$  in the east to  $> 10^5/\text{cm}^3$  in the west. This supports the model by Guilloteau, Stier and Downes (1983) of a dense torus located in front of the UCHII region on the western side.

The mean relative abundance of formaldehyde in this gas which is closely associated with W 3(OH) is  $\gg 4 \times 10^{-9}$  and may be as high as  $7 \times 10^{-8}$  if the thickness of the molecular cocoon is only equal to the diameter of the UCHII region (or 0.015 pc; see Dickel et al. 1984).

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