THE ASTROPHYSICAL JOURNAL, 231:401–403, 1979 July 15

FAILURE TO CONFIRM THE EXISTENCE OF INTERSTELLAR METHYLAMINE-D (CH_3NHD)

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Received 1978 November 6; accepted 1979 January 26

ABSTRACT

The probable detection of interstellar deuterated methylamine through its 2_{02}–1_{10} transition at 10,310.0 MHz has previously been reported. On two separate occasions we have attempted without success to confirm the existence of this spectral line. It does not seem likely that our failure to observe the line can be attributed to time variation, and we conclude that interstellar CH_3NHD has not yet been detected.

Subject headings: interstellar: molecules — line identifications

I. INTRODUCTION

Fourikis, Takagi, and Saito (1977) recently reported the detection in four sources of a spectral line at 10,310 MHz which they identified as probably due to the $2_{02}^{(+)}$–$1_{10}^{(-)}$ transition of deuterated methylamine (CH_3NHD). Their probable detection was put forward on the basis that strong spectral lines coinciding with the blend of the $F = 3$–2, 2–2 and 1–1 hyperfine components of the $2_{02}^{(+)}$–$1_{10}^{(-)}$ transition of CH_3NHD were detected toward Sgr B2, Sgr A, and Orion A, and possibly W51, during an observing session in 1976 May. In addition, they reported evidence of a line coinciding with the $F = 2$–1 hyperfine component of the same transition toward Sgr A and possibly Sgr B2 during the same observing session. In a later observing session (1976 December), a line corresponding with a blend of the $F = 3$–2, 2–2, and 1–1 hyperfine components of the same transition was detected toward W51 (N. Fourikis, private communication).

Calculations by Fourikis *et al.* based on their Sgr B2 observations indicated that the ratio $[CH_3NHD]/[CH_3NH_2]$ in that source is between 1 and 30. Such an abundance ratio for a deuterated molecule is exceptionally large and would imply very large chemical fractionation. Because Fourikis *et al.* indicated that this was a tentative identification, and because of the potential importance of these findings, we have undertaken to confirm the observations by repeating them at the Algonquin Radio Observatory.[1]

II. OBSERVATIONS

Our search for the 2_{02}–1_{10} line of CH_3NHD was carried out during two separate periods, 1977 August 12–15 and 1977 September 29–October 1. The 46 m telescope was used. At 10.3 GHz the half-power beamwidth of the antenna was 2.′7 and the beam efficiency was 0.65. System noise temperature at the zenith was typically 125 K. The ARO spectrometer consisted of a dual-bank 100 channel filter system that was operated at spectral resolutions of 300 kHz (8.72 km s^{-1}) and 100 kHz 2.91 km s^{-1}).

The spectra were obtained using position switching at 10 minute intervals with the off-source observations taken at the same declinations and hour angles as the corresponding on-source observations. Systematic effects were minimized by adjusting the focus by $\pm\lambda/8$ for consecutive spectra and by using several different local oscillator settings during each observing session.

In the August session we observed Sgr B2, W51 OH, and the Orion KL nebula, three of the four sources in which the line was reported. In the second session, Sgr A, the fourth source, was observed along with W51 OH and Ori KL again. Our W51 OH coordinates were $\alpha(1950) = 19^h21^m26^s.3$, $\delta(1950) = 14^h24^m35^s$. Coordinates for the other three sources were taken from Fourikis *et al.*

Throughout both observing sessions, system performance was checked several times daily by observing the strong 86α and 108β recombination lines at 10,161.3 MHz and 10,157.6 MHz in Ori A and W51. In addition, during the second session, we detected a blend of the weak recombination lines 161 ($\Delta n = 7$) at 10,350.52 MHz and 168 ($\Delta n = 8$) at 10,350.07 in Ori A. These lines were observed because they are close to the CH_3NHD frequency and of comparable intensity to the features reported by Fourikis *et al.*

III. RESULTS

We were unable to detect a spectral line at 10,310.0 MHz in any of the four sources during either search period. Our observational results are shown in Table 1 and in Figures 1–3. The figures show 100 kHz spectra from which no baseline has been removed. For each spectrum at the CH_3NHD frequency, we have indicated, with a dashed line, a Gaussian profile of the amplitude and width reported by Fourikis *et al.* Obviously there are no such lines present in our data.

[1] The Algonquin Radio Observatory is operated by the National Research Council of Canada as a national radio astronomy facility.

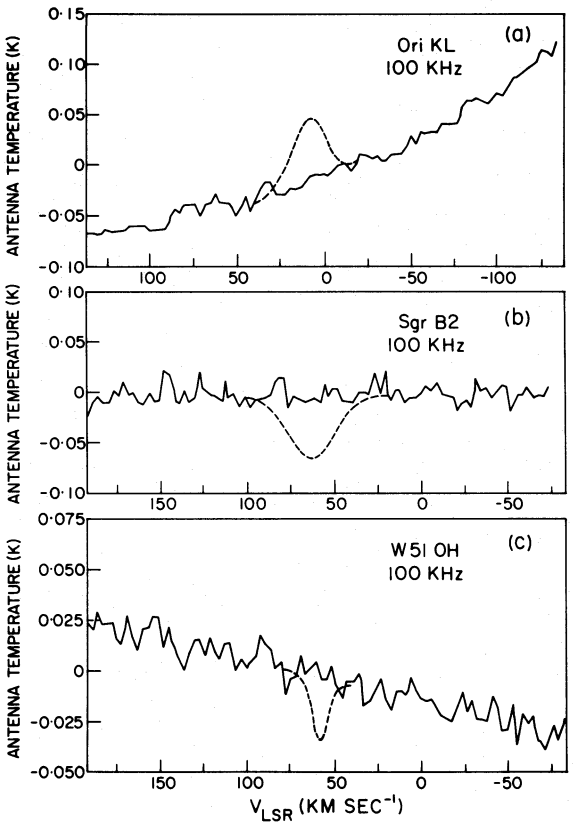

FIG. 1.—Spectra obtained during 1977 August at 10,310.0 MHz in the source (*a*) Orion KL, (*b*) Sgr B2, and (*c*) W51 OH (note different scale). The dashed lines show Gaussian profiles of the amplitudes and widths reported by Fourikis *et al.*

However, the 161 ($\Delta n = 7$) and 168 ($\Delta n = 8$) spectrum (Fig. 3) clearly shows a line of the expected amplitude.

As a final check on the system's performance at the precise CH_3NHD line frequency, a signal generator and dipole were used to illuminate the prime focus of the telescope with an artificial spectral line at 10,310.0 MHz. This line was detected by the spectrometer.

TABLE 1

SUMMARY OF CH_3NHD OBSERVATIONS AT 10,310.0 MHz

Source	Date	rms Noise (mK)
Ori KL.....	1977 August	7.7
Sgr B2.....	1977 August	9.5
W51 OH.....	1977 August	6.1
Ori KL.....	1977 October	7.1
Sgr A.....	1977 October	6.6
W51 OH.....	1977 October	5.6
Ori KL.....	August-October combined data	5.8
W51 OH.....	August-October combined data	4.4

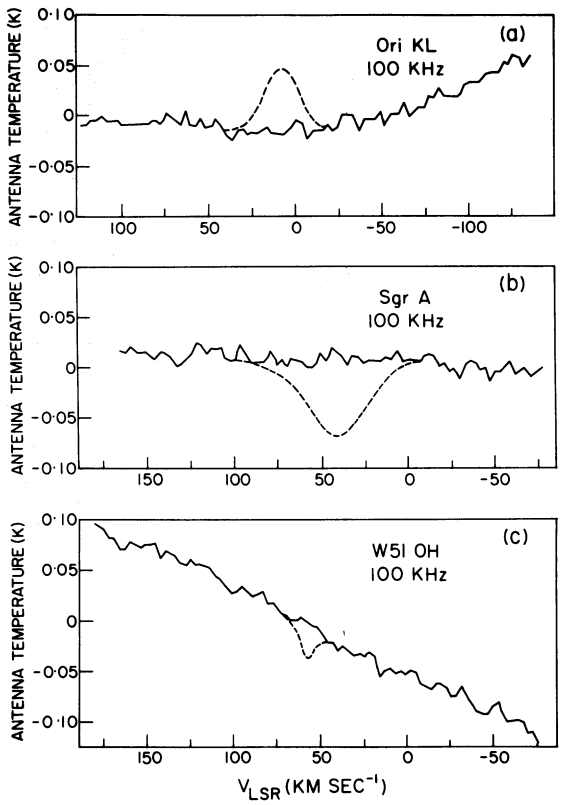

FIG. 2.—Spectra obtained during 1977 October at 10,310.0 MHz in the source (*a*) Orion KL, (*b*) Sgr A, (*c*) W51 OH. The dashed lines show Gaussian profiles of the amplitudes and widths reported by Fourikis *et al.*

IV. SUMMARY AND CONCLUSIONS

Two careful searches have been made for the 2_{02}–1_{10} transition of methylamine-D at the positions in four sources where Fourikis *et al.* reported detection of broad spectral lines. We have been unable to confirm

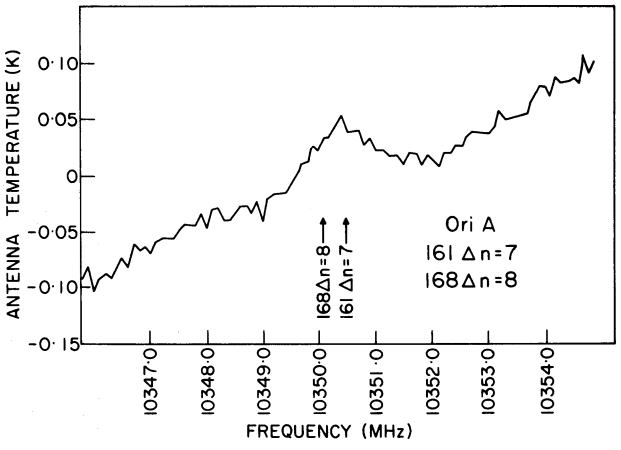

FIG. 3.—Blend of the 161 ($\Delta n = 7$) and 168 ($\Delta n = 8$) recombination lines observed in Orion A during 1977 October. The assumed value for V_{LSR} was 0.0 km s^{-1}.

this line in any of the four sources during either search in spite of noise levels low enough that the reported features should have been very prominent.

It does not seem probable that our failure to detect the line can be attributed to time variation in the sources. Such an explanation would require that all sources turned off between the time of the observations of Fourikis *et al.* and our own searches.

About a year after the paper of Fourikis *et al.* appeared, an NRAO Electronic Division Internal Report (Lockman and Rickard 1977) was published which gives a number of examples of spurious spectral features observed at the NRAO 140 foot telescope around the time that Fourikis *et al.* made their observations. The cause of these instrumental "lines" has not been definitely identified, but their intermittent presence may have contributed to the spectral features found by Fourikis *et al.*

We conclude that CH_3NHD has not been detected in the interstellar medium and that there are no spectral features of the amplitude previously reported at 10,310.0 MHz. Our 3 σ upper limits for the antenna temperature of the 2_{02}–1_{10} line are 0.017 K in Ori KL, 0.013 K in W51 OH, 0.020 K in Sgr A, and 0.029 K in Sgr B2. Assuming thermal equilibrium, this implies total column densities of CH_3NHD less than 9×10^{15} cm^{-2}, 1×10^{15} cm^{-2}, 6×10^{15} cm^{-2}, and 5×10^{15} cm^{-2}, respectively.

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