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SEARCH FOR ^{18}OH IN EMISSION

ABSTRACT

A search was made for radio emission from ^{18}OH at 1584.33 MHz in the direction of NML Cygnus, VY Canis Majoris, and W3-OH at velocities that correspond to the 1612 MHz emission from ^{16}OH in these sources. No ^{18}OH emission was found. For NML Cygnus, the upper limit is less than the terrestrial isotopic abundance ratio times the strength of the 1612-MHz emission.

In the terrestrial environment the isotopes ^{16}O and ^{18}O occur in the ratio of about 490 to 1. Strong radio emission and absorption due to the lambda doublet of interstellar ^{16}OH at about 18 cm are well known. Barrett and Rogers (1964) and Rogers and Barrett (1966) calculated the frequencies of the four corresponding transitions in ^{18}OH and obtained the values given in Table 1. They then observed the 1639-MHz absorption of ^{18}OH against the galactic center and confirmed the rest frequency of the line and the relative abundances. Similar results have been reported from Australia (Robinson 1967) and by Wilson and Barrett (1968*a*).

TABLE 1

OH LAMBDA DOUBLET FREQUENCIES

F–F	^{16}OH Frequency* (kHz)	^{18}OH Frequency† (kHz)
1–2.........	1612231	1584330
1–1.........	1665401	1637460
2–2.........	1667358	1639460
2–1.........	1720533	1692630

* As measured by Radford (1964).

† As calculated by Barrett and Rogers (1964) with an expected error of about 100 kHz.

The strength of radio emission from ^{18}OH is more difficult to calculate because the ^{16}OH emission sources are very far from thermodynamic equilibrium. We obtain the 1/490 ratio for the ^{18}OH to ^{16}OH radio emission only if this emission comes from a maser for which (*a*) the terrestrial abundance ratio for oxygen (1/490) holds for the observed OH, (*b*) the pumping mechanism is independent of isotopic species, and (*c*) the maser at both the ^{16}OH and the ^{18}OH transitions is fully saturated. Assumption *a* is likely to hold, at least approximately; however, *b* and *c* are less likely. Some of the maser-pumping models that have been proposed are sensitive to the isotopic species or at least the isotopic density. For example, models involving selective absorption of pump photons (Litvak *et al.* 1966; Litvak 1969) will be less efficient for the less abundant species unless the absorption lines at the pump frequencies overlap due to Doppler broadening. Pumping models that involve the formation of OH in excited states are probably independent of isotopic species. It is difficult to evaluate the likelihood of assumption *c*. However, the strong polarization of the 1665- and 1667-MHz emitters (e.g., W3 and W49) is probably related to a maser-saturation effect. The 1612-MHz emission from NML Cygnus (Wilson and Barrett 1968*b*) and VY Canis Majoris (Eliasson and Bartlett 1969) is less strongly polarized.

Wilson and Barrett (1968*a*) reported negative results in their search for ^{18}OH emission at 1637 MHz from W3 and W49, and gave an upper limit significantly better than the 1/490 terrestrial abundance ratio for oxygen times the 1665-MHz emission. Because the 1612-MHz emitters probably belong to a different class of objects, we searched for ^{18}OH emission at 1584 MHz from NML Cygnus and VY Canis Majoris at velocities corresponding to their 1612-MHz emission.

We used the 84-foot radio telescope of the G. R. Agassiz station of Harvard College Observatory. The antenna was equipped with a parametric amplifier at room temperature which gave a system temperature of about 150° K. We used a 50-channel filter receiver with nominal 5-kHz filters spaced by 5 kHz, and we employed Dicke switching against a sky horn.

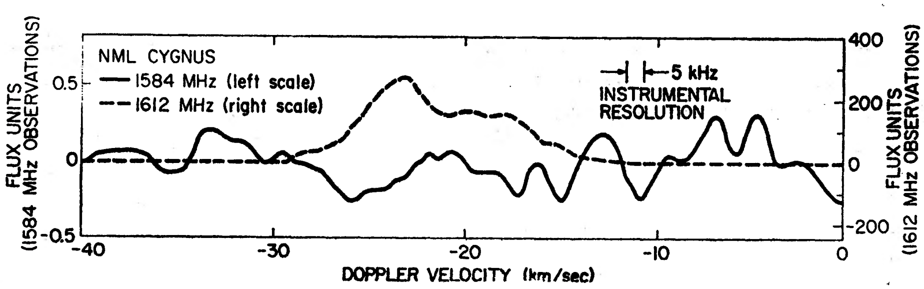

FIG. 1.—NML Cygnus as observed in ^{16}OH (1612 MHz) and in ^{18}OH (1584 MHz). The quantity plotted is S_0 obtained from right-circular plus left-circular polarization. The flux scales are in the ratio of 490 to 1 which is the terrestrial isotopic abundance ratio for oxygen. These two curves were obtained with the same receiving system and employ the same frequency resolution. The velocity axis is with respect to the local standard of rest and is based on the line rest frequencies given in Table 1. The total integration time for the 1584-MHz curve was 21.5 hours. The actual peak flux at 1612 MHz is somewhat higher than shown here because the 5-kHz instrumental resolution smears the top of the feature.

Our results for NML Cygnus are shown in Figure 1. We also observed no 1584-MHz emission in the direction of VY Canis Majoris to an upper limit of 1 flux unit (S_0) over the velocity range 24 to 74 km sec^{-1} and in the direction of the W3 OH source to an upper limit of 0.7 flux units (S_0) over the velocity range -69 to -22 km sec^{-1}. We believe that these results should be interpreted to mean that either assumption *b* or assumption *c* does not hold for NML Cygnus and probably not for VY Canis Majoris.

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JOHN A. BALL

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HARVARD COLLEGE OBSERVATORY*

AND

LINCOLN LABORATORY, MASSACHUSETTS INSTITUTE OF TECHNOLOGY†

HAYS PENFIELD

HARVARD COLLEGE OBSERVATORY*

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