INTERSTELLAR LINE SPECTRA OF A DENSE CLOUD: THE VI CYGNI ASSOCIATION

Steven P. Souza*
State University of New York at Stony Brook

Barry L. Lutz*
Lowell Observatory, Flagstaff, Arizona

Spectroscopic observations of the dense interstellar cloud which obscures the VI Cygni association have yielded an optical map of the atomic and molecular constituents in a region which may represent a transition between the diffuse and radio clouds. The velocity of the optical components found is consistent with that of a CO cloud seen in front of No. 12.

INTRODUCTION

The chemistry of interstellar clouds has long been a topic of active astronomical research. Study of the atomic and molecular constituents of such clouds has been primarily limited to extremes of cloud types: diffuse clouds and dark clouds. The midrange clouds, with optical extinctions $\gtrsim 2^{m}$ or 3^{m} , may bridge the gap between the two extremes; but they have rarely been probed to any degree of sensitivity, either optically or in the radio regime.

During the past three years we have undertaken to study such midrange clouds. In particular, we have selected a rather extended cloud which is known as VI Cygni. Two of the prime reasons for choosing the VI Cygni cloud were that it is an association of early-type stars in a large region of moderately dense obscuration with a gradient of extinction ranging up to 10 magnitudes, and it contains one of the most highly obscured early-type stars known. The high cloud density that the extinction implies suggested that this region is amenable to optical searches for new molecules. Indeed, this selection proved fruitful, for the $1\mu\text{-spectrum}$ and No. 12 provided the first detection of two rotational lines, Q(2) and R(2), of interstellar C2 (Souza and Lutz, 1977). Since that time we have undertaken an observational program of other members of the association, including Nos. 4, 5, and 9, both for new molecules and to map the optically observable interstellar species.

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OBSERVATIONS AND RESULTS

Our observations were carried out with the 1.5-meter reflector and echelle spectrograph at Mount Hopkins Observatory and with the echelle and R-C spectrographs on the 4-meter Mayall telescope at Kitt Peak National Observatory. Details of the observations are given by Souza and Lutz (1977, 1979).

Figure 1 shows a new 1μ spectrum of No. 12, which is a composite of all data, both those originally reported and those obtained subsequently. The presence of interstellar C2 is confirmed, and additional rotational lines unambiguously identified. These new data are consistent with the abundance and rotational temperature of our previous work.

Figure 2 illustrates spectra obtained for Nos. 4, 5, and 9. Curve-of-growth column densities have been determined to provide the first-order distribution of the interstellar material within the cloud, and simple chemical models have been calculated for the limited data available.

Preliminary radio mapping of this region has been carried out in collaboration with M. Simon and G. Righini-Cohen at SUNY at Stony Brook, and CO emission has been found at the same cloud velocity as the optical components exhibit.

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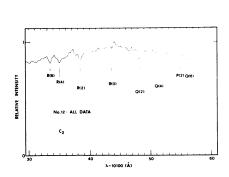


Figure 1. Spectrum of VI Cygni No. 12 showing lines of C2.

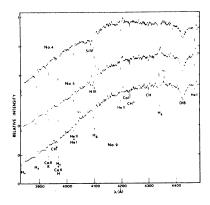


Figure 2. Spectra of VI Cygni Nos. 4, 5, and 9.

References

Souza, S. P., and Lutz, B. L. (1977). *Astrophys. J.* <u>216</u>, L49. Souza, S. P., and Lutz, B. L. (1979). *Astrophys. J.* (*Lett.*), in press.