

A confusion-limited spectral-line survey of Sgr B2(N) at 1, 2, and 3mm: Establishing the organic inventory in molecular clouds

DeWayne T. Halfen and Lucy M. Ziurys

Depts. of Chemistry and Astronomy, Arizona Radio Observatory, Laplace Center for
Astrobiology, and Steward Observatory, University of Arizona
933 N. Cherry Ave. Tucson, AZ 85721 USA
email: halfendt@as.arizona.edu

Abstract. We present preliminary results of an spectral-line survey at 1, 2, and 3 mm of the galactic center cloud Sgr B2(N). With the current data, several simple prebiotic molecules have been conclusively identified, while several more complex molecules have not. When complete, this survey will provide an accurate database of the gas-phase organic inventory in Sgr B2(N).

Keywords. ISM: molecules, astrochemistry, astrobiology, submillimeter, ISM: clouds

1. Introduction

Life on Earth is postulated to have started from simple chemical compounds. Where did this organic starting material come from? It is possible that the organic matter on the early Earth was delivered by comets, meteorites, and interplanetary dust particles. A diverse array of organic compounds have been found in meteorites, including sugars and amino acids (Cooper *et al.* 2001, Pizzarello *et al.* 2001). The most likely source of the meteoritic organic compounds is the interstellar medium (ISM). In the ISM, large quantities of organic matter have been found in giant molecular clouds. About half of the 140 molecules found in space have been detected in the Galactic center cloud Sgr B2(N), including the most complex organic species. Hence, the overall chemical composition of this source is of great interest. Therefore, we are conducting a spectral-line survey of this source to determine the identify and abundance of each molecule.

2. Observations

Observations towards Sgr B2(N) cover the millimeter atmospheric windows at 3 (65-116 GHz), 2 (130-180 GHz), and 1 (210-280 GHz) mm in wavelength. The observations were performed at the two radio telescopes of the Arizona Radio Observatory, the 12 m telescope on Kitt Peak and the Submillimeter Telescope (SMT) on Mt. Graham. The 12 m operates at 2 and 3 mm and the SMT performs measurements at 1 mm. The temperature scale is given as T_R^* for the data from 65-180 GHz, and T_A^* from 210-280 GHz. Spectral coverage is currently 78%, 66%, and 40% at 3, 2, and 1 mm, respectively, see Figure 1. This survey is conducted to the confusion limit in SSB mode, where the spectrum consists of a continuum of spectral lines, and maximum information can be obtained.

3. Results

One molecule of great interest is glycolaldehyde, CH_2OHCHO . The previous identification of this species has based on six transitions, five of which were contaminated by other molecules (Hollis *et al.* 2000). In the current data set, 40 transitions of glycolaldehyde were measured. Emission was present at all transitions, eight of which were uncontaminated. There were no “missing” lines. Therefore, glycolaldehyde is unambiguously present

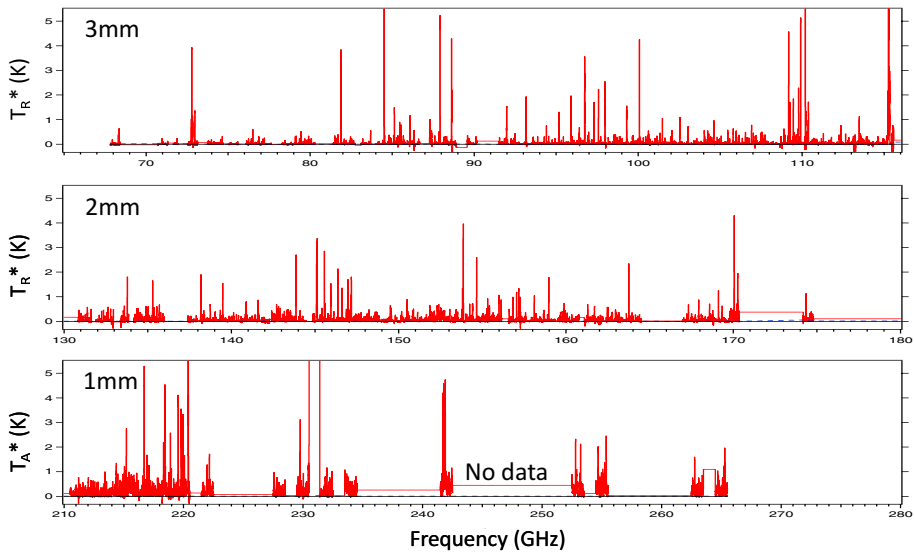


Figure 1. Current survey coverage of Sgr B2(N)

in Sgr B2(N), with an abundance of 2×10^{-11} (Halfen *et al.* 2006). Another compound of interest is formamide, NH_2CHO , the smallest species to contain a peptide bond, i. e., the important linkage between amino acids in proteins. Over 60 lines of formamide were observed, and these data give an abundance wrt H_2 of 1×10^{-10} . The next most complex simple protein analog is acetamide, CH_3CONH_2 . For this molecule, 335 transitions are present in our current data, and emission is detected at all of these frequencies. Acetamide is present in Sgr B2(N) with an abundance of 1×10^{-10} . The simplest molecule with an amine group is methyl amine. Over 220 transitions of this compound have been detected in our survey, yielding an abundance in Sgr B2(N) of 1×10^{-9} wrt H_2 . We also searched for ethyl amine. However, there are 20 transitions of this molecule where no emission is detected, and therefore, it is not present in Sgr B2(N) with an upper limit wrt H_2 of $< 3 \times 10^{-11}$ (Apponi *et al.* 2008). Several other complex molecules were not apparent in our survey. The 3-carbon sugar dihydroxyacetone (DHA), $\text{HOCH}_2\text{COCH}_2\text{OH}$, has been claimed to be present in Sgr B2(N) by Widicus *et al.* (2005). However, in our survey, we have 20 transitions where there is no emission (Apponi *et al.* 2006a). In addition, our data indicate that the sugar-like molecule hydroxyacetone, $\text{CH}_3\text{COCH}_2\text{OH}$, does not exist in Sgr B2(N) with an upper limit of 2×10^{-12} (Apponi *et al.* 2006b).

This research is supported by NASA through the Astrobiology Institute under Cooperative Agreement No. CAN-02 OSS02 and by an NSF grant AST-0602282.

References

- Apponi, A. J., Halfen, D. T., Ziurys, L. M., Hollis, J. M., Remijan, A. J., & Lovas, F. J. 2006a, *ApJ* (Letters), 634, L29
- Apponi, A. J., Hoy, J. J., Halfen, D. T., Ziurys, L. M., & Brewster, M. A. 2006b, *ApJ*, 652, 1787
- Apponi, A. J., Sun, M., Halfen, D. T., Ziurys, L. M., & Müller, H. S. P. 2008, *ApJ*, 673, 1240
- Cooper, G., Kimmich, N., Belisle, W., Sarinana, J., Brabham, K., & Garrel, L. 2001, *Nature*, 414, 879
- Halfen, D. T., Apponi, A. J., Woolf, N. J., Polt, R., & Ziurys, L. M. 2006, *ApJ*, 639, 237
- Hollis, J. M., Lovas, F. J., & Jewell, P. R. 2000, *ApJ* (Letters), 540, L107
- Pizzarello, S., Huang, Y., Becker, L., Poreda, R. J., Nieman, R. A., Cooper, G., & Williams, M. 2001, *Science*, 293, 2236
- Widicus Weaver, S. L. & Blake, G. A. 2005, *ApJ* (Letters), 624, L33