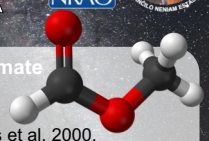
Spatial Distribution of $C_2H_4O_2$ Isomers in Sagittarius B2(N)

C. Xue[1], A. J. Remijan[2], A. M. Burkhardt[1] and E. Herbst[1]

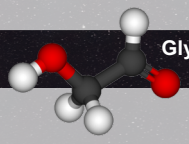
1. University of Virginia, Charlottesville, VA 22904, U.S.A. cx5up@virginia.edu

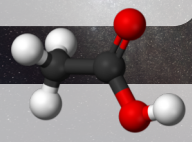
2. National Radio Astronomy Observatory, Charlottesville, VA 22903, U.S.A

INTRODUCTION



- Sagittarius B2 molecular cloud (Sgr B2) is one of the most massive star-forming regions, located ~120 pc from the galactic center.
- In Sgr B2(N), methyl formate was first detected by Brown et al. in 1975, acetic acid by Mehringer et al. in 1997 and glycolaldehyde by Hollis et al. 2000.
- A new careful confirmation and comparison for these triplets towards Sgr B2(N) are needed and can be achieved with the newest generation radio telescope, the Atacama Large Millimeter/submillimeter Array (ALMA).





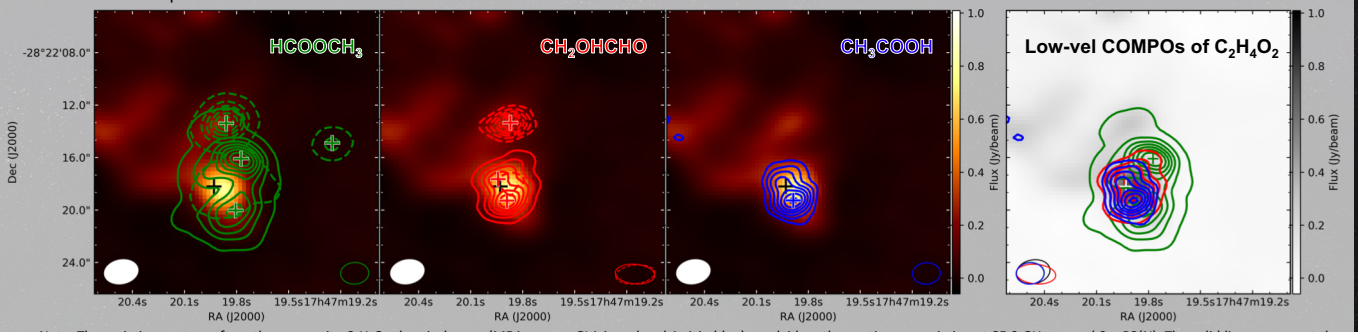
RESULTS

With the ALMA data, we found weaker, and previously undetected, transitions of the $C_2H_4O_2$ isomers. With these additional unblended transitions and more accurate continuum subtraction, we report the first high spatial resolution submillimeter maps of the $C_2H_4O_2$ isomers.

We stacked all of the transition maps of each molecule to get their chemical maps. As shown in the chemical maps, $HCOOCH_3$ and CH_2OHCHO each display two different velocity components, while only one velocity component of CH_3COOH is resolved. Moreover, the distribution of $HCOOCH_3$ is diffuse and offset from the continuum emission, unlike CH_3COOH and CH_2OHCHO, which we found to be co-spatial with with the continuum.

OBSERVATIONS

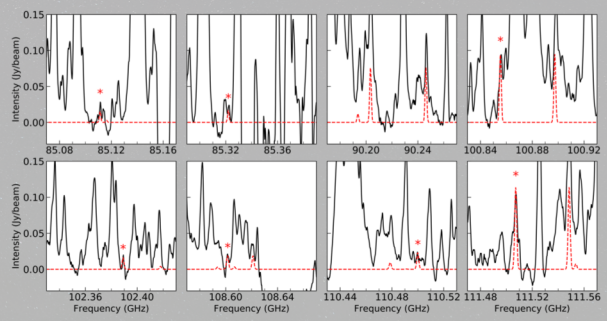
- The Exploring Molecular Complexity with ALMA (EMoCA) survey (Belloche et al. 2016) results were utilized.
- Frequency ranging from 84.1 GHz to 114.4 GHz
- ALMA Cycles 0 (2012) and 1 (2014)
- A median value of the angular resolution ~ 1.8”
- The size (HPBW) of the antenna beam varied from 69” at 84 GHz to 51” at 114 GHz (Remijan et al. 2015).



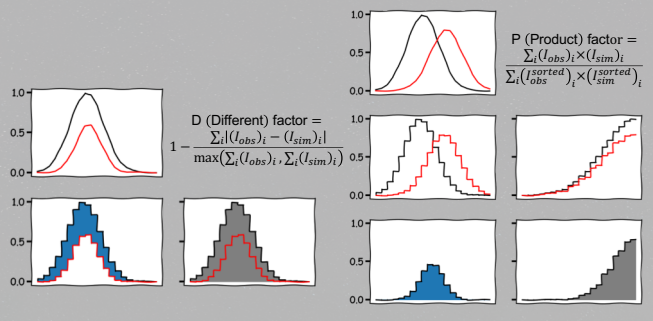
Note: The emission contours from the composite $C_2H_4O_2$ chemical maps (MF in green, GLA in red and AcA in blue) overlaid on the continuum emission at 85.9 GHz toward Sgr B2(N). The solid lines represent the low-velocity component, while the dotted lines correspond to the high-velocity component. The black (white) markers mark the the Larger Molecule Heimat (LMH) region. Emission contours from the low-velocity components (V_{lsr} ~ 64 km/s) of the chemical maps are superposed on a gray-scale representation of 85.9 GHz continuum.

DATA ANALYSIS

- We compared the single-excitation temperature simulated spectra (McGuire et al. 2018) with the observed spectra from EMoCA survey.



Note: The observed spectra toward the the LMH from EMoCA survey are shown in black, and adjusted to V_{lsr} = 64 km/s. Single-excitation temperature model spectra of CH_3COOH at 190 K are overlaid in red. Asterisks mark the unblended transitions of CH_3COOH.



- We quantified the degree of consistency of simulated spectra and observed spectra with an intensity-weighted index, C (Consistency) factor, which is the product of D and P factor, where D factor measures the proximity of the line intensity and P factor characterizes the frequency agreement.

DISCUSSION

The chemical maps are based on many unblended transitions across a wide range of upper level energies. Because each of the distributions are spatially consistent across these energies, we can rule out the excitation conditions as the source of the distinct distributions of the $C_2H_4O_2$ isomers. Instead, these morphological differences might be explained by their different formation mechanisms:

- Grain chemistry
  small radicals → mobile radicals → O-bearing COMs (Garrod et al. 2008)
  $e.g.\ HCO+CH_3O \rightarrow HCOOCH_3$
- Gas phase reaction ($HCOOCH_3$ & CH_3OCH_3 Laas et al. 2011, Balucani et al. 2015)

BIBLIOGRAPHY

Belloche, A., Müller, H. S. P., Garrod, R. T. & Menten, K. M. 2016, A&A, 587, A91
Brown, R. D., Crofts, J. G., Godfrey, P. D. et al. 1975, ApJ, 197, 29
Hollis, J. M., Lovas, F. J. & Jewell, P. R. 2000, ApJ, 540, L107
Mehringer, D. M., Snyder, L. E., Miao, Y. & Lovas, F. J. 1997, ApJ, 480, 71
McGuire, B. A., Shingledecker, C. N., Willis, E. R., et al. 2017, ApJL, 851, L46
Remijan, A. J., 2015, IAU General Assembly, 22, 2257092

Credit: ESO/B. Tafreshi, H.H. Heyer