A search for biomolecules in Sgr B2, and the massive star-forming region NGC 3576

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Biomolecules project

- A wide range of complex organic molecules, including amino acids, have been found in comets.
- These may have seeded the `pre-biotic soup' on Earth.
- A wide range of organic molecules have been detected in molecular clouds, but no amino acids.
- We are searching for the simplest amino acid, glycine, $\text{NH}_2\text{CH}_2\text{COOH}$.
Biological molecules are chiral, but the origin of this chirality is a mystery. One possibility is circularly polarised light in the ISM (Jeremy Bailey) leading to a chiral excess in the seeded cometary material.

No chiral molecules have been detected in molecular clouds.

We are searching for a simple one, propylene oxide, $\text{C}_3\text{H}_6\text{O}$. 
Precise frequencies for 3-mm transitions of glycine and propylene oxide have been measured in the laboratory by the Monash University group - Peter Godfrey, Dinah Cragg

We have looked at 2 positions

* Sgr B2 (N) LMH = Large Molecule Heimat, which is where the largest number of large, complex molecules have been detected, a dense, dusty region

* IRAS 16562-3959 = G345.5+1.5 - a region found to be rich in simpler molecules, comparable to Orion KL, from Mopra and SEST observations.
If the molecules are confined to the densest regions (shielded from UV, formed in dense regions) then the angular size may be only a few arcsec, and the best way to detect then would be with high resolution and an interferometer eg ATCA at 3 mm. This has the advantage that the `forest' of confusing spectral lines is resolved out.

On the other hand, if the molecules are distributed more widely, then the interferometer will resolve the emission out (no zero spacings) and a single dish observation eg Mopra, is needed.

We are using both the ATCA (C1077) and Mopra (UNSW key project).
ATCA results at 3 mm (C1077)

- June 2002, 2 days, Sgr B2 and G345.5+1.5, EW 352 = 3 EW baselines
- August 2002, 2 days, Sgr B2, H75 = 3 NS baselines
- Data cubes and spectra show RMS around 30 mJy/beam in line free channels (as expected)
Sgr B2

- Sgr B2 3 mm continuum (EW352 + H75) shows extended 2.5 Jy source, and background RMS = 35 mJy/beam (dynamic range limited)
- Self-calibration used.
- Spectral lines in Sgr B2 all coincide with the LMH continuum source.
- Emission (ethyl cyanide and unknown line) and absorption ($^{13}\text{CO}^+$) in 86.709 GHz data.
- There are more unidentified lines in the other spectra of Sgr B2 LMH at 86.754, 86.954, 88.761, 90.451, 89.829 and 90.022 GHz.
G345.5+1.5

- The continuum image shows no detectable continuum, and has RMS = 4 mJy/beam
- The spectra show H$^{13}$CO$^+$, but not other unidentified lines (not as rich as Sgr B2 LMH)
ATCA

- As yet, no significant detection of glycine or propylene oxide, but ATCA limits comparable to BIMA/OVRO searches.

Mopra results

- Data are not yet fully reduced, but also show unidentified lines in Sgr B2, none (yet?) identified with glycine or propylene oxide
File = 2002-07-28_0741.rpf  Source = SGR_S

Channels plotted = 50 to 975  Quadrants = 1 to 1

Sgr B2 Mopra spectrum
Other searches

- Poster paper at Bioastronomy 2002, Hamilton Island, Y.-J. Kuan et al., and associated New Scientist article, report a tentative (?) detection of glycine in NRAO 12-m observations (including Sgr B2 LMH) from multiple higher transitions. Nothing yet on astro-ph or published.
The massive star-forming region G291.3-0.7 (alias NGC 3576 or RCW 57A)

- 3 mm HCN and HCO\(^+\) (C1079, Sept 2002, EW 352)
- and 6 cm formaldehyde (H\(_2\)CO) absorption (C1080)
- We observed 3 pointing centres at 3 mm,
  1) IR peak, near the centre of the radio H II region, where massive stars have formed, but still with dense dust
  2) E cloud, and 3) W cloud which have different velocities and may be colliding.
We detect 3 mm continuum towards the IR and W positions, but the latter has complex extended structure, poorly sampled with only 3 baselines.

We detect HCN (86.829 GHz) and HCO$^+$ (89.189 GHz) in all 3 positions, but extended and weak in the E and W positions, and also poorly sampled with only 3 baselines.
The HCN and HCO$^+$ at the IR pointing centre has complex structure, around the 3-mm continuum peak, with absorption at the continuum position, and emission on either side, perpendicular to the elongated continuum peak.

The velocity structure is complex, but is probably an outflow.
Conclusion

- The ATCA at 3 mm is giving good results for dense cores (continuum and line), with the expected sensitivity, but complex structures are hard to image with only 3 baselines (!), so start with the simple ones (2003) and strong ones, as self-calibration helps in phase ‘shake-down’ problems.