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Wide field imaging of Giant Molecular Clouds with the ATA

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Abstract. Galactic Giant Molecular Cloud (GMC) complexes are among the largest objects in the sky. In order to get the full picture of Galactic star formation a large field of view is important. The Allen Telescope Array (ATA) is the first of a new generation of large-N, small-D radio telescopes designed to provide high quality images on large angular scales. We present here the first wide field images of GMCs made with the ATA.

Keywords. masers, stars: formation, ISM: individual (W3), ISM: molecules

1. Introduction

The Allen Telescope Array is a joint project between the SETI Institute and the University of California at Berkeley. Among its features are a wideband dual-polarization feed which provides continuous spectral coverage from 0.5 to 11.3 GHz, four simultaneous spectral windows tunable anywhere in the band, and eight dual-polarization beamformers for simultaneous observation of multiple target stars with the SETI 1-Hz resolution backend. This paper shows some initial science observations made with the partially completed system.

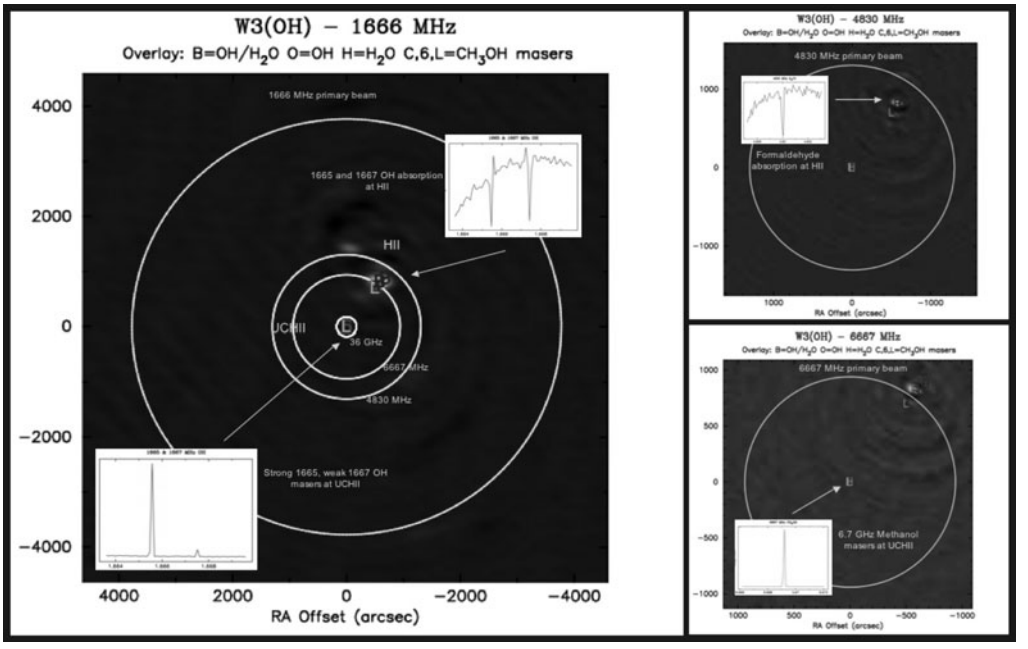
2. Instrument and observations

The completed ATA will have 350 six-meter dishes, a total extent of 900 m and a minimum baseline of 9.8 m. The final ATA correlator will allow full Stokes observations using all antennas, or simultaneous observation at up to four frequencies using subarrays. The ATA is currently (March 2007) operating with 20 antennas and two interim 4-antenna, 50 MHz, 512-channel correlators.

The GMC observations were made in January 2007 using four antennas connected to one of the two correlators, each providing six baselines at a single polarization and sky frequency. Observations at sky frequencies of 1666 (OH), 4830 (H_2CO) and 6667 (CH_3OH) MHz were made for each GMC observed. Tsys is below 55K at frequencies up to 6667 MHz. The length of each observation was typically a few hours at each antenna configuration. A continuum image was formed from the average of line-free channels in a 12 MHz bandwidth, and data cubes were made for channels containing line emission. The continuum sensitivity was between 7 and 17 mJy/beam, and 80 to 190 mJy/beam in the channel maps.

3. Results

Figure 1 shows ATA observations at 1.6, 4.8 and 6.7 GHz toward the W3 massive star-forming region, centered on the compact HII region W3(OH). The left (1666 MHz) panel shows the field of view of the 6-meter ATA antennas at all three frequencies. Continuum images are shown in grayscale at each frequency, and spectra are shown for



specific locations in the ATA fields. All panels show the FWHM beam at the frequency of observation as a white circle. Symbols representing known positions of OH, H_2O and CH_3OH masers are overlaid.

At the 2.0 kpc distance to W3 the 1.6 GHz FWHM of the ATA antennas (2.1 deg) is 73 pc across. This field contains two clusters of maser emission, one at the field center and another 17′ away near the edge of the 6.7 GHz primary beam. The cluster of masers at 17′ is associated with a continuum source detected at all three ATA frequencies, suggesting that it is an optically thin HII region. The OH spectrum taken at this location shows absorption by the 1665 and 1667 MHz hyperfine transitions of the OH radical, along with weak emission at slightly different velocities. Formaldehyde at 4.8 GHz is detected in absorption toward this HII region. The OH spectrum at the field center shows strong maser emission in the 1665 MHz line and weak emission at 1667 MHz. At 6.7 GHz a strong methanol line is also detected there, in agreement with previous observations.

4. Conclusions

Multi-frequency wide field imaging is a powerful way of assimilating complex astronomical process like the formation of massive stars and their association with masers, molecular clouds and HII regions. With sufficient sensitivity and dynamic range a full census of maser emission over a large field can be taken with a single pointing, and large scale surveys can be undertaken with much greater speed and efficiency than with single-dish telescopes or arrays with larger diameter antennas.

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