### 1 Summary

We present high-resolution observations (1.3″ x 2.3″) of the massive star-formation regions NGC 6334 I and I(N) in the 230 GHz band (1.3 millimeters). Data were obtained with the Submillimeter Array (SMA) interferometer, a joint venture of the Smithsonian Astrophysical Observatory (SAO) and the Academica Sinica Institute of Astronomy and Astrophysics. Various pieces of past evidence, including a molecular line survey by Thorwirth et al. (2003), have suggested that these two fields exist in different evolutionary stages, with field I(N) being younger. Our new observations help to explore this hypothesis. In both fields, we have resolved the strong continuum emission into multiple sources. Most of the continuum arises from dust grains. In source I, there are four major components, the third brightest of which coincides with the compact HII region. In source I(N), we have resolved at least seven sources. One of the fainter ones is associated with a weak 3.5 cm source while the others have no centimeter continuum counterpart. In addition to the millimeter continuum emission, we have detected and imaged a number of molecular lines that trace the outflow activity and the location of dense gas in both fields. So far, our results suggest that both fields contain protostellar clusters, each with at least one line-rich core and a number of other (perhaps younger) cores that exhibit no known compact phenomena at centimeter wavelengths. These observations demonstrate the power and promise of high-resolution submillimeter observations.

### 2 Introduction and Observations

NGC 6334 is a prominent molecular cloud/HII region complex composed of a series of luminous star formation regions at various stages of evolution (Straw & Hyland 1989). At a distance of only 1.7 kpc (Neckel 1978), it is relatively nearby compared to the typical ultracompact HII regions. These characteristics make it an ideal target for investigating the details of massive star formation. Due to the low declination of this object (~35°), the Submillimeter Array (SMA) on Mauna Kea is the first millimeterwave interferometer able to study the details of this region. We have begun with far-infrared source I (also known as radio source F). Specifically, we observed two fields centered on source I and I(N) in each of three tracks with the SMA. Observations were made on May 12 and May 27, 2004 in the compact configuration (partial tracks) and May 1, 2005 in the extended configuration (full track). Between 5 and 7 antennas were available during these tracks. Initial calibration was performed in Miriad. The line and continuum emission were properly separated using the AIPS task UVLSF. Self-calibration was then performed in AIPS on the continuum data, with solutions transferred to the line data.

### 3 Results

The continuum image of NGC6334 I(N) is shown in Figure 1. There is one dominant source of emission and at least six other subpeaks. Compact HC$_3$N line emission is seen on the dominant source, and is accompanied by a bipolar SiO outflow in the northeast/southwest direction (not shown). The cross marks a 6.7GHz CH$_3$OH maser (Ellingsen, Norris & McCulloch 1996). The “X” marks a faint 3.5 cm continuum source (Carral et al. 2002). The small yellow dots mark the 44 GHz masers observed at the VLA (Kogan & Slysh 1998). One group of these masers may be associated with the southernmost millimeter peak. The asterisks near the top of the image mark near-infrared H$_2$ nebulae (Megeath & Tieftrunk 1999).

The continuum image of NGC6334 I is shown in Figure 2. There are four major sources, the two brightest of which correspond exactly to NH$_3$ (1,1) and thermal CH$_3$OH peaks (Beuther et al. 2005). The second brightest source also coincides with a CH$_3$OH maser (Ellingsen, Norris & McCulloch 1996, marked by two crosses). The third brightest millimeter continuum peak coincides with a mid-infrared source (IRS1E, marked by a square) that is thought to be the excitation source of the compact HII region Keck (De Buizer et al. 2002). The fourth brightest millimeter source has no compact counterpart at other wavelengths and may be the least evolved. The triangles mark H$_2$O masers (Moran & Rodríguez 1980; Forster & Caswell 1989) which sit closest to the main peak but not coincident with it. The small circles mark OH masers (Brooks & Whiteoak 2001; Gaume & Mutel 1987).

### References

Figure 1: SMA continuum image of NGC6334I(N) at 217 GHz. Contours begin at $4\sigma$ (where $1\sigma$ is 6 mJy) and each successive contour is larger by a factor of 1.414. The synthesized beamsize is 2.3'' by 1.3''. The wedge scale on the right side is in Jy/beam.

Figure 2: SMA continuum image of NGC6334I at 217 GHz. Contours begin at $4\sigma$ (where $1\sigma$ is 12 mJy) and each successive contour is larger by a factor of 1.414. The synthesized beamsize is 2.3'' by 1.3''. The wedge scale on the right side is in Jy/beam.