

# Evidence for Multiple Dust Condensations in NGC 1333 IRAS 7

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## Introduction

As part of our ongoing program to observe continuum emission from young, embedded stellar systems at  $\lambda = 2.7$  mm with the BIMA interferometer (Welch et al., 1996), we have observed four systems in NGC 1333. IRAS 7 is the latest system observed in our program. Located at 350 pc (Herbig & Jones, 1983), the region south of the NGC 1333 reflection nebula has long been associated with active star formation. We have previously observed the regions around IRAS 2, SVS 13, and IRAS 4 at  $\lambda = 2.7$  mm, each of which have multiple continuum sources and interesting dynamics (Looney et al., 1999; Welch et al., 1999). IRAS 7 also proves to have multiple continuum condensations.

IRAS 7 was first associated with HH 6 (Herbig, 1974) by Jennings et al. (1987). It is also host to a water maser (Henkel et al., 1986) and a 6 cm continuum source identified using the VLA (Snell & Bally, 1986). Aspin et al. (1994) surveyed the region in the near infrared and 5 of these objects overlap our field. Aspin et al. (1994) also mention that a blue-shifted CO outflow is associated with the HH 6 region. Bally et al. (1996) are the first to identify IRAS 7A and 7B as separate objects. They claim IRAS 7A is associated with an CO outflow towards the HH objects and IRAS 7B is associated with a H<sub>2</sub> jet towards the northwest (in the direction of what we identify as IRAS 7C). The observations presented here were taken in the fall of 1998 and spring of 1999 in the BIMA C and B array with synthesized beams of  $\sim 8''$  and  $\sim 2''$  respectively.

## Conclusions

- The embedded source, IRAS 7, contains multiple condensations at  $\lambda = 2.7$  mm as have all the other embedded sources in our survey (Looney et al., 1999).
- The central source appears elongated in the northeast-southwest direction, possibly indicating a disk.
- The HH 6 outflow does not seem to be originating from the main dust concentration IRAS 7A (which is coincident with the VLA continuum source).
- The region is dominated by extended, low surface brightness emission, probably the envelope from which the young stellar objects within have formed.

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## References

- Aspin, C., Sandell, G., & Russell, A. P. G. 1994, *A&AS*, 106, 165
- Bally, J., Devine, D., & Reipurth, B. 1996, *ApJ*, 473, L49
- Henkel, C., Guesten, R., & Haschick, A. D. 1986, *A&A*, 165, 197
- Herbig, G. H. 1974, *Lick Observatory Bulletin*, 658
- Herbig, G. H. & Jones, B. F. 1983, *AJ*, 88, 1040
- Jennings, R. E., Cameron, D. H. M., Cudlip, W., & Hirst, C. J. 1987, *MNRAS*, 226, 461

Looney, L. W., Mundy, L. G., & Welch, W. J. 1999, ApJ, submitted

Morgan, J. A. 1995, ASP Conf. Ser. 77: Astronomical Data Analysis Software and Systems IV, 4, 129+

Snell, R. L. & Bally, J. 1986, ApJ, 303, 683

Webster, Z. T., Welch, W. J., Looney, L. W., & Mundy, L. G. 2000, in prep.

Welch, W. J., Looney, L. W., & Mundy, L. G. 1999, in prep.

Welch, W. J., Thornton, D. D., Plambeck, R. L., Wright, M. C. H., Lugten, J., Urry, L., Fleming, M., Hoffman, W., Hudson, J., Lum, W. T., Forster, J. R., Thatte, N., Zhang, X., Zivanovic, S., Snyder, L., Crutcher, R., Lo, K. Y., Wakker, B., Stupar, M., Sault, R., Miao, Y., Rao, R., Wan, K., Dickel, H. R., Blitz, L., Vogel, S. N., Mundy, L., Erickson, W., Teuben, P. J., Morgan, J., Helfer, T., Looney, L., De Gues, E., Grossman, A., Howe, J. E., Pound, M., & Regan, R. 1996, PASP, 108, 93+

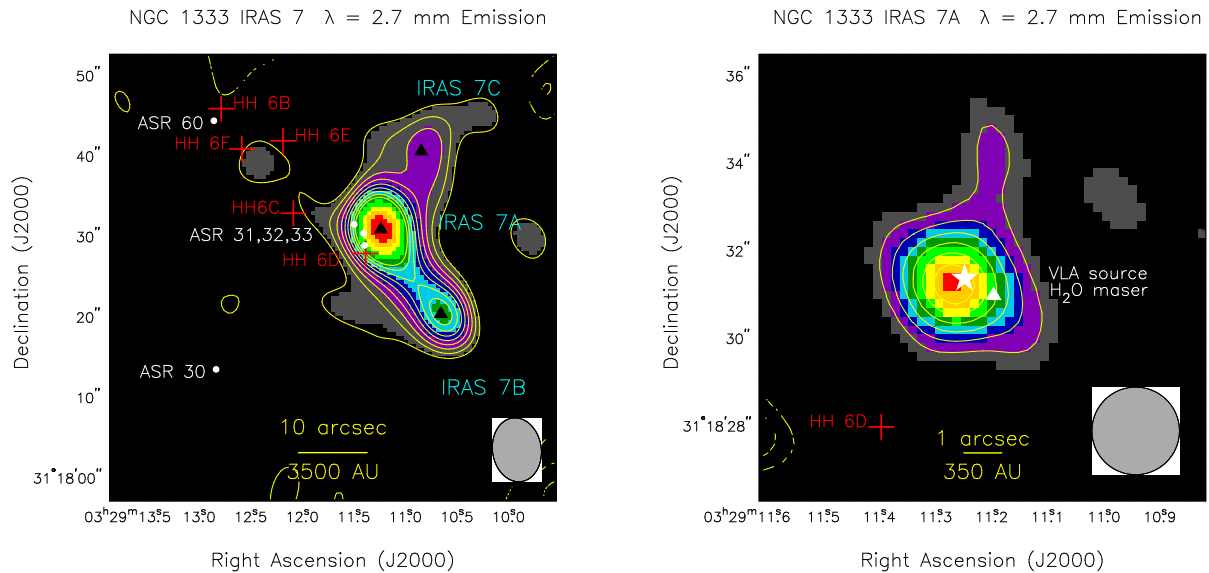


Figure 1: On the left is a  $\lambda = 2.7$  mm continuum emission map of IRAS 7, naturally weighted from the BIMA compact C array. This map is contoured in steps of  $(-3 -2 2 3 4 \dots 18) \times$  a rms noise of 1.0 mJy/beam; with a beam of  $7''.98 \times 6''.06$ , P.A. =  $7.97^\circ$ . Three peaks in the continuum emission have been labeled with upright triangles, hereafter identified as IRAS 7A, IRAS 7B, (after Bally et al., 1996) and IRAS 7C. Crosses indicate the Herbig-Haro objects (Herbig, 1974), and white squares indicate near-IR sources detected by Aspin et al. (1994) in the near infrared. The continuum source identified by Snell & Bally (1986) at 6 cm and the water maser source identified by Henkel et al. (1986) are not shown, but are nearly coincident with the center of IRAS 7A. There are suggestions of two other condensations; one to the east, and one to the west. There is also some faint emission between HH 6E and HH 6F that is probably *NOT* continuum emission, but CO associated with the outflow. Another interesting feature is that the HH outflow does not appear co-linear with the central condensation IRAS 7A, but instead appears to originate from a point below IRAS 7A.

The figure on the right shows the central  $10''$  of IRAS 7A. Using the B array data alone, it was possible to obtain a high resolution map of IRAS 7A with a synthesized beam of  $2''.06 \times 1''.57$  using a super-uniform weighting scheme. In this image, the map has been restored with a circular beam, FWHM =  $2''$  in order to highlight the relevant geometry. The contours are in steps of the rms noise, 1.2 mJy/beam, beginning with the  $\pm 2\sigma$  contour. The central source, IRAS 7A, is extended in the northeast-southwest direction possibly indicating the presence of a disk (preliminary fit:  $2''.8 \times 2''.6$ , P.A. =  $38^\circ$ , approximately the direction of the HH outflow sources). Further modeling of the geometry of the individual sources is planned (Webster et al., 2000). At a less significant level ( $2\sigma$ ), an extension to the north is seen. This may indicate a second object in this central region. The peak flux density of IRAS 7A is 10 mJy/beam.