# Compact Mid-IR Emission from High-Mass Protostellar Candidates

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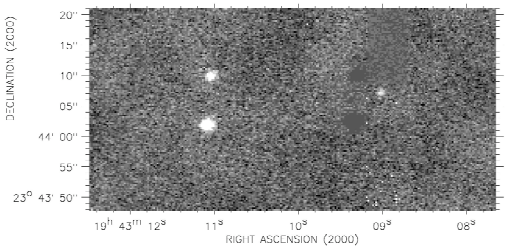
**ABSTRACT:** We observed 23 fields for High-Mass Protostellar Objects (HMPOs) at the IRTF in N band (10.47mu). 26 sources were detected in 18 fields. Most sources are compact, and they emit a significant fraction of the flux seen in the larger beam of the MSX telescope. The N band fluxes appear to correlate with the bolometric luminosities of the regions. Many N band sources peak near the 1.2mm continuum peak emission, so they appear to be preferentially located near the centers of each star-forming core. They appear to be individual HMPOs.

• Fields containing candidate HMPOs were chosen from a sample of 69 bright far-ir objects that have IRAS $F_\nu$(60 μm) > 90 Jy and $F_\nu$(100 μm) > 500 Jy, IRAS colors indicative of high mass star formation, known molecular line emission, and low-level cm continuum emission (Sridharan, et al. 2002). The fields observed on the IRTF were chosen for bright, compact emission in MSX Band C (12.1μm).

• 26 objects were detected in N band (10.47 μm) in 18 of 23 fields observed with MIRSI on the IRTF.

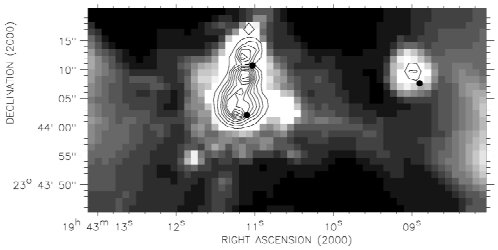
**Example: IRAS 19410+2336 IRTF Image Compared to GLIMPSE Spitzer IRAC Image and mm Dust Continuum Maps**

IRAS 19410+2336: IRTF N Band (10.47 μm) Image



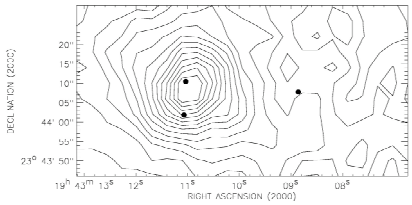

Single frame, 12 second integration under partly cloudy conditions. The southeast source is 4.0 Jy.

IRAS 19410+2336: IRTF Sources on IRAC 8 μm Image



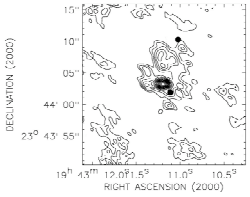

IRTF sources are filled circles Contours are 10-90% of max IRAC flux of 6282 MJy/sr. Grayscale shows diffuse ( 0-4%) emission.

IRAS 19410+2336: IRTF Sources on 1.2mm Continuum Map




IRTF sources are filled circles. Contours are from the center of map of 1.2mmdust continuum Emission of Beuther et al. (2002)

IRAS 19410+2336: IRTF Sources on 1.3mm PdBI Map




IRTF sources are filled circles. Contours are 1.3mm PdBI data of Beuther and Schilke (2004)

• Most sources are compact--near the IRTF diffraction limit of 0.9″.

• The fields each contain only 1-3 sources,
  • Estimated 10 σ detection limits vary from 0.05 - 1.0 Jy.
  • IRTF positions in this survey are estimated to be uncertain to about 5″.

• For IRAS 19410+2336, the IRAC 8 μm image from the GLIMPSE database shows shifts in peak locations, suggestions of some fainter sources, and extended emission. It confirms the prominence of the bright point sources. Note, however, that the N band relative positions come from a single frame of the MIRSI array.

• IRTF sources account for large fractions of the mid-ir flux observed by the 18.1″ beam MSX telescope. For the brightest source in each field, the average ratio of IRTF N band (10.47 μm) $F_\nu$ to MSX Band C (12.1μm) $F_\nu$ is 0.38.

•Within broad limits (±factor of 10), the IRTF N band fluxes are proportional to bolometric fluxes based on IRAS SEDs derived from luminosities given by Sridharan et al. (2002). The relatively weaker N band sources are probably more deeply embedded in their natal clouds.

• Many IRTF N band positions are near peaks in 1.2mm continuum emission from cool dust presented by Beuther et al. (2002) .

• The importance of high resolution mm continuum maps for understanding each region's structure is shown by the 1.3 mm PdBI map of IRAS 19410+2336 in comparison both to the single dish 1.2 mm map and to the mid-ir images.

• The IRTF N band sources are apparently due to circumstellar dust emission around the brightest HMPOs or high-mass young stellar objects in each field. The HMPOs appear to be preferentially located near the center of each star-forming cloud clump or protocluster.

APPENDIX. IRTF N BAND (10.47 μm) OBSERVATIONS AND COMPARISONS

| IRAS | IRTF Source | $F_\nu$ Jy N Band | $F_\nu$/10σ N Band | IRTF $F_\nu$(N)/ MSX $F_\nu$(12.1) | IRTF-1.2mm Separation, ″ | cm $F_\nu$, mJy | 2MASS $K_s$ Obj. Within 5″ |
|---|---|---|---|---|---|---|---|
| 05338+3543 | 1 | 0.81 | 8.7 | 0.16 | 14 | <1 | yes |
| | 2 | 0.10 | 1.1 | 0.02 | 6 | | yes |
| 05553+1631 | 1 | 0.46 | 5.7 | 0.24 | 5 | 1.30 | yes |
| | 2 | 0.05 | 0.7 | 0.03 | 11 | | yes |
| 18089-1732 | 1 | 0.51 | 7.5 | 0.20 | 8 | 0.90 | yes |
| | 2 | 0.26 | 3.9 | 0.10 | 8 | | yes |
| 18151-1208 | 1 | 11.16 | 224.8 | 0.53 | 1 | <1 | yes |
| 18223-1243 | 1 | 0.93 | 9.9 | 0.08 | 12 | <1 | yes |
| 18247-1147 | 1 | 5.17 | 17.0 | 0.57 | 4 | 47.00 | yes |
| 18337-0743 | 1 | 0.68 | 5.4 | 0.10 | 14 | <1 | yes |
| 18348-0616 | 1 | 5.80 | 52.8 | 0.77 | N/A | 54.00 | yes |
| 18472-0022 | 1 | 3.83 | 5.4 | 1.27 | N/A | 194.00 | no |
| | 2 | 0.63 | 0.9 | 0.21 | 24 | | no |

| IRAS | IRTF Source | $F_\nu$ Jy N Band | $F_\nu$/10σ N Band | IRTF $F_\nu$(N)/ MSX $F_\nu$(12.1) | IRTF-1.2mm Separation, ″ | cm $F_\nu$, mJy | 2MASS $K_s$ Obj. Within 5″ |
|---|---|---|---|---|---|---|---|
| 18530+0215 | 1 | 7.26 | 76.1 | 0.35 | 3 | 311.00 | yes |
| 18553+0414 | 1 | 3.33 | 21.1 | 0.59 | 3 | <1 | no |
| 19410+2336 | 1 | 3.95 | 26.1 | 0.44 | 8 | 1.00 | no |
| | 2 | 1.59 | 10.5 | 0.17 | 2 | | no |
| | 3 | 1.27 | 2.1 | 0.14 | N/A | | no |
| 20216+4107 | 1 | 4.62 | 4.7 | 0.58 | 4 | 1.40 | yes |
| 20343+4129 | 1 | 8.10 | 113.0 | 0.44 | 16 | 1.80 | yes |
| | 2 | 3.74 | 52.1 | 0.20 | 3 | | yes |
| | 3 | 0.22 | 3.1 | 0.01 | 21 | | no |
| 22134+5834 | 1 | 3.94 | 9.6 | 0.30 | 9 | 3.70 | no |
| | 2 | 2.07 | 5.0 | 0.16 | 11 | | no |
| 22570+5912 | 1 | 0.57 | 2.0 | 0.05 | 3 | 29.00 | yes |
| 23033+5951 | 1 | 3.22 | 13.6 | 0.57 | 9 | 1.70 | yes |
| 23151+5912 | 1 | 22.10 | 20.3 | 0.44 | 2 | <1 | yes |

Fields with non-detections in N band: 18445-0222, 18566+0408, 20293+3952, 20332+4124, 21391+5802

References: Beuther, H. et al. 2002 ApJ 566, 945 Beuther, H. & Schilke, P. 2004 Science 303, 1167 Sridharan, T. K. et al. 2002 ApJ 566, 933

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