ARC-SECOND INFRARED IMAGING OF THE BN-KL STAR FORMATION REGION

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ABSTRACT: Infrared images of the BN-KL region in Orion obtained with the Univ. of Rochester IR Array Camera on the Mees 0.6-m (2.5"/pixel) and the Kitt Peak 1.3-m telescopes (1"/pixel) are presented. These images demonstrate the utility of small telescopes for infrared studies of star formation regions.

We have developed a near-IR (1-5 μm) array camera, based on a 32 x 32 InSb detector array read out by a Si CCD, and have used extensively both 0.6-m and 1.3-m telescopes for testing the camera system and for obtaining images of a variety of astronomical sources (Forrest *et al*. 1985 *Pub. Astr. Soc. Pac.* 97, 183). These observations are intrinsically very interesting and have also proven invaluable in guiding our research efforts on larger aperture telescopes. IR array detectors with good quantum efficiency ($\gtrsim 0.60$), excellent pixel to pixel uniformity, individual pixel, and non-destructive read-out, are now becoming available to the general astronomical community. The impact of this new technology on the study of active star formation regions, external galaxies, bipolar nebulae, etc., will be immense. Since large field-of-view, dark current limited ($\lambda < 3$ μm) and background-limited ($\lambda \gtrsim 3$ μm) observations at high spatial resolution ($\lesssim 3$"/pixel) are possible with small aperture telescopes, many interesting projects can be undertaken without the need for large (and generally over-subscribed) telescopes.

The high spatial resolution images of the BN-KL region presented here were obtained to identify new sources, and to deduce their physical nature. Astrometric positions were obtained from H (1.65 μm) and K (2.2 μm) images where mainly foreground stars and scattered light are detected. At longer bandpasses (L' [3.75 μm]; M' [4.67 μm]) the effects of extinction diminish. The spatial distribution of heated dust was revealed and highly obscured point sources were detected, including IRc2 (possibly the source of energetic flows in the core of the star formation region). At M', IRc2 is the second brightest source after BN. With our higher resolution we were able to determine which sources were point-like and which were extended. From the intensity

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maps we derived color temperature maps which were used to deduce the probable source emission mechanism.

We have detected 28 sources: 20 of these can be identified with foreground stars, 8 have no visual counterparts. The IR sources are surrounded by extended nebulosity. Figure 1a shows the large scale structure of the BN-KL complex, especially the two extended lobes of nebulosity NW (P.A.$\sim$350°) and E (P.A.$\sim$90°) of BN. At H and K a trough in the diffuse nebulosity is seen (Figure 1b) which is identified with a circumstellar doughnut around IRc2, proposed as the disk collimating the outflows from IRc2. The total luminosity of IRc2 is $\sim 10^5 L_\odot$ (Downes *et al.* 1981 *Ap. J.* 244, 869) and it is probably responsible for nearly all of the observed luminosity of the BN-KL. The only other self-luminous sources are thought to be BN and IRc9 (Wynn-Williams *et al.* 1984 *Ap. J.* 281, 173). In our color maps (K-L', L'-M') these three sources are the prominent temperature peaks; however interpretation of these maps in conjunction with high resolution polarimetric observations (Werner *et al.* 1983 *Ap. J.* 265, L13) suggest that the sources IRc3 and 4 are not illuminated by IRc2 and could be self-luminous.

Our images also show interesting structure associated with BN. A wisp extending NE from BN (most prominent in the K and L' bandpasses) is identified as scattering off the inner surface of the doughnut surrounding IRc2. Further, in the K band images a jet-like structure consisting of several colinear sources whose apex is BN is found at a P.A. $\sim$ 132°. This may indicate that energetic flows are also associated with BN.

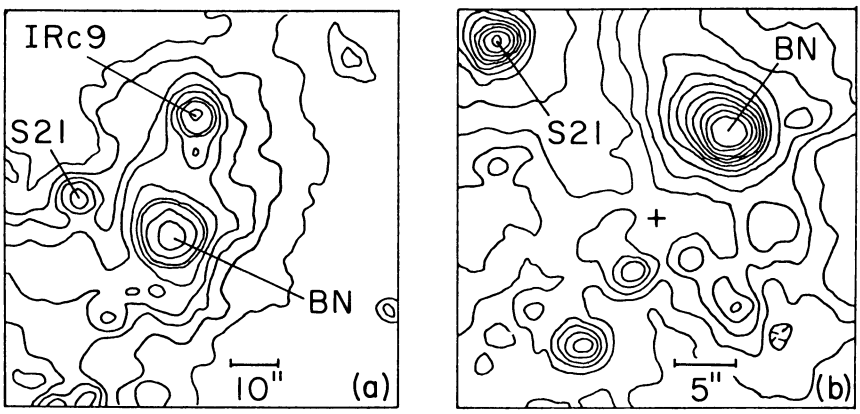

Figure 1: The Orion BN-KL region at 2.23 μm (a) from the Mees 0.6-m (2.5"/pixel). The contours are in logarithmic intervals. Here the large scale structure of the infrared complex is clearly seen. The total observing time for this image was 198 sec. (b) from the Kitt Peak 1.3-m (1"/pixel). The contours are 8.3 - 17.3 mags/pixel every 0.4 mags/pixel. At this resolution the myriad of individual IR point sources is evident. Note the wisp of emission extending NE from BN at a P.A. $\sim$ 30° and a jet of emission at P.A. $\sim$ 132°. The cross indicates the position of IRc2 determined from the M' image where it is clearly detected. The total observing time for this image was 425 sec. Prominent sources are labeled, and the scale is inset in each map. The orientation of each map is North up and East to the left.

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