

## Infrared L' band ( $\lambda_{\text{cen}} \sim 3.9 \mu\text{m}$ ) observations with TIFR Near-Infrared Camera (TIRCAM)

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**Abstract.** TIRCAM is based on the SBRC InSb Focal Plane Array (58×62 pixels) sensitive between 1–5  $\mu\text{m}$ . TIRCAM system is described in Ojha et al. (2002). TIRCAM had its first light observations during March–April 2001 from Gurusikhar 1.2m PRL telescope at Mt. Abu. After having the successful first run in 2001, the TIRCAM was used for the L' band observations of a few scientific targets in combination with fresh telescope mirrors in Nov. 2002 & Jan. 2003 (the aluminising operation of the primary & secondary mirrors of 1.2m telescope was carried out in mid 2002). Several infrared standard stars and the Trapezium cluster were observed in L' band centred at 3.9  $\mu\text{m}$ . We could detect the stars upto  $\sim 7$  mag in L' band from the Gurusikhar site. The TIRCAM L' mag of detected stars in Trapezium cluster were compared with the L band (3.5  $\mu\text{m}$ ) data of Muench et al. (2002). These measurements are in good agreement with each other considering the two different center wavelengths. We plan to explore TIRCAM's performance in the broad L (3.5  $\mu\text{m}$ ) & M (4.5  $\mu\text{m}$ ) bands from Hanle site in near future.

### 1. Observations

The observations were performed in Nov. 2002 & Jan. 2003, using TIRCAM at  $f/13$  Cassegrain focus of the 1.2 m telescope of Gurusikhar Observatory (altitude  $\sim 1700\text{m}$ ) of PRL, Ahmedabad. We had observed several infrared standards and the Trapezium cluster in Orion region in J, H, K and L' bands. The plate scale was 1"/pixel. The observations were performed near the full moon phase during Nov. 2002 & in non-photometric conditions during Jan. 2003. The FWHM seeing was between 2.5" – 3" during the observations. The log of observations is shown in Table 1.

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**Table 1.** Log of observations

Source	L' mag	Sp. Type	Filter(s)	Date of Obs.	Total Int. time
Trapezium Cluster			J,H,K,L'	17/18 Nov 02 & 28 Jan 03	6.8m in K & 38.4s in L' (Nov 02) 1228.8 s in L' (Jan 03)
HR 2216	-1.59	M3III	L'	17 Nov 02	12.8 s
HR 3613	2.15	K2Iab	L'	17 Nov 02	12.8 s
HR 8551	2.26	K0III	L'	18 Nov 02	12.8 s
HR 0074	0.88	K2III	L'	18 Nov 02	12.8 s
HR 8905	2.97	F8IV	L'	18 Nov 02	12.8 s
HR 0015	2.33	B8IV	L'	18 Nov 02	12.8 s
HR 0039	3.49	B2IV	L'	18 Nov 02	12.8 s
HR 0617	-0.72	K2III	L'	18 Nov 02	12.8 s
HR 0739	3.04	G3III	L'	18 Nov 02	12.8 s
HR 1165	2.92	B7III	L'	18 Nov 02	12.8 s
HR 1239	3.60	B3V	L'	18 Nov 02	12.8 s
HR 1552	4.17	B2III	L'	18 Nov 02	12.8 s
HR 1713	0.08	B8Iab	L'	18 Nov 02	12.8 s
HR 1791	2.05	B7III	L'	18 Nov 02	12.8 s
HR 0134	3.59*	K0III	L'	18 Nov 02	12.8 s
HR 0414	2.74*	K1III	L'	18 Nov 02	12.8 s
V 569	4.89	M3	L'	28 Jan 03	409.6 s
GL 390	5.87	M1.5	L'	28 Jan 03	204.8 s
HR 1552	4.17	B2III	L'	28 Jan 03	25.6 s
HR 3981	4.54	A0III	L'	28 Jan 03	307.2 s

\*L' mags of HR 0134 & HR 0414 are derived using the calibration curve shown in Fig. 1.

## 2. Results

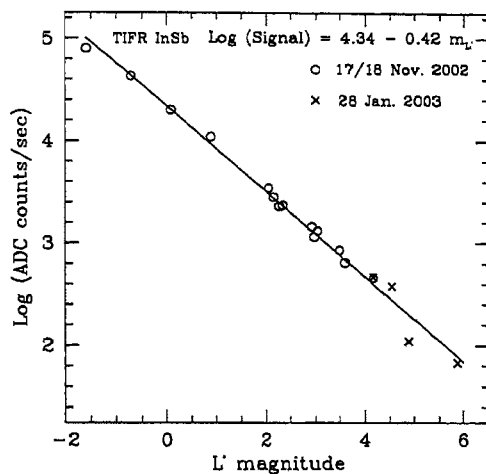
### 2.1 Calibration curve in L' band

Fig. 1 shows the calibration curve in L' band obtained by using the infrared standards, which demonstrates the linearity between the measured signal and L' mag. The L' mags of HR 0134 and HR 0414 were not available in the literature. Hence, we derived the L' mags of HR 0134 and HR 0414 as 3.59 and 2.74, respectively using the calibration curve shown in Fig. 1 (see Table 1).

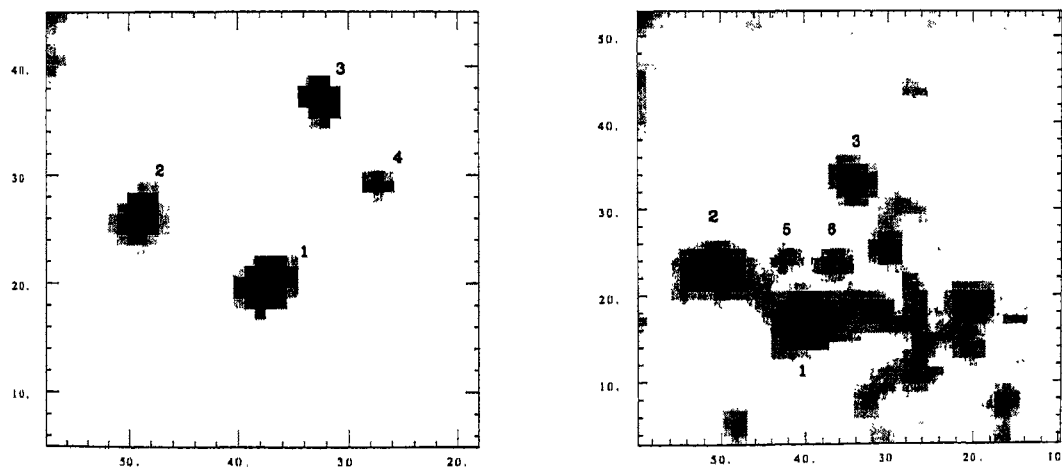
### 2.2 Trapezium cluster in L' band

Observations of Trapezium cluster at L' band with TIRCAM were performed with four pointings (two sets with 0.032 s of integration time of 200 co-additions & other two sets with 0.064 s of 200 co-additions) during Nov. 2002. After aligning the different pointings, images were co-added to get the final image of Trapezium cluster in L' band with a total integration time of 38.4 s. During Jan. 2003, the Trapezium cluster was observed for a long duration and several frames were co-added to get the final image with a total integration time of ~ 1228 s. Fig. 2 shows the L' band

image of Trapezium cluster observed with TIRCAM during Nov. 2002 & Jan. 2003. We are able to detect the stars upto  $\sim 7$  mag in  $L'$  band from the Gurusikhar site (see Table 2). We probably also see the warm diffuse emission around the cluster region (Fig. 2b).



**Figure 1.** Plot of the measured signals (ADU/s) vs the standard  $L'$  magnitudes of infrared standards observed with TIRCAM.



**Figure 2.** (a).  $L'$  image of Trapezium cluster (left) observed with TIRCAM on 18 Nov. 02. The total int. time is of  $\sim 38.4$  s. (b).  $L'$  image of Trapezium cluster (right) observed on 28 Jan. 03. The total int. time is of  $\sim 1228.8$  s.  $L'$  mag of the marked objects are given in Table 2.

**Table 2.** Comparison between L band mags of detected stars in Trapezium cluster with TIRCAM and Muench et al. 2002

Id	L mag from TIRCAM) ( $\lambda_{cen} \sim 3.9 \mu m$ )	L mag ( $3.5 \mu m$ ) (Muench et al. 2002)
1	4.15	4.33
2	5.07	5.52
3	5.20	5.50
4	6.14	5.82
5	7.18	7.50
6	7.01	8.22

### 2.3 Comparison of TIRCAM L' magnitudes

Table 2 shows the comparison between L' band magnitudes of detected stars in Trapezium cluster with TIRCAM and Muench et al. 2002. The observations of the Trapezium cluster in L band ( $3.5 \mu m$ ) by Muench et al. 2002 were obtained at the Fred Lawrence Whipple Observatory on Mount Hopkins, Arizona (altitude  $\sim 2606$  m), using the 1.2 m f/8 Ritchey-Chretien telescope with  $256 \times 256$  InSb detector arrays. The integration time used by Muench et al. 2002 for a single position was 0.1 s with 100 co-additions at L band. The final image in L band was of a total integration time of 3 m. The two measurements in L band are in a good agreement (Table 2) considering the two different wavelengths ( $\lambda_{cen}$ ).

## 3. Conclusion

Although the observations were made during the bright sky (near full moon period) & in the non-photometric sky conditions, we could observe the sources in L' band ( $\sim 3.9 \mu m$ ) upto  $\sim 7$  mag from the Gurusikhar site. In near future, we plan to explore TIRCAM's performance in the broad L ( $3.5 \mu m$ ) & M ( $4.5 \mu m$ ) bands from Hanle site.

## References

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