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Near Infrared Survey of the Galactic Nuclear Bulge Region

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Abstract. Inner 300 pc of the Galactic Center region is surveyed with the SIRIUS camera mounted on the InfraRed Survey Facility (IRSF) telescope of the SAAO, during June-July 2002, resulting in the deepest near infrared view of the Milky Way Nuclear Bulge Region. Here we present first results from this survey underlining the capabilities of the SIRIUS camera and the photometric procedures adopted in this work involving highly crowded star fields.

Keywords : Galaxy – Milky Way: Nuclear Bulge – surveys: near infrared

1. Introduction

Due to proximity of the Galactic Center, it is possible to study the processes in galactic nuclei with high spatial resolution. Such a study is also very important for understanding the structure of the Milky Way and galactic evolution (Serabyn & Morris 1996, Mezger et al 1996, Ellis 2001). Due to the large extinction, studies of the Galactic structure in optical have been restricted to high Galactic latitudes. However, the longer wavelength observations can penetrate the high extinction at low latitudes. Recent past has seen several NIR surveys, i.e. DENIS(Epchtein et al 1997), 2MASS (Skrutskie et al 1997), etc, which, however, either lack depth or suffer from confusion due to high source densities in these regions. Also, the J band data in DENIS is undersampled in this region of high extinction. A large number of Ks sources do not have counterparts in I & J. The situation has not improved much with the availability of 2MASS data. To overcome these problems, and to better understand the stellar populations distribution in the inner bulge region, we are carrying out a deep imaging survey in J, H & Ks bands. The observations are planned so as to reach the tip of the RGB at the distance of the Galactic center.

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2. The Survey Observations and Data Analysis

Our survey of the inner bulge region within $|l| = 1.5$ deg, $|b| = 0.5$ deg is carried out using the 1.4 m IRSF telescope at Sutherland, South Africa. The IRSF is jointly operated by the SAAO and Nagoya University, Japan. The telescope is equipped with a three channel camera(Nagashima et al. 1999) known as SIRIUS (Simultaneous InfraRed Imager for Unbiased Survey), capable of imaging in J(1.25μm), H(1.63 μm) & Ks(2.14μm) bands, with 1024×1024 pixels array detectors. The FOV is $7.8' \times 7.8'$ with a scale of 0.45 arcsec/pixel. The observations were made during June 25-July 1 & July 9-15, 2002 under good (better than 1".2) seeing conditions. For each field, 10 dithered images were taken with 0.1 and 5 second exposures. Towards some directions we have taken 10 second exposures to reach fainter levels in the highly extincted J band. Observations were also made for sky, dark, flat fields and on a set of standard stars (Persson et al 1998) for data reduction and calibration.

The images were reduced using the IRAF package, scripts written in-house and the SIRIUS pipeline (Nakajima, private communication). We performed source detection and photometry with Christophe Alard's (Alard 2000) software using psf fitting. We obtain limiting magnitudes in J, H and Ks as 17.2, 17 & 16, respectively.

3. Results and Discussion

Here we show sample results obtained from the 8' x 8' image centered at the Galactic Center. The emission at NIR is much less extincted as compared to optical and is mainly from the photosphere of late spectral type, evolved stars. In the image central bright star cluster and filamentary, inhomogeneous distribution of molecular material are seen clearly. In the J band extinction is maximum, decreasing at longer wavelengths. The sources seen in J band are either blue foreground sources or very bright stars of the central cluster. The H and Ks band images show overcrowding of the sources. The source extraction results in more than 7500 sources in Ks. The magnitude values used in the results are calibrated with 2MASS data. The Ks v/s J-Ks CMD (Fig.1) and color-color (not shown here) diagrams are plotted using sources common to all bands to distinguish between stellar populations. The CMD shows foreground bright stars (to the left) and some highly reddened sources towards right. The color-color diagram shows that stars are distributed in a much wider range than one finds in less extincted regions. A large number of the sources right to the main concentration indicates to the large amount of circumstellar material. It is to be noted that our survey is deeper by more than 2-magnitudes compared to 2MASS & DENIS and therefore measurements on a large number of sources (fainter than 14 mag in Ks) are being reported for the first time.

Figure 2 shows CMD of a lower extinction region (l,b=0.0), also indicating a superior depth in photometry as compared to 2MASS. It clearly reveals the red clump which can be used as a standard candle to estimate distances. An estimate of the extinction and the distances to the bulk of the sources in a given LOS can help figure out 3-dimensional distribution of the stellar matter

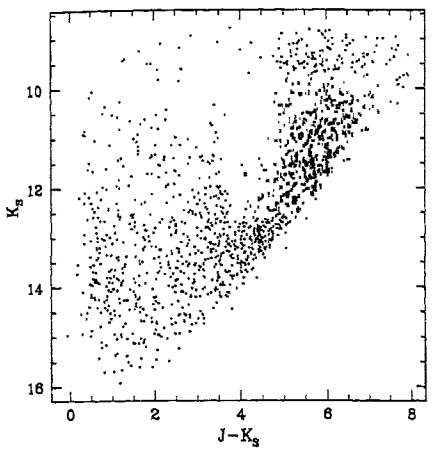

Figure 1. Ks v/s J-Ks CMD showing sharp cut off on the lower right due to high extinction at J.

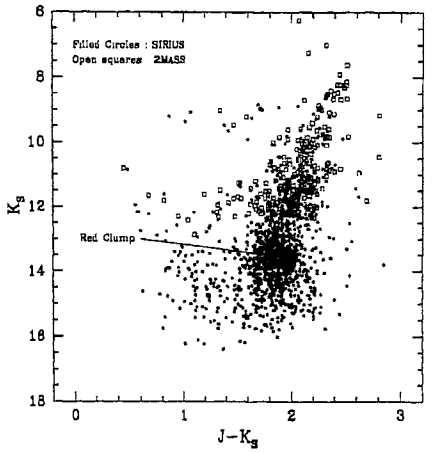

Figure 2. 2MASS & SIRIUS CMD for a field with intermediate extinction.

in the Bulge of the Galaxy. Thus the present deeper survey provides a better view of the inner Galaxy improving our understanding of the Milky way.

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