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NEAR-INFRARED WIDE-FIELD IMAGING CAMERA WITH PtSi 1040×1040 CSD

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ABSTRACT

We have constructed a near-infrared imaging camera which is attached to the prime focus of 105cm Schmidt telescope at Kiso Observatory. The camera is equipped with a 1040×1040 PtSi CSD array developed by Mitsubishi Electric Co. The combination of Kiso Schmidt and the array gives a wide field of view of $18.4' \times 18.4'$ with a reasonable spatial resolution of 1.06"/pixel. The system performances of the camera have been evaluated through laboratory and observational tests. Low noise, good cosmetics(no defect pixels), and good stability of the camera system show an excellent performance for astronomical use.

Key Words : Near-infrared, PtSi CSD, Wide-field, Imaging

I. INTRODUCTION

Near-infrared emission is mainly radiated by low temperature stars and warm interstellar dust, which are clues to understanding the physics of star formation, the structures and the evolutions of galaxies. Extinction by interstellar dust is less effective at longer wavelengths. Near-infrared, therefore, may allow us to study embedded stars in dark clouds and galaxy structures hidden behind dust, where an extinction is serious at optical wavelengths.

So far, typical astronomical near-infrared cameras have $\sim 4 \times 4$ arcmin^2 field of view or smaller, which may not be large enough to observe widely extended objects such as nearby galaxies and galactic objects. A new generation of near-infrared large format array will open a new era in astronomy through wide-field imaging. We present here a wide field imaging camera, which is mainly devoted to wide field imaging for nearby galaxies, galactic star forming regions, and wide field sky surveys, with a large format array (PtSi 1040×1040 CSD made by Mitsubishi Electric Co.; Yutani *et al.* 1991).

II. CAMERA SYSTEM

Camera system is divided into three parts; the dewar, the cooling system, and the data acquisition system.

The Kiso Observatory Near-Infrared camera (hereinafter KONIC) is attached to the prime focus (F/3.1) of 105cm Schmidt telescope at Kiso Observatory. We designed the camera dewar as compact as possible because the space at the prime focus of Kiso Schmidt is not so large and the camera itself becomes the cause of a vignetting. In the dewar, the radiation shield and the cold box are settled in. A filter turret, a cold shutter, and a cold baffle are on the radiation shield and the detector is fixed in the cold box. J, H, and K' filters are set in the filter turret usually and other two filters can be set in the turret. We show the photo KONIC in figure 1.

A compact refrigerator (Iwatani Cryomini) has two stages and the first stage cools a radiation shield below 100K and the second stage cools a cold box below 60K. A temperature controller (Lakeshore Model 330) keeps the camera temperature constant with an accuracy of 0.15K. A compressor of the refrigerator is located on the dome floor and connected with camera dewar by flexible tube. Helium gas is used as refrigerant.

The data acquisition system we use is Messia II+. Messia (Modularized Expandable SiStem for Image Acquisition) is a universal array control system on VME bus developed at National Astronomical Observatory in Japan. Messia II+ is a modified system of Messia to deal with high speed data sampling for IR arrays. The control software package consists of many small commands and we manage these commands through Unix script files. The detail structure and data acquisition system is reported in Itoh *et al.* (1995).

III. PERFORMANCE

We determined the conversion gain(e^-/ADU), quantum efficiency(Q.E.), linearity and dark current in the laboratory test. The conversion gain can be read on the figure plotting a curve of rms noise as a function of signal. We estimated the conversion gain at 6e^-/ADU and readout noise at 4.5ADU from the photon transfer curve. The quantum efficiencies at J, H, and K' band were measured using 1000K black body radiator. Results were 8.0±0.9%, 4.5±0.4%, and 2.0±0.3% at J, H, and K' band respectively. The linearity was measured under the same condition as Q.E. test. The fractional deviation from the linear regression line is smaller than 1% below 15000 ADU or $9.0\times10^5 e^-$. The dark current is a function of array temperature. We measured the dark current in this array over time-range from 10 sec to 2400sec and found 1 ADU/sec at 57.5K. It is worth mentioning that the cosmetics of the PtSi 1040×1040

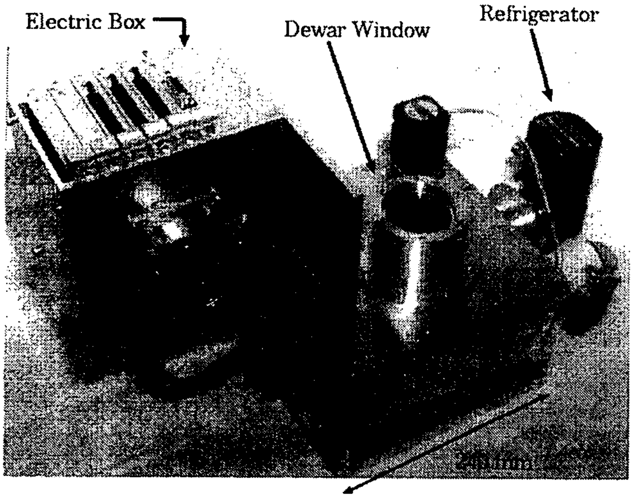

Fig. 1.— The photo of KONIC.

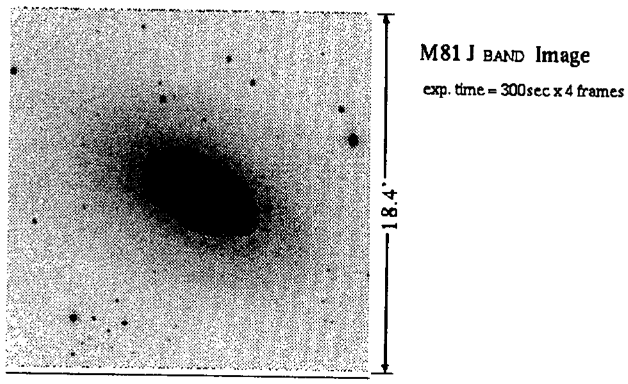

Fig. 2.— This is the M81 *J* band image. We co-added four object frames. Exposure time for each frame was 5 min and the total integration time was 20 min.

CSD is quit well. We could not find any defect pixels after several tens of heat cycles.

We performed an evaluation of charge transfer efficiency (CTE) through observations of an open cluster M67. It is well known that the CTE is a function of parameters such as the transfer speed, the temperature, and the number of electrons to be transferred. We fixed the transfer speed and the temperature during the observation, and changed exposure time from 10sec to 300sec. We found that the background flux plays an important role in the improvement of the CTE; the threshold level, at which the effect of low CTE is negligible, is about $6000e^-$.

We finally present the M81 image in figure 2 to demonstrate how large KONIC's field of view is.

IV. SUMMARY

We have constructed a near-infrared camera with PtSi 1040×1040 large format array. In this paper, we have introduced the camera system and shown the performances. Although the ultimate sensitivity does not compete with the HgCdTe or InSb, low dark current, low noise, good cosmetics make the the array very useful in astronomical applications.

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