CCD CAMERA FOR THE 60CM TELESCOPE AT KAGOSHIMA SPACE CENTER

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ABSTRACT. A CCD detector has been developed for photometry and image detection with the 60cm reflector at Kagoshima Space Center. The structure and the manipulation of the instrument were simpified by the use of Peltier devices for cooling the CCD in order to eliminate thermal noise. A micro-computer system is used to control the instrument and process the data. A test observing run has demonstrated that a photometric sensitivity of 20th magnitude in the W band(3800-7000 Å) can be achieved in a 3600sec exposure.

1. GENERAL DESCRIPTION OF THE CCD CAMERA

As an astronomical detector, Charge Coupled Devices(CCDs) have the excellent properties of high quantum efficiency and broad dynamic range with good linearity and stability. We have developed a CCD camera designed for photometry and image detection with the 60cm reflector at Kagoshima Space Center(KSC). The CCD we have used is NEC μPD3511D, a front surface incident and interline transfer type CCD with 384(H) × 490 (V) pixels whose unit size is 23(H)× 13.5(V)μm.

Our CCD camera is composed of three units; the vacuum chamber, the circuit box and the micro-computer system. The first two units are connected together and mounted at the prime focus of the 60cm reflector, at which the image size on the CCD is 11.8' × 8.8'.

The configuration of the vacuum chamber is shown in Fig.1. The chamber consists of a cylindrical vessel of stainless steel with a quartz window and a copper disk on which the CCD and 3 layers of Peltier elements are compressed by a plate spring. The heat transfered from the hot side of the Peltier element to the disk is removed by the circulation of cooled water. The chamber is pumped to 10^{-3} torr by a rotary vacuum pump.

J. B. Hearnshaw and P. L. Cottrell (eds.), Instrumentation and Research Programmes for Small Telescopes, 111–112.

By using Peltier devices to cool the CCD, the structure and the manipulation of the instrument were simplified rather than the standard liquid nitrogen cooling system.

The upstair electronics in the circuit box consists of three cards; the clock card produces the required TTL level clocking from a master clock in the downstair micro-computer; the driver card converts the TTL level clock to the proper CCD driving levels; the analog card converts the CCD output to 12bits digital data. The control signals to and image data from the upstair circuit are carried along a 15m multiwire cable from/to the micro-computer. The image data of the CCD is read synchronously with the master clock into the micro-computer memory at a rate of 80k pixels/sec, and recorded onto the floppy disks along with the time and date, integration time and other housekeeping information.

2. THE PERFORMANCE OF THE CCD CAMERA

The operating temperature of -70°C can be maintained with sufficient stability by our cooling method. The thermal noise of the CCD we have used is ~1 electron/sec/pixel at an operating temperature of -60°C, roughly equivalent to the sky brightness of KSC, and so the cooling ability of our instrument is sufficient for practical use.

The results of laboratory measuremants showed the total readout noise to be ~50 electrons/pixel with no incident light, and the nonuniformity in sensitivity between pixels was found to be small, not exceeding 5% over the field.

A test observing run for photometric calibration using several standard stars demonstrated that in a 1000sec exposure a photometric sensitivity of up to 17th magnitude extending over a 5 magnitude range can be achieved with better than 5% accuracy in the V band, while a sensitivity of 20th magnitude in the W band (3800-7000 Å) can be achieved within a 3600sec exposure.

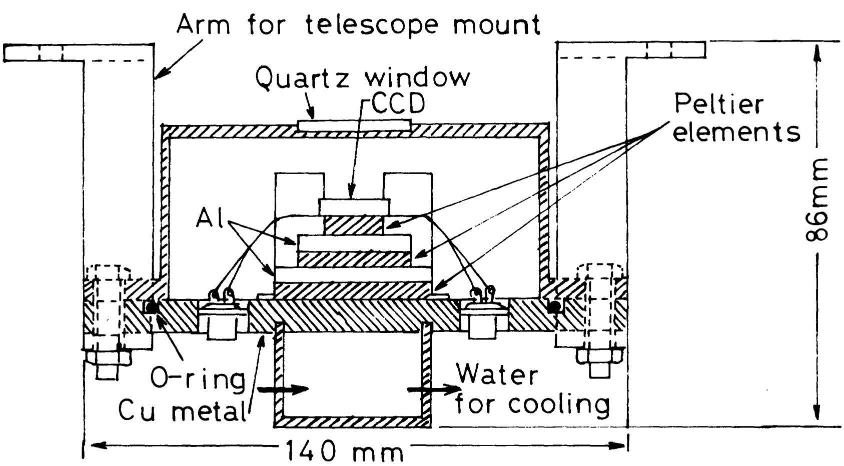

Fig.1 The configuration of the vacuum chamber

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