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Lunar Occultations with Infrared Arrays

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Abstract. Recently we have successfully observed the lunar occultation of a carbon star IRC+20120 and a M5 star IRC+10241 with the NICMOS sub array at the 1.2m Gurushikhar telescope. The integration times were respectively 5 millisec and 3 millisec per sample in the broad K band. The interval between two integrations was $\sim$ 16 millisec. FOV of the sub array was 10 arcsec $\times$ 10 arcsec. Details of the experiment and results are discussed.

Keywords : Infrared arrays, Lunar occultation, High Angular Resolution

1. Introduction

Till recently single element IR detectors like the InSb, installed in LN2 cooled dewars, have been successfully used for Lunar Occultation high angular resolution studies of bright IR sources of the Two Micron Sky Survey (TMSS) catalogue (m_k <3.0) (Chandrasekhar, 1999). With the advent of two dimensional IR arrays like NICMOS, PICNIC, HAWAII etc. in the 1-2.5 μm region single element detectors are being phased out. The recent Two micron All Sky Survey (2 MASS) has a large number of IR sources whose positions are determined well enough for good lunar occultation predictions to be made for any observatory. It therefore becomes important to investigate use of an IR array for observing lunar occulations (LO).

Apart from their increased sensitivity the advantage of using an IR array in the Area of Interest (AOI) mode is in the reduction of the background noise (due to scattered Moonlight) due to a reduced field of view in the sky compared to a conventional photometer. Calculations by Richichi (1994) indicate that even with a 1.5 m telescope it should be possible to reach on S/N $\sim$ 50 for 2 millisec integration on an array upto a K magnitude of $\sim$ 6.5.

The main difficulty is in rapid sampling of the lunar occultation event with an array due to inherent delays in readout and processing electronics of the array. We have investigated the fast

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Table 1. LO events with NICMOS IR array

Date of occultation	28 Sep. 2002	25 Dec. 2002
IR Source	IRC+20120	IRC+10241
m_k	1.76	2.67
m_v	10.0	8.7
Spectral type	N3	M5
Lunar Phase(after New Moon)	21.7 days	21.6 days
Position Angle (NESW)	202^o	327^o
Vel. Comp.(km/s)	0.451	0.662
Altitude	56^o	55^o
Integration time	5 millisec	3 millisec
Sampling time (achieved)	16.6 ms	15.8ms
Angular size	~4.0 milliarcsec	unresolved

sampling of a small AOI of the NICMOS array which is in regular use at the 1.2 m telescope of Gurushikar Observatory,Mt Abu. Using the array in this AOI mode two lunar occultation events have been successfully observed.

2. Instrumentation

The NICMOS camera clocking unit is programmed using a C++ menu selection program and commands sent on serial RS-232 9600/N/2 for fast AOI sampling. Filter selection, integration time, reset time, sub array size, number of cycle etc. are programmed through a PC in the telescope control room. AOI position in full frame image,is selected through keyboard. After setting the required parameters a RUN command is given. Then CPU creates a clocking control image in memory. Physical control is then passed to electronics hardware counter sequencer located near the array dewar. Then clock signal, charge transfer, pre-amplifier, sample hold, 16 bit ADC, digital data transfer is accomplished through AMD 7968 Taxi chip to fibre optics driver, cable, fibre receiver, taxi receiver AMD 7969 and then the FIFO memory of PCI-DMA card. PCI-DMA is held in polling mode as command computer is expecting to receive data. DMA channel responds to data in FIFO which is then kept in memory buffer in PC. The AOI can be in any one quadrant only. The integration below 3 msec, reset to reset 3 msec, is not possible in the present hardware system.However some improvement is underway to use all AHC series of chips intead of HC series chips and to use faster ADC chip. Limitation to acquiring sub frames more rapidly is mainly due to: The existing hardware configuration of NICMOS, mainly 6502 8 bit processing control CPU, ADC chip, and TAXI transmitter chip. Data is saved in BIN format with header text file in hard disk. Data collected at small intervals is stored in an array and after finishing a burst of 40 sec it is recorded in file.(Fig 1)

3. Observations and Analysis

Details of the observations are given in Table 1. Both events were dark disappearances. The sub array size for both events was 20 pix × 20 pix corresponding to a FOV of 10″ ×10″. A nearby sky frame has been subtracted from the raw images to remove sky and instrumental artifacts. It is found that nearly 12 millisec is needed to read out each subframe image. For each sky subtracted subframe, the averaged counts were derived and used to generate the lunar occultation light curves shown in Fig.2. A occultation model fit to the data is also superposed. It can be seen that the carbon star IRC+20120 is resolved at 4 milliarcsec inspite of the poor time sampling of the event, while IRC +10241 is unresolved. Efforts are underway to reduce the overall sampling time to less than 10 millisec with the existing system.

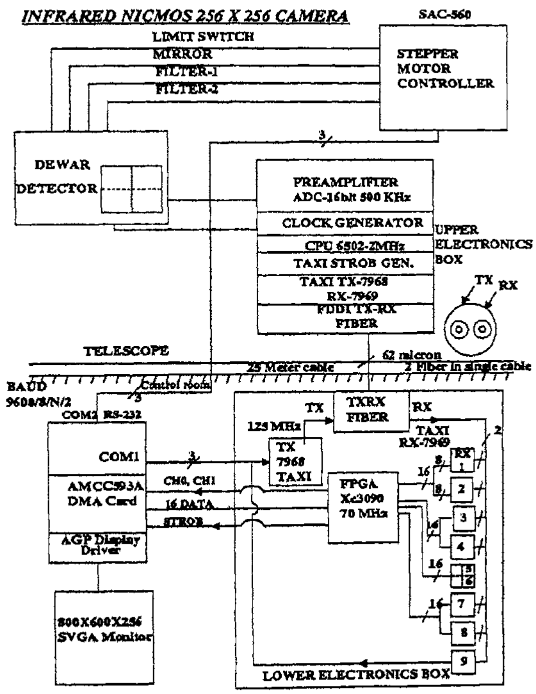

Figure 1.

4. Conclusions

A beginning has been made in the high angular resolution observations of lunar occultations with NICMOS array in the K band. Two successful events are reported. One source is resolved. It is

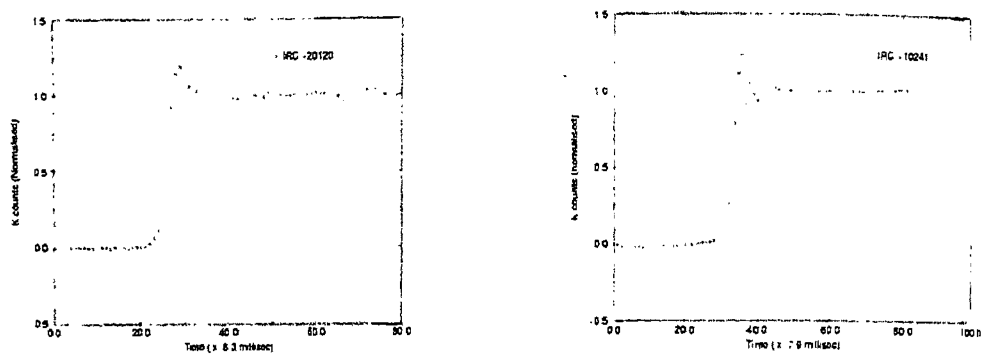

Figure 2.

clear that the sampling time between sub frames has to be reduced further within about 3 millisec before the advantages of the array for better S/N on the source can be fully exploited. However for binary detections and for extended sources ($\geq$ 10 mas) the present arrangement would be suitable and superior to single elements detectors.

References

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