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Near infrared high angular resolution observations of stars and circumstellar regions by the technique of lunar occultations

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Abstract. A program of high angular resolution observations of stars and their circumstellar regions using the technique of lunar occultations has been initiated at the Physical Research Laboratory, Ahmedabad. A liquid nitrogen cooled InSb detector based high speed infrared photometer with millisecond data acquisition capabilities has been developed and a dozen occultations have been successfully observed at 2.2 μm. A detailed analysis of the system capability suggests a presently achievable angular resolution of 3.5 milliarcseconds.

Key words : near-infrared—lunar occultation

Technique

The technique of lunar occultations presents a different approach to high angular resolution in the sense that it is not the source itself that is observed but the diffraction pattern of the source produced by the sharp limb of the moon. One dimensional structure in the direction of occultation can be extracted from the observed fringe pattern after detailed analysis taking into account the frequency response of the detection system, the optical filter bandwidth and the telescope size. The lunar occultation technique has the advantage of (a) being a relatively simpler method suitable for small telescopes of the 1 m class; (b) having the potential to achieve one dimensional angular resolution at the level of a few milliarcseconds. Observing in the near IR (~ 2.2 μm) has an advantage due to reduced level of scattered moonlight. In the fast (occultation) mode there is no sky chopping and the detector/preamplifier output is directly digitized with a 16 bit A/D converter and recorded in a PC based data acquisition system. Data sampling is at the rate of 1 millisecond for 30 seconds centred on the predicted time of the occultation event.

Figure 1 shows the experimental arrangements used. Using the above system a dozen occultations have been successfully observed in K band (2.2 μm) including a day time event. Figure 2 is a representative occultation light curve, which shows 3 fringes of the diffraction pattern clearly. An occultation data analysis package taking into account the finite time response of the detector, filter bandwidth, telescope aperture and scintillation has been developed. Figure 2 also shows the data fitted with a 3.5 mas angular size source using the above package.

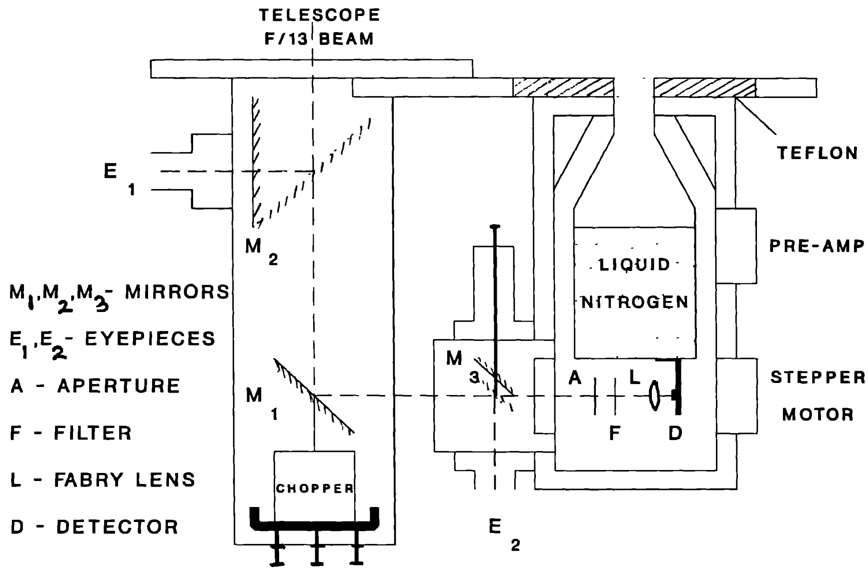

Figure 1. Schematic diagram of the near infrared photometer.

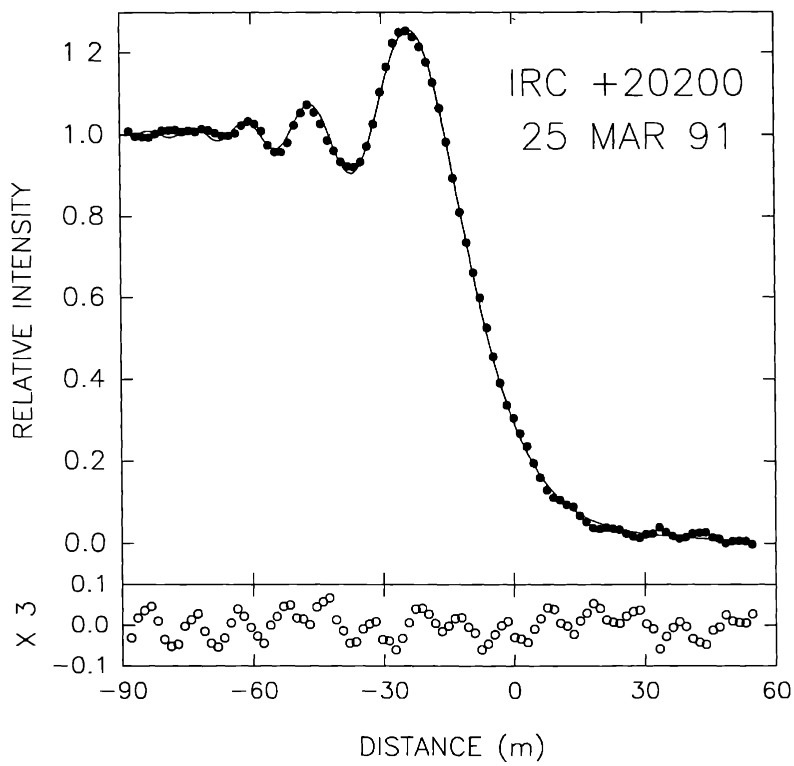

Figure 2. Lunar occultation light curve of IRC + 20200.

With the present system it is estimated that angular resolution down to 3.5 mas is realisable for single sources brighter than $m_k \sim 3$ for 1m class telescopes.

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Reference

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