Contrib. Astron. Obs. Skalnaté Pleso **43**, 246 – 247, (2014)

Application of an InGaAs NIR camera for photometry

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Received: October 22, 2013; Accepted: January 14, 2014

Abstract. The performance of a near infrared camera for photometry is investigated by observations of multiple samples of spatially close non-variable stars. Objects with a J-band magnitude less than 9.2 have been observed by the application of differential photometry. For the faint objects a statistical scatter of 7.9 mmag has been determined. Possible future applications include the examination of planets orbiting late type stars by an eclipse or a timing analysis.

Key words: near infrared – photometry

1. Introduction

This work presents the preliminary results of an investigation of the photometric accuracy that can be achieved by a XEVA camera. The exploration of the NIR wavelength regime is very promising for late type stars whose emission peaks in the near infrared. This is especially true for substellar objects and very cold components. In addition, NIR photometry is only slightly affected by stellar spots. Indeed, these objects are very valuable targets for exoplanet characterisation because they are very frequent, comparatively small in diameter and have lower masses than early type stars. Furthermore, eclipses of PMS objects that are embedded in circumstellar matter can be investigated. The use of NIR photometry has already been proven successful for eclipsing binary systems, e.g. on TY CrA. Consequently, the extension of photometric follow-up programs for small telescopes to the NIR wavelength range is planned.

2. Observations & Data Reduction

The observations were conducted with a CMOS NIR InGaAs camera fabricated by Xenics. The FPA consists of 640×512 pixels. Each pixel has a pitch of 20μm and a full well capacity of 1.25 10^6 e^-. It can be thermoelectrically cooled down to 260K. In combination with the local 1.2m telescope it has a FOV of $135'' \times 169''$. The detector chip is sensitive from 0.9 to 1.7μm with QE $\geqq$80%. No filter was used.
The performance of the detector and the photometric accuracy were tested by

Table 1. Log of observations of June 7th/8th 2013 (no. 1) and July 23rd/24th 2013 (no. 2-4).

no.	2MASS des.	$m_{J,1}$	2MASS des.	$m_{J,2}$	ρ[as]	t[s]	σ
1	18074956+2606047	5.503	18074950+2605504	5.547	14.3	1.0	21.2
2	19295845+5358280	7.403	19300531+5358474	7.447	63.5	5.0	5.31
3	19510116+5317113	8.022	19510141+5315337	7.776	97.6	14.0	10.4
4	19443057+5307302	8.300	19443575+5307524	9.142	51.6	20.0	7.95

observing neighbouring non-variable stars with approximately the same brightness. Since photometric observations are not catalogued for the specific passband of the XEVA camera, the J-band magnitude has been used as a brightness estimator for the observed objects. Choosing objects with roughly equal brightness is advantageous because, on the one hand, the exposure time can be chosen long enough to collect a sufficient number of photons while, on the other hand, saturation of the detector is prevented. In addition, pairs of stars had to be chosen that could be accommodated inside the small FOV of the detector. The objects were selected from the 2MASS PSC. Tab. 1 lists the 2MASS designation, J-band magnitude, distance between components ρ, exposure time t and the scatter of the data points σ in mmag. The nonvariability was checked by consulting the GCVS, the VSX and the WISE All-Sky Data Release.

The raw data has been reduced by differential photometry. One of the stars has been taken as the target and the other was used as a comparison star. Theoretically, the magnitude difference would be constant. However, by photon and detector noise, as well as atmospheric effects, a scatter in the data points can be observed. It is given in Tab. 1. The scatter is highest for the brightest and closest objects. Excluding pair no. 1, the average scatter is 7.9 mmag.
In this work the photometric scatter for bright NIR sources has been determined. Future applications of the XEVA camera will be monitoring of late type eclipsing binaries either for direct observations of transiting exoplanets, or to indirectly find exoplanets by transit timing variations.

References

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URL: 2MASS PSC, `http://cdsarc.u-strasbg.fr/viz-bin/Cat?II/246`

URL: General Catalogue of Variable Stars, `http://cdsarc.u-strasbg.fr/viz-bin/Cat?B/gcvs`

URL: The International Variable Star Index, `http://www.aavso.org/vsx/`

URL: WISE All-Sky Data Release, `http://cdsarc.u-strasbg.fr/viz-bin/Cat?II/311`