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THE FIRST TEST OF NEW ANDOR IXON 897 EMCCD CAMERA

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Abstract. Here the results of the testing of a new, very quick, EMCCD Andor iXon 897 camera are reported. The camera was examined in early June and September 2017. The CCD frames of low-separation visual double stars were obtained with short exposures of a few milliseconds. The camera was mounted on the 60 cm telescope in June and on the 1.4 m telescope in September at Astronomical Station Vidojevica (ASV). This quick camera will be part of the equipment for the speckle-interferometric technique of observing double stars and for the beginning it will be utilized for obtaining frames by applying lucky imaging.

1. INTRODUCTION

The basic task in studying visual double and multiple stars is to determine the orbital or linear elements from the time series of the measurement of the position angles and the angular separations between the components. In other words, observers need to answer the question concerning the nature of their motion. Therefore, we need observations covering very long time intervals. Only for a small number of pairs, about 2200, the orbital elements have been calculated, i.e. a Keplerian motion has been confirmed. In the case of many pairs no change in position angle and/or angular separation over a sufficiently long time interval has been registered. Such pairs are probably not gravitationally bound, i.e. they are optical pairs.

Binary stars have been studied for decades for the purpose of accurate determination of stellar masses, verification of the evolutionary models and star formation theories. With a CCD camera it is impossible to detach too close pairs (less than 1.5 arcsec). Close pairs are observed by using speckle interferometric technique. Due to their small separations, they have been mostly observed with speckle cameras on larger telescopes. These techniques can dramatically increase the resolution of ground-based telescopes. Use of these techniques has led to a number of discoveries, including thousands of binary stars.

Speckle interferometry of close double stars avoids seeing limitations through a series of diffraction-limited high speed observations made faster than the atmospheric coherence time scale. This technique not only allowed observations of binaries (stars gravitationally bound to each other) with angular separations below the seeing limit, but the observations were generally an order of magnitude more accurate than visual observations (McAlister 1985).

Lucky imaging is one form of speckle imaging. Speckle imaging techniques use a high-speed camera with exposure times short enough (100 ms or less) so that the changes in the Earth's atmosphere during the exposure are minimal. With lucky imaging, those exposures least affected by the atmosphere (typically around 10%) are chosen and combined into a single image by shifting and adding the short exposures, yielding a much higher resolution than it would be possible with a single, longer exposure which includes all the frames. Lucky imaging is one of several methods used to remove atmospheric blurring. Used at a 1% selection or less, lucky imaging can reach the diffraction limit of even 2.5 m aperture telescopes, a resolution improvement factor of at least five over standard imaging systems.

This quick EMCCD Andor iXon 897 camera will be part of the equipment for the speckle-interferometric technique of observing double stars and for the beginning it will be utilized for obtaining frames by applying lucky imaging.

2. EMCCD ANDOR IXON 897 CAMERA

The iXon Ultra 897 platform takes the popular back-illuminated 512 x 512 frame transfer sensor and overclocks readout to 17 MHz, pushing speed performance to an outstanding 56 full frame per second (fps), whilst maintaining single photon sensitivity and quantitative stability throughout. New Optically Centred Crop Mode unlocks unparalleled frame rate performance from centrally located ROIs, ideal for the particular speed and sensitivity requirements of super-resolution microscopy.

The iXon Ultra maintains all the advanced performance attributes that have defined the industry-leading iXon range, such as deep vacuum cooling to -100°C, extremely low spurious noise, and Andors patented EM gain recalibration technology (EMCA^{TM}).

New, very quick, EMCCD Andor iXon 897 camera was procured in April 2017. It was tested in early June for the first time 2017 and at late September 2017 more one.

The main characteristics of the EMCCD Andor iXon 897 camera[1] are given in Table 1.

Table 1: The main characteristics of the EMCCD Andor iXon 897 camera.

Active pixels (H x V)	512 $\times$ 512
Pixel size (W x H; μm)	16 x 16 μm
Image area (mm)	8.2 x 8.2 mm
Active Area Pixel Well Depth (e$^-$)	180,000 e$^-$
Max Readout Rate (MHz)	17 MHz
Frame rates (fps)	56 (full frame) - 11,074
Read noise (e$^-$)	$<$ 1 with EM gain e$^-$
QE Max	$>$ 95%

[1] http://www.andor.com/cameras/ixon-emccd-camera-series

Figure 1: EMCCD Andor iXon 897 camera was mounted on the 60 cm telescope in early June 2017 (left) and on the 1.4 m telescope at the end of September 2017 (right) at ASV.

3. TESTING OF CAMERA

The new EMCCD Andor iXon 897 camera was first tested on a 60 cm telescope (Figure 1, left panel) at the beginning of June 2017. The camera is successfully mounted on the telescope using a specially-built adapter. By applying the appropriate drivers the camera is linked to MaximDL software that allows the telescope to be operated simultaneously. After that, the problem of placing the camera's chip in the focal plane of the telescope (focusing) is successfully solved. More details of determining the focal length for different detectors can be found in Cvetković et al. (2012). The pixel scale for 0.6 m telescope is 0.55 arcsec/pixel and field of view is 4.7 arcminutes. During the night, more than 500 CCD frames of double stars were made. As an illustration we give two CCD images of multiple star ADS 48 made with different exposures: 1 second (Figure 2 – left panel) and 0.001 second (Figure 2 – right panel). Separation of the brightest pair is 6 arcsec and its apparent magnitudes of the components are $m_A = 8.98$ and $m_B = 9.15$.

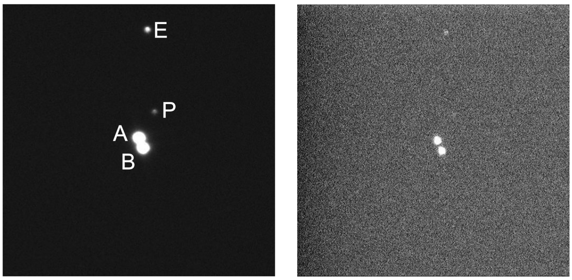

Figure 2: The CCD frames of multiple system ADS 48 were obtained with two different exposures: 1 second (left) and 0.001 second (right).

We repeated the same procedure for testing this camera on the 1.4 m telescope "Milanković" (Figure 1, right panel) at the end of September 2017. Then there were better weather conditions, so we made many more high quality frames with very short exposures. As an illustration, CCD images of two double stars, BRT 2465 and J 201, are presented. Their separations are 3.0 and 2.7 arcsec, respectively (Figure 3). Pixel scale for a 1.4 m telescope is 0.29 arcsec/pixel and field of view is 2.5 arcminutes.

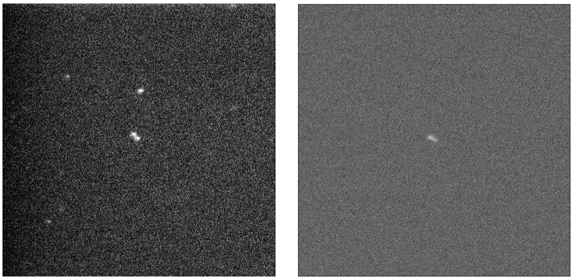

Figure 3: The CCD frames of two visual double stars, BRT 2465 (left) and J 201 (right).

We made stacked image (each one is 0.001 second) of the best 20% frames for double star J 555 (Figure 4).

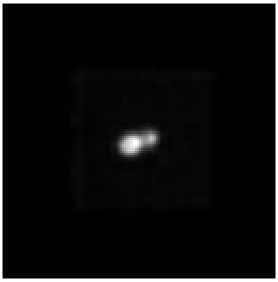

Figure 4: Stacked and croped image of the best 20% frames for double star J 555.

4. CONCLUSION

The next step is to find optimal driver parameters which give the best CCD frames for very short exposures. Also, we plan to procure optical equipment which will make it possible to do speckle interferometry of double stars with separations less than 1 arcsec.

Acknowledgment

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