The ASAS-3 system, its operation and prelimnary data.

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1 Abstract

ASAS-3 is the next step of The All Sky Automated Survey. This paper describes the new hardware consisting of two wide field (9x9 deg) telephoto instruments and one F=750 mm D=250 mm telescope with 2x2 deg FOV, each equipped with 2Kx2K CCD camera. Preliminary photometric data are also presented ands discussed.

2 Introduction

The All Sky Automated Survey (Pojmański 1997, 1998, 2000) is an observing project which ultimate goal is photometric monitoring of various objects all over the sky (Paczyński 1997). In the years 1997-2000 a small, automated prototype instrument equipped with 768×512 MEADE Pictor 416 CCD camera, 135 mm f/1.8 telephoto lens and I-band (Schott RG-9, 3mm) filter had been monitoring 3% of the sky to the limiting magnitude of $I \sim 13$. During 3 years of operation it has collected over $50x10^6$ measurements of over 150.000 stars and detected almost 4000 variable stars.

The prototype instrument, data acquisition and reduction pipeline and the ASAS Catalog were described by Pojmański (1997), the first results of the search for short time scale periodic variables were presented by Pojmański (1998) and results of the search for long term variables in the ASAS Selected Fields using data obtained during the first two years of the prototype instrument operation, were summarized by Pojmański (2000).

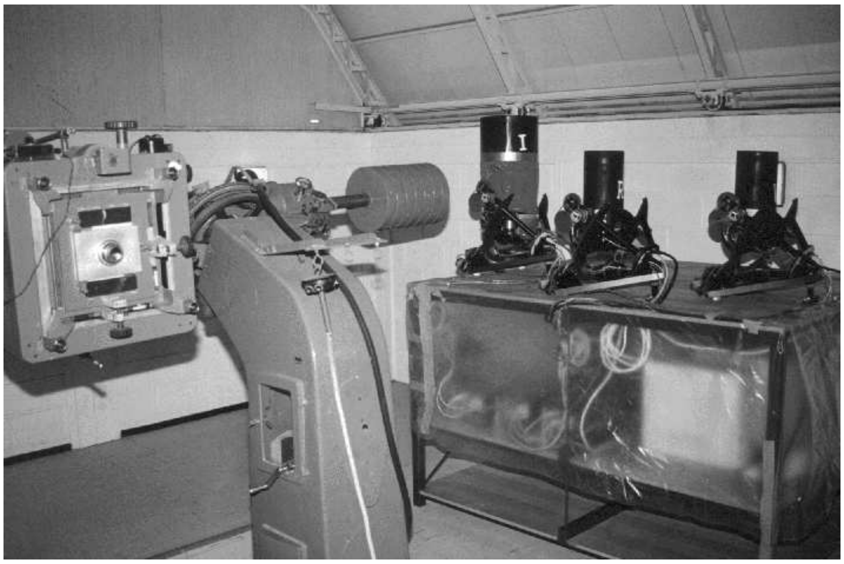
After completing the prototype phase of the project in early 2000 we have installed the upgraded ASAS-3 system in the dome of the 10ąstrograph in the Las Campanas Observatory (operated by the Carnegie Institution of Washington). New hardware consists of the three independent instruments (Fig. 1), each equipped with the automated paralactic mount, imaging optics with standard filter, 2Kx2K CCD camera (AP-10 from Apogee) and dedicated computer.

3 Instrumentation

3.1 Mount

Equatorial mount is a compact (500 mm side) horseshoe design driven in both axes by stepper motors, intermediary sprocket gears and friction rollers. It is controlled by dedicated electronic box, containing power supplies, microprocessor controller and translator drives. Both stepper motors are controlled over the same serial link.

RA drive transmission rate was designed for 1.5 arcsec steps, so it requires about 10 steps per second to track the sky rotation. Sprocket gears and friction roller form a non-backlash drive with



Rysunek 1: ASAS-3 in the 10" astrograph dome. From the left: 10" astrograph, $F = 750\ mm$ telescope, 2 wide-field instruments with 200/2.8. telephoto lenses

a very good positioning repeatability. Declination drive has a much smaller gear rate, so each step corresponds to about 12.5 arcsec on the sky.

Maximum slewing rate is about 5 deg/sec in hour angle and 40 deg/sec in declination. The average pointing time during a regular observing run is about 10 seconds.

Instrument bay is 280 mm in diameter and the total total weight of the iamging equipment should not exceed 15 kg.

3.2 CCD camera

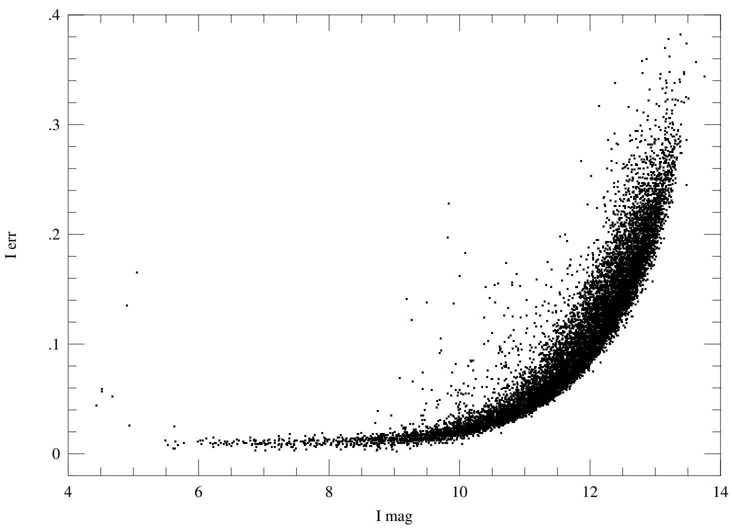
Three 2Kx2K (14 um) commercial cameras were purchased for the project. High readout noise (>10 e-) and 14 bit ADC were accepted as a trade-off for 5 sec readout time. Each camera is thermoelectrically cooled to -20 C during the night operation. Unfortunately two of three systems do not meet yet factory specifications and show read-out noise twice larger than desired reducing system sensitivity. Each camera system is linked to the dedicated Dual Pentium-3 650 MHz Linux box, which handles telescope and camera control, data aquisition and data reduction.

3.3 Imaging optics

Two wide-field sytems are equipped with the Minolta 200/2.8 APO-G telephoto lenses. These provide superb sharpnes (in fact better than needed: FWHM of stellar images is only 1.3-1.8 pixels) but unfortunately also strong vignieting (40-508.8x8.8 deg of the sky. One system is equipped with standard I filter and the other with V.

Narrow field instrument is $D = 250$ mm, $F = 750$ mm Cassegrain system with three element, Wyne-type field corrector. It gives sharp images (FWHM < 2.2 pixels) in the field of 2 deg diameter. With 2Kx2K CCD the field of view is 2.2x2.2 deg. This system has I filter in its optical path.

4 Performance



Rysunek 2: Standard deviation σ_I of the stellar magnitudes *vs* I-band magnitudes for LMC stars observed with wide-field I camera and 1-minute exposures.

For the 1 mniute exposure the limiting magnitudes for wide-field V, wide-field I and Cassegrain I systems are 13.5, 13.2 and 14.8, respectively (Fig. 2). The last two numbers shell improve by 0.5-1 magnitude once problems with high read-out noise are fixed.

Mechanical quality of the mount allows for exposures as long as 5-10 minutes for wide-field systems and about 3 minutes for Cassegrain telescope without any substancial degradation of PSF of the stellar images. Relatively large Cassegrain system is sensitive to moderate winds (> 7 m/s) in which case slightly elongated images are produced.

Pointing accuracy of the mounts (without any pointing model applied) is a few arc minutes in both axes.

5 Observations

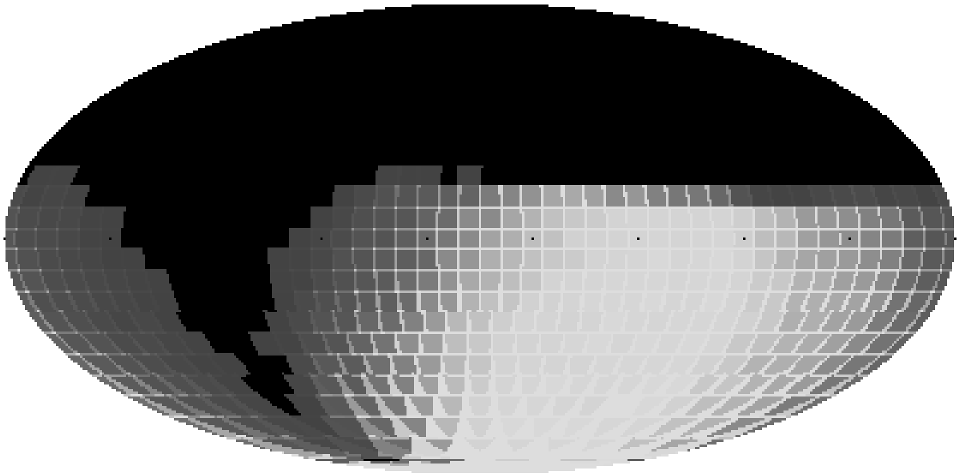
The whole sky has been divided into 709 8x8 deg fields of which 422 (60%) can be observed from Las Campanas (about 300 on single summer night).

The routine observing schedule for each wide-field camera consists of cycling through the list of fields and picking up the one that is the most suitable for observation at the moment.

Default exposure time for I systems is 2 minutes while for the wide-field V system - 3 minutes. Taking into account read-out and pointing time overhead we are capable to take between 160 and 200 frames per night for V system and between 230 and 300 frames per night for I systems (depending on the season). This means that we are covering the whole available sky in both filters each one or two days.

After the initiall period of the whole-sky data aquisition we will slightly change the above schedule to allow each field in turn to be searched for short-period variability too.

The ASAS-3 system is currently exposing about 600 frames per night, which means a raw data stream of 5 GB per night. The loss-less compresion reduces this stream to 2 GB per night (>1 DAT-3 tape per week), so we are considering some lossy compresion in future.



Rysunek 3: Coverage of the sky with observations after three month of ASAS-3 operation. White color corresponds to the area observed at least 70 times.

As for now (February 2001), after first months of unattended operation, over 400 fields were observed. 15000 frames from each of the wide-field I and Cassegrain I systems and 11000 frames from wide-field V system were collected, covering 95% of the observable sky on average nearly 40 times (Fig. 3).

6 First variables

Before the regular observing schedule has started we have collected several thousand images of various fields for the testing purposes. LMC field was used as a primary target for photometric tests. For a few nights this field was observed with 1 minute exposures by all three instruments. Data were reduced and analized by the default data processing pipe-line.

Although only very provisional search for variability has been performed, afew periodic and irregular variable stars have been immediately identified in the data (Fig. 4);

Figure 3 presents an example of 4 light curves of short period

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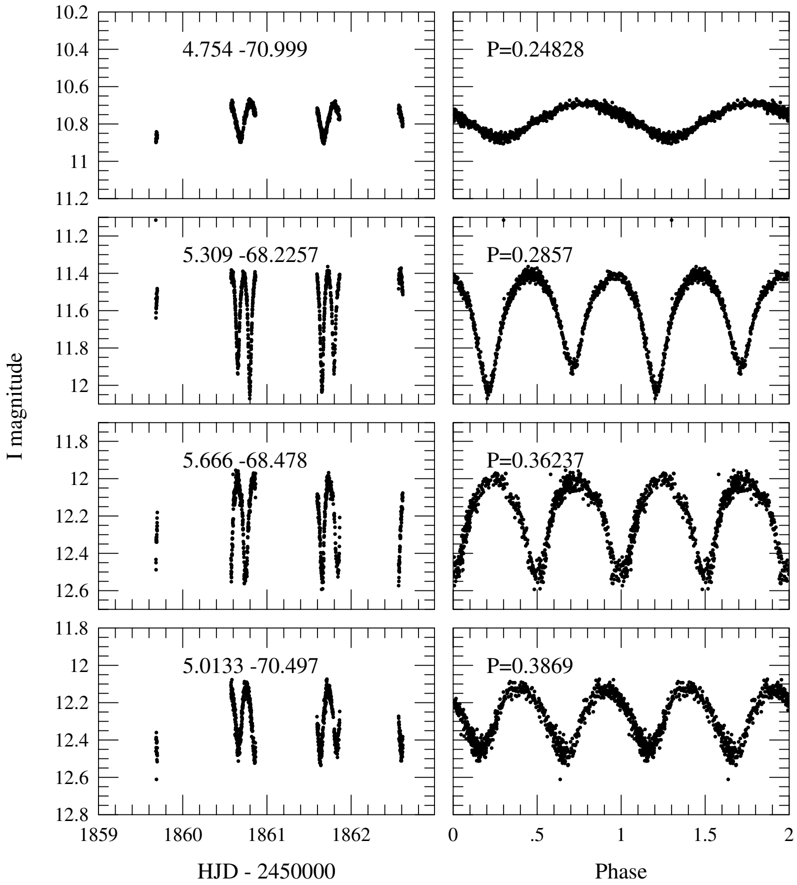

Rysunek 4: Variable stars observed by ASAS-3 instruments in the fields of LMC and SMC.

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