HISTORY AND STATUS

ASAS-3 site. In the background - Polish OGLE telescope.

The initial idea of the project was introduced in 1996 by Prof. Bohdan Paczynski of Princeton University. He saw a great need to create a system that would systematically monitor all bright objects on the whole sky.

One cannot possible underestimate the value of star catalogs that are complete spatially and in a given magnitude range. At the time, catalogs of variable stars were very incomplete: observations were carried out on random parts of the sky, with different equipment and methods.

At the same time, thanks to new observational techniques and faster computers, real-time data acquisition and analysis became possible.

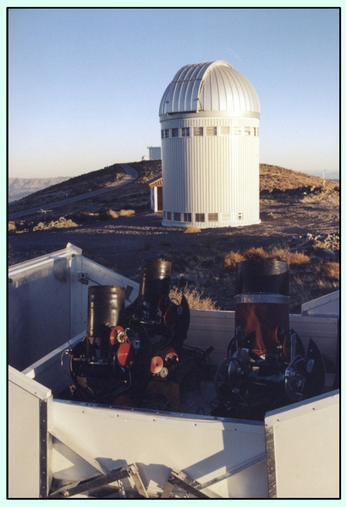
The Story

A uniform, whole-sky survey was what was needed, and by the end of the year 1996 ASAS-1, a prototype instrument developed by Dr. Grzegorz Pojmanski of Warsaw University Observatory, was ready and fully operational. It started its mission in April 1997 at the Las Campanas Observatory.

During the next stage of the project (ASAS-2) selected fields were observed for two years. The outcome of this project was the photometric I-band Catalog and almost 4,000 variable stars.

At the end of year 2000 the system was replaced with the ASAS-3 hardware. New, higher resolution CCD cameras were used and, at that time, four telescopes looked at the whole available sky. Two of them haven't passed the test of time and only the remaining two are working now.

Recently, in June 2006, two telescopes were placed on Haleakala, Hawaii (Maui island) to look at the northern sky. The system is a copy of the southern station but it has slightly better optics.



Four ASAS-3 telescopes and a dome of OGLE.

Sunset at the ASAS-3 site.

Current Status

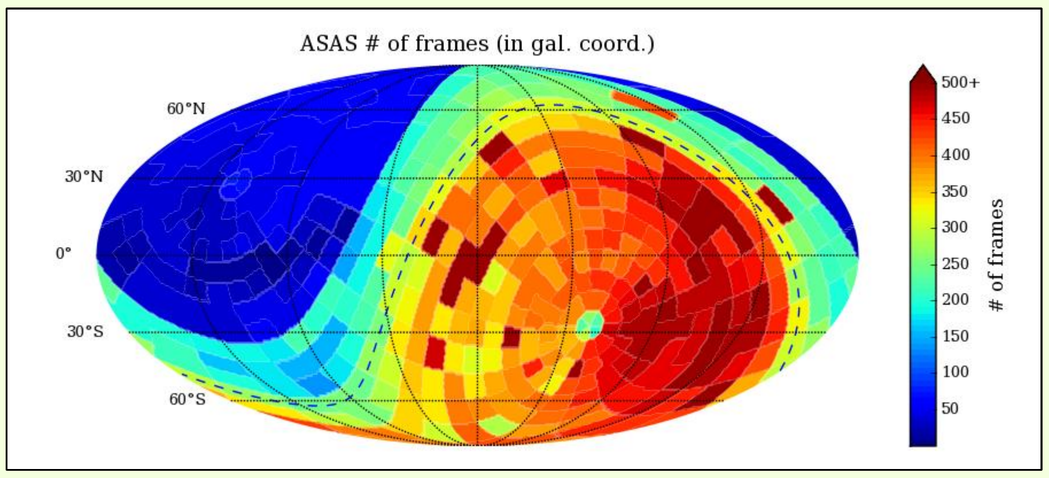
Presently, ASAS consists of four instruments divided equally between two sites: two telescopes are in LCO, Chile (since 2000) and the other two on Haleakala, Hawaii (since 2006). All of them are wide-field instruments equipped with I and V filters. Over 400,000 frames were gathered since the beginning of the project. For details see table below.

	ASAS-3	ASAS-3N
Location	Chile, LCO	Hawaii, Haleakala
Latitude	29.01°S	20.707083°N
Longitude	70.70139°W	156.25747°W
Altitude	2215 m	3056 m
# of t-scopes	2	2
Filters	V, I	V, I
Lens	200/2.8	200/2.0
FoV	8.5° x 8.5°	8.5° x 8.5°
CCD	2048 x 2048	2048 x 2048
Exp. Time	180s	180s
# of V frames	> 236,689	> 38,641
# of I frames	> 181,353	> 17,223

Two ASAS-3N telescopes located at Hawaii.

ASAS FACTS

Sky coverage:	south of declination +28° (full sky since June 2006)	**Number of stars observed:**	~20 million
Coverage rate:	once in 1-3 days	**Measurements per star:**	~400 (South) ~60 (North)
V-band range:	8 - 14 mag	**Found and classified variables:**	~50,000
I-band range:	7.5 – 13.5 mag	**Number of new variables:**	~39,000



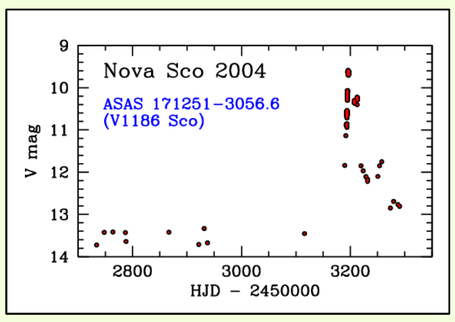
Distribution of the number of frames on the sky in galactic coordinates.

Alerts & Discoveries

In February, 2004, the ASAS data reduction pipeline started to release alerts on significant photometric changes of observed objects, and on any new events in the sky. The service includes monitoring of cataclysmic variables and minor planets identified with MPChecker, as well as all comet detections.

The alert service allowed for several real-time discoveries:

- 6 Novae (and 10 with prediscovery observations)
- 7 Dwarf Novae
- 2 Comets:
  - C/2004 R2 (ASAS)
  - C/2006 A1 (Pojmanski)



Nova Sco 2004 = ASAS 171251-3056.6 (V1186 Sco)

There is still more to be extracted from the ASAS data.

The image on the left-hand side is a single frame, which is quite noisy, and has a magnitude limit of about 14 mag.

About 250 frames were combined to create a higher resolution one on the right. The galaxies are seen more clearly and the magnitude range was increased to 17 mag.

A single ASAS frame.

About 250 combined frames.

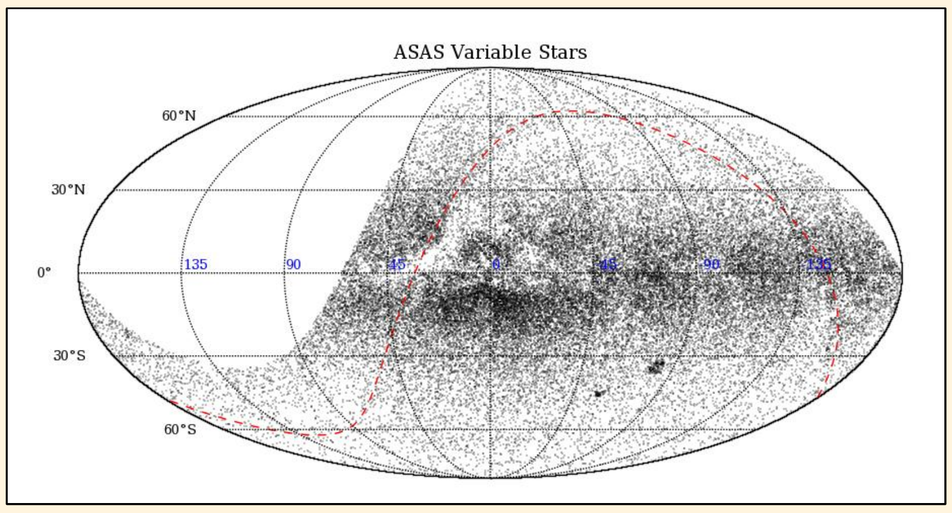
Variable sky in the eyes of

ASAS

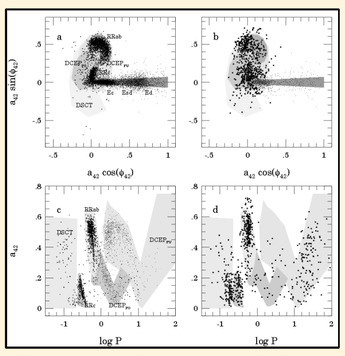
www.astrouw.edu.pl/asas

ACVS

In the year 2005, ASAS released the final part of the variable star V-band catalog of the sky visible from the southern station, ie. south of the declination +28°. About 3/4 of the sky has been examined and among 15,000,000 stars over 50,000 variables have been found. Almost 80% of them were new discoveries. The ASAS Catalog of Variable Stars (ACVS) is one of the main goals and one of the main achievements of the project.

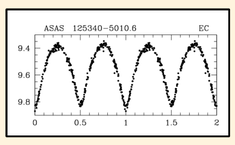


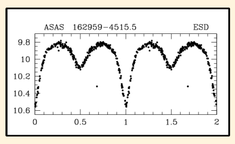
ASAS variable stars in galactic coordinates.

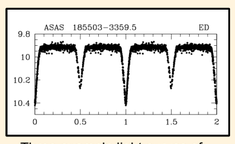


Fourier parameter planes used in the classification process.

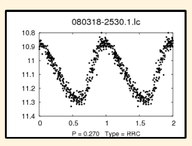
The ASAS-3 Catalog of Variable Stars contains over 10,000 eclipsing binaries (EC, ESD, ED), almost 8,000 periodic pulsating (RRab, RRc, DCEP, DSCT, MIRA and others) and over 31,000 irregular stars. The classification process is semi-automated. Variability type is assigned automatically, but needs to be approved by human eye. The procedure utilizes Fourier parameter planes (see figures) and external color information (from 2MASS).



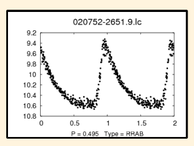




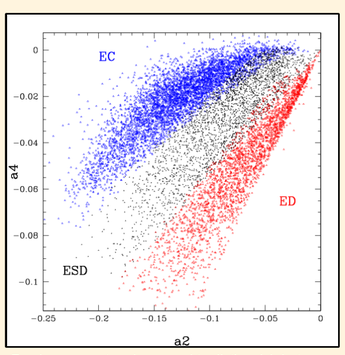
Three example light curves of eclipsing binaries: contact (top), semi-detached (middle) and detached (bottom).



RR Lyrae type *c*.



RR Lyrae type *ab*.



Fourier parameter plane used to distinguish between contact, semi-detached and detached binaries.

I-band

During the second stage of the ASAS project observations were carried out in the I-band filter. The data was then used to search for variability, which resulted in almost 4,000 variable stars including 382 periodic. Now, ASAS-3 I-band data is being processed and a new catalog is to be released. Over 100,000 variables are expected this time.

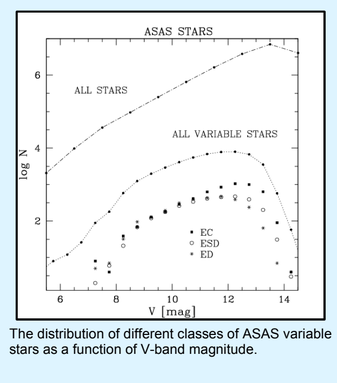
TYPE	#	NEW
EC	5,384	11%
ESD	2,949	17%
ED	2,743	31%
RRab	1,455	52%
RRc	757	17%
DCEP	1,176	42%
DSCT	1,272	6%
MIRA	2,895	79%
TOTAL	**18,631**	**20%**

DATA

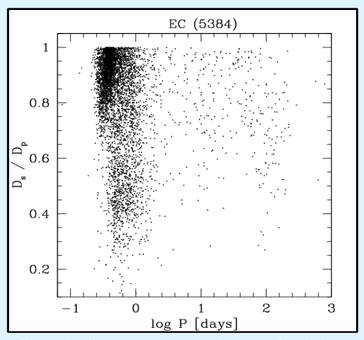
Although the ASAS project is primarily focused on searching for variability and preparation of the catalogs, some effort is placed in data analysis.

It started with the paper "Eclipsing binaries in the All Sky Automated Survey catalogue." (Paczynski et al. 2006). The aim was to introduce a vast and uniform catalog of the eclipsing variables, and perform statistical analysis on the ASAS binary sample.

One of the particularly surprising result was that there is no lack of contact binaries with poor thermal contact. As seen in the figure below (left) the majority of EC binaries are in good thermal contact with the depth of secondary eclipse almost the same as the primary. But there are many contact binaries that have both eclipses very unequal. Qualitatively, this is just what was expected in the models with relaxation oscillations (Lucy 1976, Flannery 1976, Robertson and Eggleton 1977, Yakut and Eggleton 2005).



The distribution of different classes of ASAS variable stars as a function of V-band magnitude.

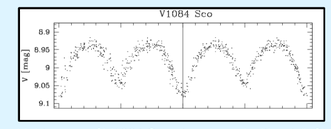


The ratio of eclipse depths as a function of period for contact binaries.

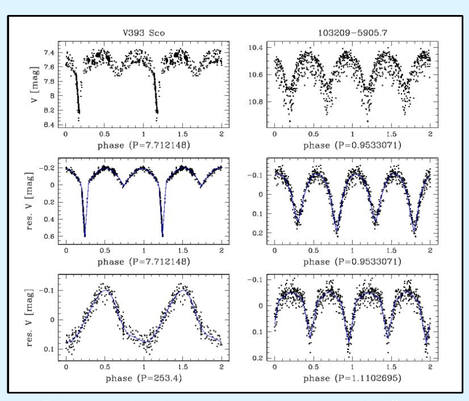
Using data presented in the above paper, Pilecki, Fabrycky and Poleski (2007) analyzed period changes in contact and semi-detached binaries ("ASAS Eclipsing Binaries with Observed High Period Change Rates"). They found 31 bright eclipsing stars (29 new) for which the change rate was high enough to be detected in relatively short 5-year observation period of ASAS. Quite surprisingly the orbital periods of only 10 binaries are increasing, while of 21 are decreasing. This inequality was then found to be present in the OGLE data. An interesting spectroscopic quadruple V1084 Sco exhibits both period change and brightness modulation.

In an IBVS article "13 New Binaries with Additional Variability in the ASAS Catalogue" (Pilecki & Szczygiel 2007) we investigated binaries with a complex variability behavior. When the main variability was removed a dozen of binaries have revealed an additional periodic variations.

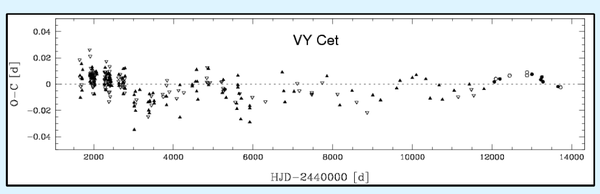
We found several possibly quadruple systems with two eclipsing binaries and stars with a mix of eclipsing and pulsating behavior.



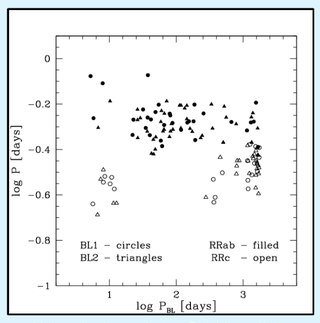
Light curve of V1084 Sco star phased without (left) and with (right) taking period change into account.



Eclipsing binaries showing either another eclipses with different period (right) or long-term pulsations (left).



O-C diagram of VY Cet star. ASAS minima times are marked with circles.



Main pulsation period vs. Blazhko period. The Blazhko periods of RRc stars exhibit a strongly bimodal distribution.

An analysis of the sample of pulsating RR Lyrae variables was performed in the paper "Multiperiodic Galactic field RR Lyrae stars in the ASAS catalogue" (Szczygiel and Fabrycky, 2007).

A deficiency of RRab Blazhko variables with main pulsation periods greater than 0.65 days was observed, and the Blazhko periods of RRc stars were noticed to exhibit a strongly bimodal distribution.

A very unusual object was discovered, namely ASAS 050747-3351.9 = SU Col, exhibiting Blazhko effect with multiple periods (89.3 d and 65.8 d and a candidate of 29.5 d), which may inspire new models of the Blazhko effect, that has eluded a consistent theory since its discovery about one hundred years ago.

Five new Galactic double mode pulsators (RRd) were discovered, four in the work mentioned above and one in the "ASAS 122801-2328.4 - A New Galactic Field RRd Star" (Pilecki & Szczygiel 2007).

It raised the number of ASAS discoveries of such objects to 17, out of 28 known in the field of our Galaxy.

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