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INVESTIGATION OF ASTEROIDS AT THE BULGARIAN NATIONAL OBSERVATORY: RESULTS AND PERSPECTIVES

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Abstract. The investigation of the Solar System bodies is traditional for astronomy in Bulgaria. New research possibilities, based on astronomical observations were opened with setting up the National Astronomical observatory -Rozhen. There are 3 optical telescopes as follows: 2m Ritchey-Chretien-Coude telescope, 50cm/70cm Schmidt telescope and 60cm Cassegrain equipped with single-channel photometer. All three telescopes, admittedly to a different extent, are used for observations of asteroids. 'Because of acute financial hardships, continuing nowadays, while the main instrument for observations of asteroids (Schmidt telescope) was out of work. By joint efforts of Bulgarian Academy of Sciences, Institute of Physics, Scopje and a Space Frontier Foundation grant a new CCD camera for this telescope was purchased. A summary of the results is presented here and the possibilities for integration with colleagues from other countries will be discussed.

1. INTRODUCTION

The institute of Astronomy of Bulgarian Academy of Sciences is the main center for astronomical observations and investigations in Bulgaria. There are seven thematic departments in structure of the Institute: Solar system, Sun, Nonstationary stars, Stellar atmospheres and envelopes, Chemically peculiar stars, Stellar clusters and Galaxies. Two observatories belong to the Institute of Astronomy: Rozhen National Observatory and Astronomical observatory in Belogradchik.

NAO-Rozhen is situated at altitude of 1750 m in Rodope Mountain. Its coordinates are: longitude – 24 $^\circ$ 44'30" and latitude – 41 $^\circ$ 41'39". These data for Belogradchik observatory are 610 m, 22 $^\circ$ 40'30" and 43 $^\circ$ 37'35" respectively.

60cm Cassegrain Telescope of AO Belogradchik has the same optical characteristics and photomultiplier. But there a CCD camera ST-8, Kodak KAF-1600, 1520×1020px^2 is in use.

Microdensitometers

The institute of Astronomy provides access to the microdensitometers (Joyce Loeble at NAO, PDS1010 in Sofia), as well as INTERNET access to a plate archive: "Data-base for wide-field astronomical images".

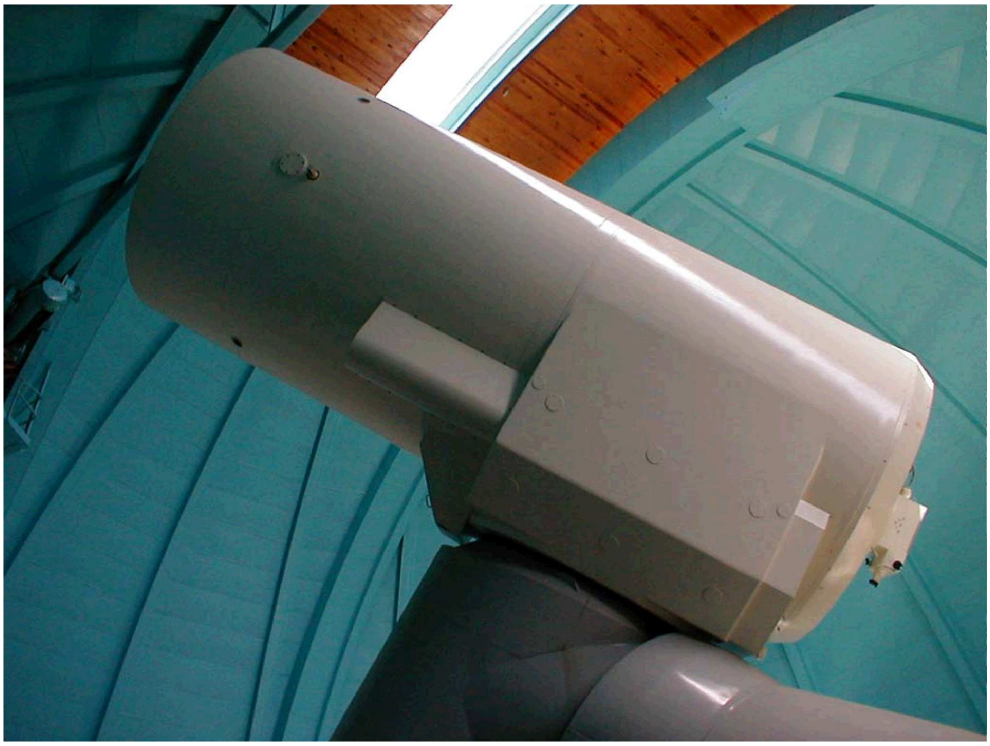


Figure 1: **NAO Rozhen**
2m Ritchey-Cretien-Coude telescope

RC
Field of view: $1^O \times 1^O$, (5.5'×5.5' with CCD)
Focal length: 16000mm
Resolution: 12.89"/mm

FoReRo (Focal Reducer Rozhen)
Field of view: $2.2^O \times 2.2^O$, (11.7'×11.7' with CCD)
Focal length: 7200mm
Resolution: 28.65"/mm

Coude Spectrograph
3 cameras 4A/mm, 9A/mm and 18A/mm respectively
Focal length: 72000mm

CCD camera - Photometrics CE200A-SITe,
1024×1024px2, 1px=24mm, cooling - liquid nitrogen

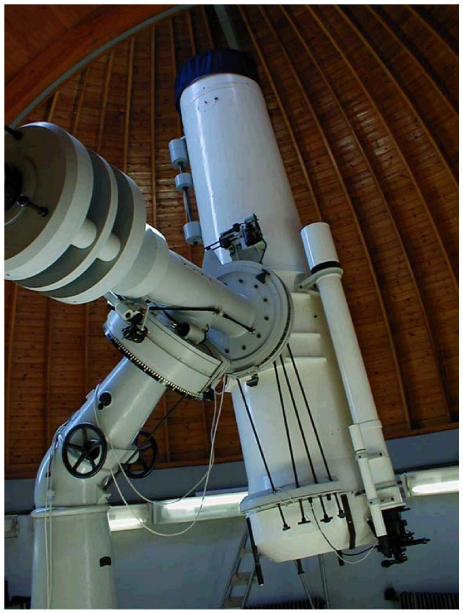


Figure 2: **0.50m/0.70m Schmidt Telescope**
Schmidt
Field of view: $5^O \times 5^O$ on plates
$16 \times 16 mm^2$
(27.6'×18.4' with CCD)
Focal length: 1720mm
Resolution: 120"/mm
CCD camera
ST-8E, Kodak KAF-1602E,
$1520 \times 1020 px^2$, 1px=9μm=1.1"

Figure 3: **60cm Cassegrain Telescope**
Cassegrain
Field of view: 20'×20'
Focal length: 7500mm
Resolution: 27"/mm
Limit magnitude: 13^m
Photomultiplier
EMI – 9789QA without cooling
Pulse counting system

2. INVESTIGATION OF THE SOLAR SYSTEM

The study of the Solar system bodies is traditional for the Astronomy in Bulgaria. New research possibilities, based on astronomical observations were opened with setting up the Rozhen National Astronomical Observatory.

All the three telescopes of the Observatory admittedly to a different extent are used for observations of asteroids, comets, and natural satellites of the planets.

2. 1. ASTROMETRY

Astrometric observations of small bodies of the Solar System form the first systematic observational program started at NAO Rozhen. Regular astrometric observations were begun in 1983, primarily with Schmidt telescope. Active observations were registered by Director of Minor Planet Center B. Marsden (Marsden 1983). The observations were made for new discoveries and for the needs of the Ephemerides

Survey. We have to mention especially our participation in the first international program for search of asteroids approaching the Earth - INAS (International Near Earth Survey). After an invitation by Prof. E. Helin (JPL), observing at Mount Palomar Observatory, to us and to Caussol (Observatory de la Cote d'Azur), we took part in this survey. NEO object 4486 Mithra was discovered in the frame of this program. Altogether, more than 100 new asteroids are discovered from NAO Rozhen.

Very successful was our participation in International Halley Watch in Astrometry and Large Scale Phenomena Disciplines.

During the International Halley Watch campaign in 1986 we began studies of physico-chemical processes in comets, continuing very successfully nowadays.

Here we present the number of the objects and positions taken over the years, as well as new discoveries.

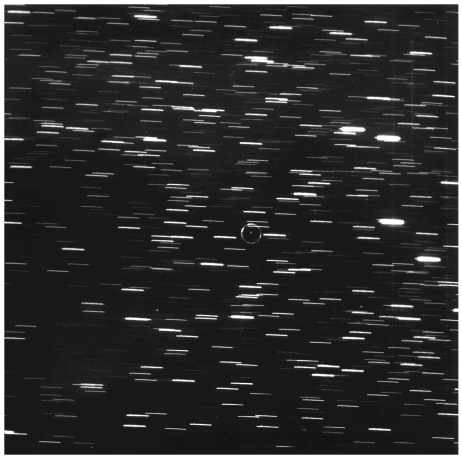
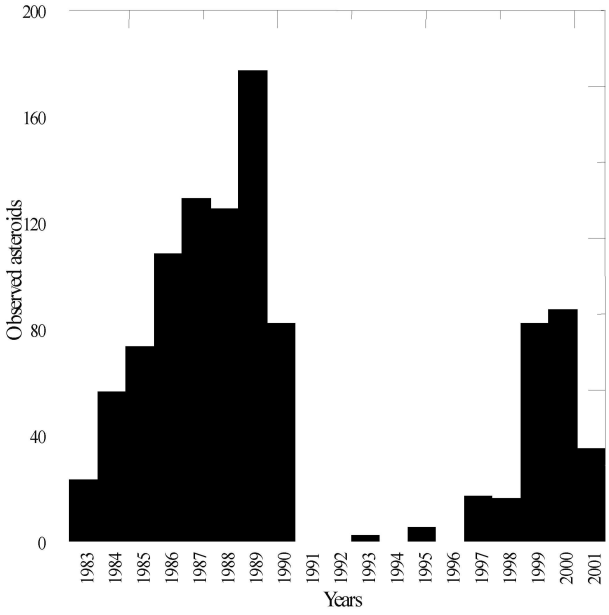
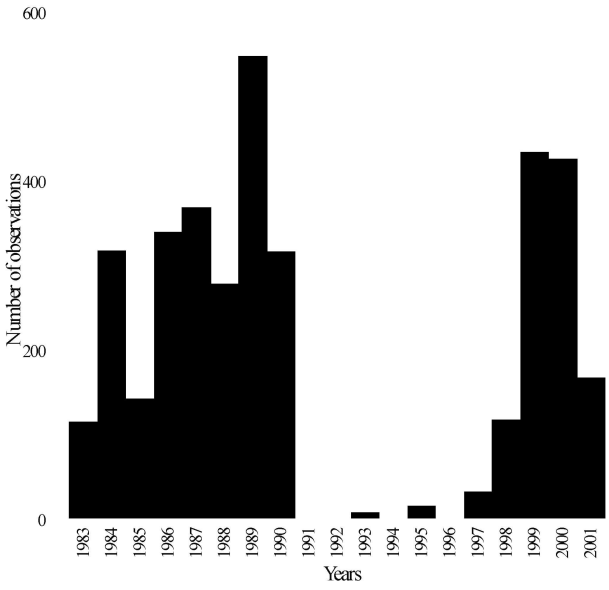


Figure 4: **Comet Halley - 25 November 1984**
This photography of Comet Halley was taken by Prof. V. Shkodrov and Dr. T. Bonev with 2m RC telescope on November 25th 1984, when its magnitude was approximately 22^m. This picture was one of the firsts taken in the world and the first in Europe during the last apparition of the Comet.

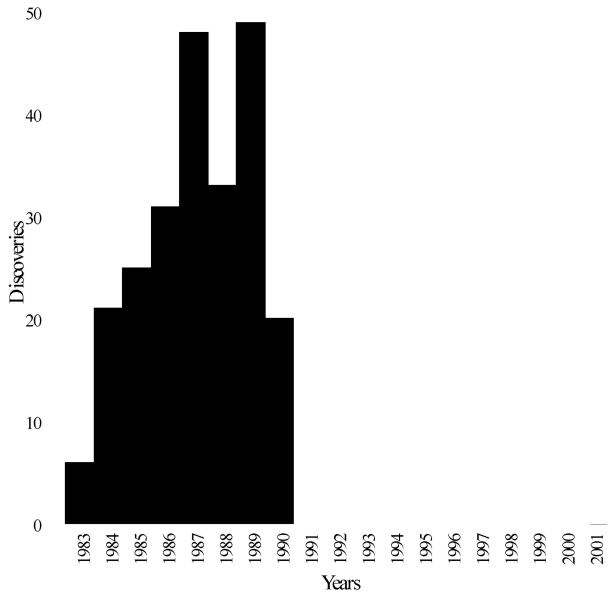
The lack of observations in the period 1990-1997 is due to the financial hardships, continuing nowadays, while the main instrument for positional observations was out of work. By joint efforts of Bulgarian Academy of Sciences, Institutes of Physics, Skopje and a Space Frontier Foundation grant a new CCD camera (ST-8E) and computers for observations and data reduction were purchased. The choice of CCD camera was accorded with our aims to work partially on two programs: follow up observations of NEOs and CCD photometry of asteroids. Camera SBIG ST-8E with pixel dimension 1μm and spatial resolution of 1.1" was the most efficient solution. As can be seen from figures, the small field of view with CCD camera is compensated with short time exposures, so the number of the observed positions with new technology is comparable with those taken by plates. Nevertheless, we consider that the small field of view is not so appropriate for new discoveries, and taking account of the importance of "follow up" of NEOs we intend in the future to make positional observations mainly of those objects. The number of observed objects and positions, during 2001, has decreased, because of beginning of active photometric observations with the Schmidt telescope.



Graph 1: **Observed asteroids**



Graph 2: **Number of observations**



Graph 3: **New discoveries**

Discovered Asteroids

3546	Atanasoff	9936	1986 PN
3860	Plovdiv	10059	1988 FS
3903	Kliment Ohridski	11852	1988 RD
4400	Bagryana	11846	
4477	1983 SB	11848	
4486	Mithra	11856	Stara planina
4891	Blaga	12246	1988 RJ
6636	1988 RK	13930	1988 RQ
9309		14342	1984 SL
9732	Juhnovski	14839	1988 RH

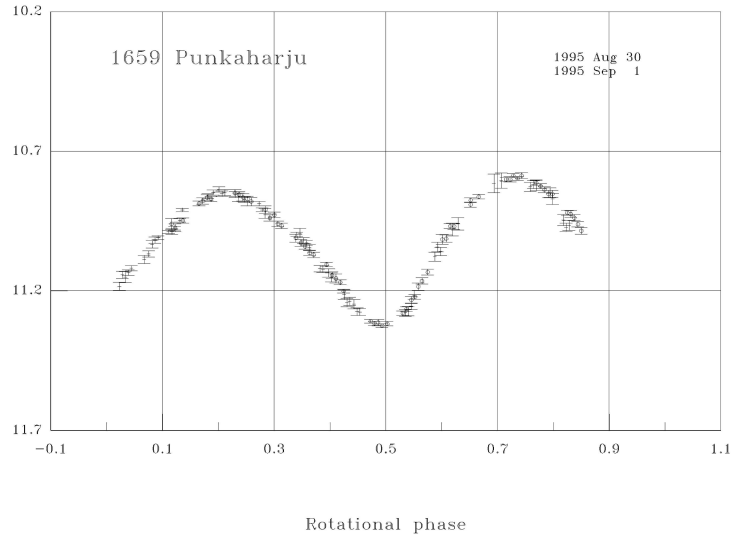
2. 2. PHOTOMETRY

Photoelectric observations started in 1991. P. Denchev made PDP (Photometric Data Processing) software.

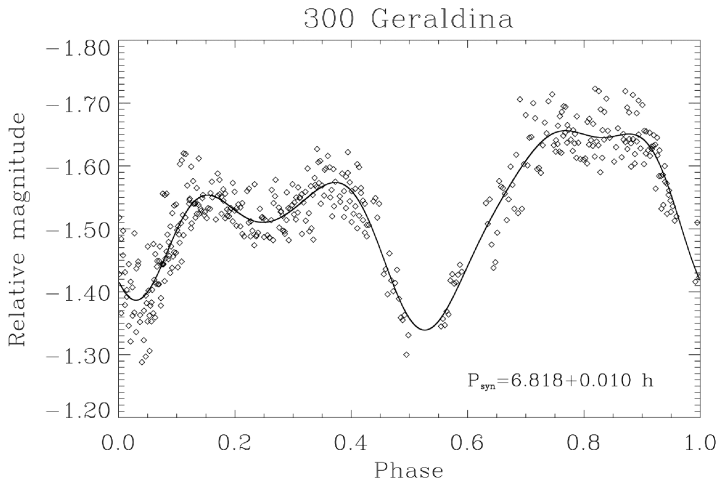
CCD observations started in:

- 1993 with the 2m RCC telescope (Geographos campaign)
- 2000 with the Schmidt telescope

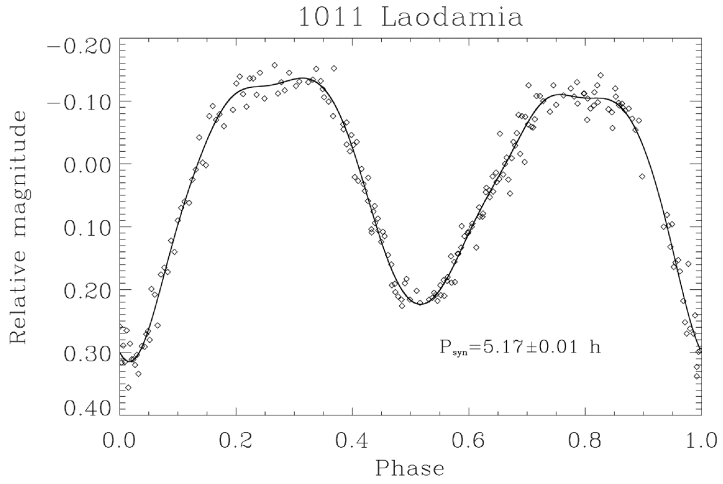
Here we present three light curves, taken with the telescopes of NAO-Rozhen. 1659 Punkaharyu was observed photoelectrically with 60 cm Cassegrain, 300 Geraldina and 1011 Laodamia were observed with CCD cameras attached to 2m RCC telescope and Schmidt telescope respectively.



Graph 4: Light-curve of 1659 Punkaharyu



Graph 5: Light curve of 300 Geraldina



Graph 6: Light curve of 1011 Laodamia

Astrometric and photometric programs afford opportunity to solve many problems, connected with the determination of the orbital and rotational parameters as well as the physical characteristics of asteroids. Both problems are of significant importance for understanding the evolution of the Solar System, clarifying the role of the impact processes in it as well as the structure of the asteroid belt.

For more efficient achievement of these goals, nowadays a scientific cooperation of astronomers from three Balkan countries (Bulgaria, Macedonia and Serbia) is being established. The observations, astrometric and photometric, will be made with the telescopes of NAO Rozhen, still the largest observatory in South-East Europe. This cooperation is opened for other countries as well.

References

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