Publ. Astron. Obs. Belgrade No. 65 (1999), 121 – 125 *Invited paper*

ACTIVITIES CONCERNING THE FOUNDATION OF A BALKAN CENTRE FOR NEOs

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Abstract. The idea of establishing a Balkan centre for detection of asteroid and comets potentially dangerous to human kind has been seriously considered since the first successful collaboration between the experienced Bulgarian group for the Sun system and astronomers from Macedonia. The National Astronomical Observatory at Rozhen (NAO) has been currently upgrading its facilities in order to start a new generation of asteroid discovery programs. The implementation of CCD on a Shmidt telescope has started CCD based projects for detection of the potentially dangerous asteroids and for providing a better estimate of the current near Earth object population. The observations have been performed by the Shmidt telescope (50/70), while for the case of fainter objects (m $\geq$ 13), they will be performed with Ritchey - Cretien (diameter 2 m) telescope with Photometrics CCD camera (1024x1024 px).

1. INTRODUCTION

A number of minor bodies (asteroids and comets)in the Solar system exist whose orbits intersect or pass close to that of the Earth (Near Earth Objects or NEOs). The possibility therefore exists that some of these bodies may impact on Earth sometime in the future, as has happened a number of times in the past as shown by the geological record. Especially the risk for impact arise for the Potentially Hazardous Asteroids (PHAs)- objects larger than 1 km in diameter and approaching the Earth at distance smaller than 0,5 AU. The existence of such a risk is attracting increasing attention from the public and the media. The IAU encourages all countries of the world to contribute to the effort of charting the NEO population and the practical execution of it's policy is organised by the IAU Working Group on NEOs of IAU Division III and the IAU Minor Planet Center. Search programmes to chart the NEO population have recently increased greatly in efficiency due to the use of modern wide-field detector technology and advanced data processing techniques. Positions of moving objects are

being rapidly compared to the data base of existing observations and either assigned to known bodies or labelled as new discoveries. When a few accurate positions of an object have been accumulated over a period of weeks or months, a preliminary orbit can be computed. This orbit is then used to (i): Predict where follow-up observations can be made in the near future to improve the determination of the orbit, size, and physical characteristics of the object, and (ii): compute the trajectory of the body far into the future to check for any close approaches to earth. In such cases, the object in question will of course be followed with particular attention in order to reduce the uncertainty of its predicted future course.

Several observatories around the world are currently upgrading their facilities in order to start a new generation of asteroid discovery programs. Since 1989, the Spacewatch group in Tucson has shown very clearly that CCDs were detecting moving sources, such as asteroids, much more efficiently than photographic plates. The primary goal of Spacewatch is to explore the various populations of small objects in the solar system, and study the statistics of asteroids and comets in order to investigate the dynamical evolution of the solar system. Spacewatch also finds potential targets for space missions, provides astrometric support for spacecraft mission planning, and finds objects that might present a hazard to the Earth. The first change produsedby this camera is that 80 percent of the requested oberving programs are now CCD-based programs, even though the field of this camera is, so far, only 1 per cent that of photographic emulsion. EUNEASO -which stands for EUropean Near-Earth Asteroids Search Observatories is a cooperation between European institutes working in the field of asteroid research to organize a large-scale NEO search, follow-up and physical observation programme. O.D.A.S. (OCA-DLR Asteroid Survey, it's operated at the 90 cm Scmidt-telescope at Calern, north of Nice, and the DLR Institute of Planetary Exploration, Berlin) is a dedicated programme to search for asteroids and comets, with special emphasis on NEO's within the framework of the EUNEASO project, in cooperation and support of global efforts in NEO-research, initiated by the Spaceguard Foundation.

2. OBSERVATIONS OF ASTEROIDS AND COMETS AT BULGARIAN NATIONAL OBSERVATORY – ROZHEN

Observations of asteroids and comets at NAO-Rozhen began in 1983. Much earlier started the preparation for this activity - the choice the objects to be observed and suitable observational methodology; creating the reduction software as well as such for interpretation of the results. The Shmidt telescope at National Astronomical Observatory at Rozhen has a diametar of the main mirror 70 cm, a radius of the fokal surface of 172 cm, and has a wide field 5 x 5 degrees. It worked with photographigs plates with dimensions 16x16 cm. With the time of exposition 45 minutes was possible to achieve 19,5 m magnitude. A single photograph from one of the large Schmidts contains about a bilion pixels; more practically, each deep exposure records between 100 000 and 1 000 000 images of stars and galaxies. This limited early work to visual inspection of the atlas prints, or to detailed study of very small regions. To exploit the power of the Scmidts properly required the development of very fast automatic plate measuring mashines.

There is a wealth of useful information in Schmidt plate archives pertaining to earlier detections of asteroids and comets. Astrometric measurments of those plates can lead to the rapid determination of accurate orbits for newlyrecognized objects. Inspection of the images may lead to discoveries of physical importance. Comets and asteroids were previously thought to be two completely distinct groups of solar system objects. A comet is operationally defined by the presence of a coma, while an asteroid has no coma. However, recent observations have shown that comets can sometimes take on asteroidal appearances and even asteroidal photometric behavior.

The great revolution in the utilisation of the Shmidt telescope was the appearance of large two-dimensional charge-coupled devices (CCDs). Placed at the focus of a telescope, one gets an electric image of the field of view. CCDs contain an imaging area, a serial register, and an amplifier. The camera electronics shift the image into the serial register line by line, and then shift charge packets one at a time to the amplifier. The amplifier measures the charge delivered to it and generates a voltage proportional to the amount of light that fell on the photosites. A digitized image consisting of a distribution of intesities all over the plate is built up in a compjuter, which is similar to the intensity distribution that is obtained by scanning a photogrphic plate with a measuring mashine equipped with microdensitometers. The output from a CCD consists of a mixture of the desired signal caused by light and an unwanted thermal signal. At room temperature, thermal electrons can fill the potential wells within a few seconds. When this happens, the chip is "saturated", but by cooling the CCD to a temperature of -25 degree Celsius, the number of thermal electrons is reduced by factor of 300, thus making exposure times of several minutes possible. In most CCD cameras, cooling is accomplished by mounting the CCD chip on a thermoelectric cooler, or Peltier - effect junction (as in our case with the Schmidt telescope, where the limited temperature interval is 50 degrees).

The regular observations of comets and asteroids at NAO Rozhen, made with ORWO ZU-21 astroplates, started in the autumn of 1983 in the frame of two international programs. First one was "Observations of asteroids for the purposes of ephemeris calculations - improvement of their orbits" in cooperation with the Institute of Theoretical Astronomy - Sanct Peterburg and observations in the frame of the first international programs for search of NEAs - International Near-Earth Asteroid Survey". The coordinator of INEAS was Eleanor Helin (JPL) and participating observatories were Palomar Observatory - California, Rozhen Observatory - Bulgaria and Observatory de la Cote d'Azur - France. 50/70 Schmidt telescope was used primary for these observations, very suitable for watching the scy with it's large field of view -5x5 degrees. Rarely only for some fainter objects, 2-m telescope - the bigest telescope in South-East Europa, with field of view 1x1 degrees was also used.

These observations continued intensive until 1987. Main observers were V. Ivanova, V. Shkodrov and A. Georgieva. More than 100 new minor planets were discovered and more than 20 have now permanent numbers. Since 1990 activity of positional observations decreased, because of lack of astroplates and suitable CCD camera for Schmidt telescope.

In July 1998 a ST-6 CCD camera was attached to Schmidt telescope and regular observations started again. A a result, Schmidt telescopes can now be used as primary

research telescopes in their own right for a multitude of projects, ranging from the study of the universe on the largest scales, by mapping out the distribution of quasars and galaxies, to a census of asteroids in our immediate vicinity in the solar system.St-6 camera has a size of 375x242 pxl and field of view is 17,2x13, 1'. This field is too small for search of new asteroids, but permits to conduct "follow up" observations of NEOs. At NEODys (Near Earth Objects dynamic site **http://newton.dm.unipi.it/cgi-neo/neoibo?sites_list**) have been published 257 CCD observations of NAO Roshen which code is 071 (Smolyan). Since August 1998 until June 1999 for improvement of the orbits of 56 objects, 245 observations made at Rozhen observatory at MPC (Minor Planet Circulars) have been cited. As the discovery rate of faint NEAs increase we have to equip Schmidt telescope with more effective CCD camera and in some case to use 2m telescope where a Photometrics CCD is available.

The preliminary preparation of follow up observations contains three steps: choise of the objects to be observed, calculations of ephemerides of chosen unusual objects and making charts for observations.

The data needed are acquired from the website of Minor Planet Center, Cambridge, USA, (http://cfa-www.harvard.edu.).We are especially interested in objects which have small numbers of observations and their orbital elements haven't been accurately determined. With orbital elements taken from MPC and using WET software we calculate the ephemerides for the object which according to it's motion have different time-step. Using GSC (Guide Star Catalog)we make the chart for observations and the scale of the chart is depending on the scale of the telescope, which will be used.

For processing of the images the observer must take additional images, called: Dark exposure and Flat field. The dark images must be taken with the same exposure of the images with the objects. Subtracting the dark frame removes thermal and bias signals. Dividing by a flat field frame removes sensitivity variations. The calibrated image is a faithful record of the light that fell on the CCD during the exposure of the raw image. After the primary processing we using software ASTROMETRICA to blink compare images to search for moving objects.The determination of asteroid's coordinates is possible by the selection of maximum 12 reference stars, which is done with CCD image displayed simultaneosly with a star chart based on the USNO-A2.0 oriented and scaled to match the CCD image. We have used the USNO-A2.0 the larg star catalog, which includes astrometric and photometric data on nearly half bilion stars, from the brightest naked eye stars down to magnitude 23. After the last step, conversion of x, y, values and fluxes into right ascensions, declinations and magnitudes, obtained coordinates of the object must be send to Minor Planet Center, as soon as possible.

Positional observations are only a part of the researches made at the Institute of Astronomy, Sector "Solar system". Photometric observations of asteroids in order their period of rotation and other rotational characteristics to be determined are also carrying out, as well as photometric observations of the comets. For this purpose 60 cm Cassegrain telescope and 2-m telescope at National observatory are used.

3. CONCLUSION

The implementation of ST-6 CCD camera on a Schmidt telescope have been provided regular and numerous observations. Since August 1998 until September 1999 have been published 257 CCD observations. In the same period for improvement of the orbits of 56 objects, 245 observations made at Rozhen observatory at MPC (Minor Planet Circulars) have been cited.

We have to mention that positional observations and photometrics observations with Schmidt telescope would be much more effective by the use of CCD camera with larger size and higher efficiency.

Because the mutual collaboration had started and the first results had been achieved, the idea for establishing a Balkan astronomical center for detection of asteroids and comets potentially dangerous to human kind appears as a reality.

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