OBSERVATIONS OF SPACE DEBRIS IN GEO

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INTRODUCTION

Regular observations by CCD-cameras of space debris in a geostationary orbit were started in Terskol and Zvenigorod observatories of Institute of Astronomy of Russian Academy of Sciences (INASAN). Current primary tasks: regular GEO monitoring, discovery and tracking of new objects, photometry of tracked objects. Works are spent in close cooperation with Pulkovo Observatory and Keldysh Institute of Applied Mathematics of RAS (KIAM). Most of the space debris's research activities are coordinated by V. Agapov of KIAM when there were organized International Scientific Optical Network (ISON). New instruments to observe space debris in Zvenigorod and Terskol observatories are installed in 2009. Observations are performed using GPS-timing system and APEX software package for CCD frame processing and camera control developed in Pulkovo observatory of RAS [1], [2].

TERSKOL OBSERVATORY

Terskol observatory located in Kabardino-Balkaria Republic of Russia (φ = +43^0 16' N, λ = 2h 50m E, H = 3100 m) near the Elbrus mountings (Fig. 1). Main researches are conducted on Zeiss-2000 telescope [3]. A view of the telescope is given in Fig. 2. Till 2009 we have used focal reducer of Max-Planck-Institute (MPAe, Germany) with CCD camera of "FOTOMETRICs" (Fig. 3). In 2009 we installed CCD camera FLI PL4301 on the RC focal plane. Old and new CCD-camera's parameters are given on the table 1. Many fragments of space debris, not presented in catalogues are found out. E.g. unknown fragment of 18 star mag. with high AMR was detected on May 20, 2007. During next four nights about 400 positions of this object were measured. Mean elements of orbit at the Epoche 21.05.2007 (MJD = 54241.0) are: e = 0.0166364, i = 9.74924 deg, Ω = 330.46317 deg, ω = 208.20954 deg, M = 124.84926 deg, n = 1.004220328 rev/ day, AMR - ~2 m^2/kg. Brightness changes are given in Fig.4. Later this object was catalogued in KIAM as fragment number 90060.

Fig. 1. Dome of the Zeiss-2000 telescope. On the background – Elbrus mountings' peaks.

Proc. '5th European Conference on Space Debris', Darmstadt, Germany
30 March – 2 April 2009, (ESA SP-672, July 2009)

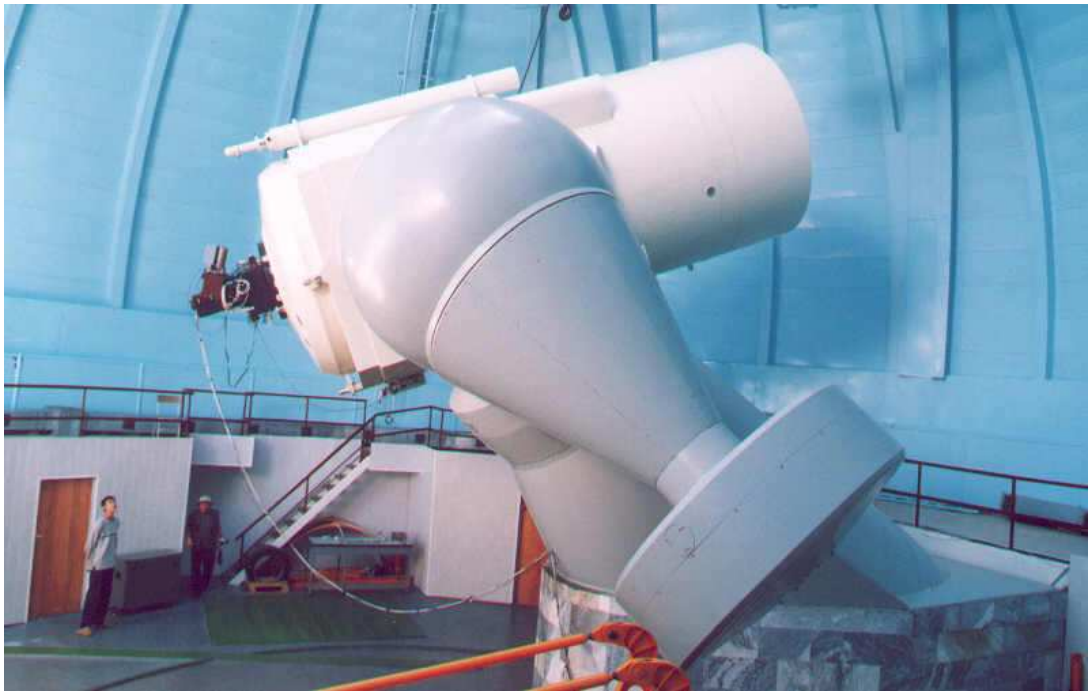

Fig. 2. Zeiss-2000 telescope of the Terskol observatory.

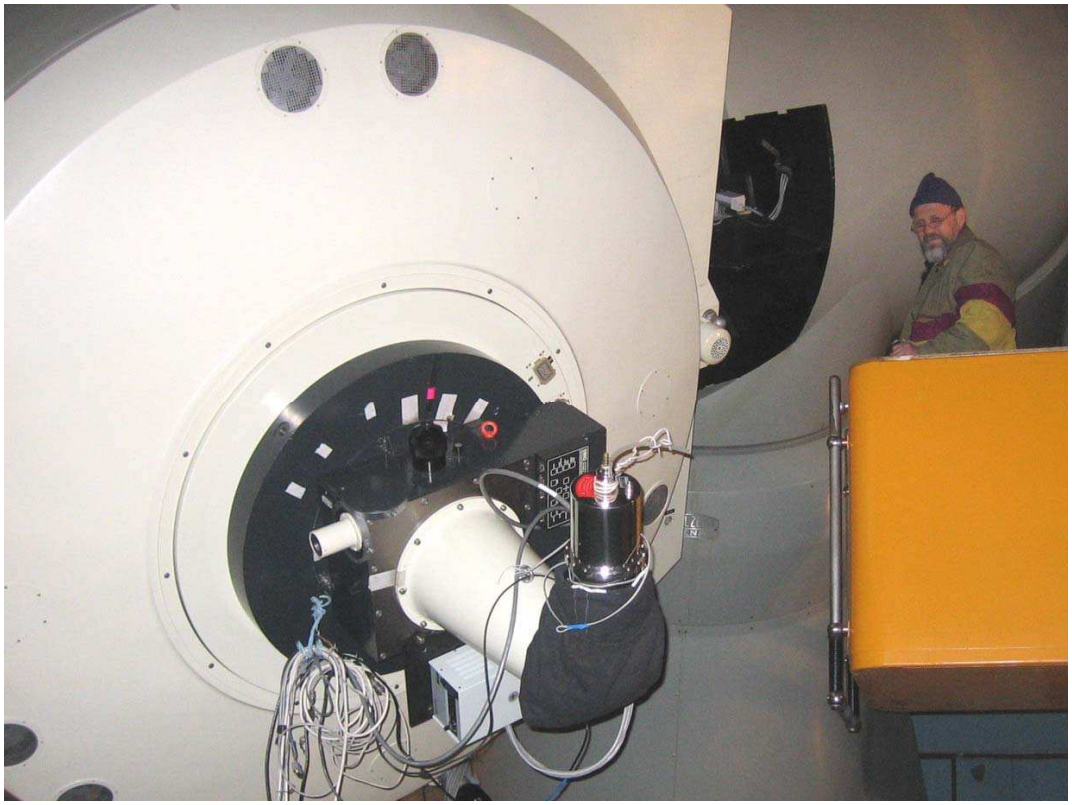

Fig. 3. Focal reducer of Max-Planck-Institute (MPAe, Germany) with CCD camera of "FOTOMETRICs" .

Table 1. Parameters of the old and new CCD-cameras of the Zeiss-2000 telescope.

	CCD camera of "FOTOMETRICs" with the focal reducer	CCD camera FLI PL 4301 in the RC focus
Aperture	2 m	2 m
Focal length	~6.3 m	16 m
CCD size	561 x 512 pixels	2084 x 2084 pixels
Pixel size	~27 x 27 mkm	24 x 24 mkm
Field of view	8 x 8 arcmin	~ 12 x 12 arcmin
Read-out time	10 – 20 sec	2 – 5 sec
Detection threshold on GEO	20 mag	21 mag

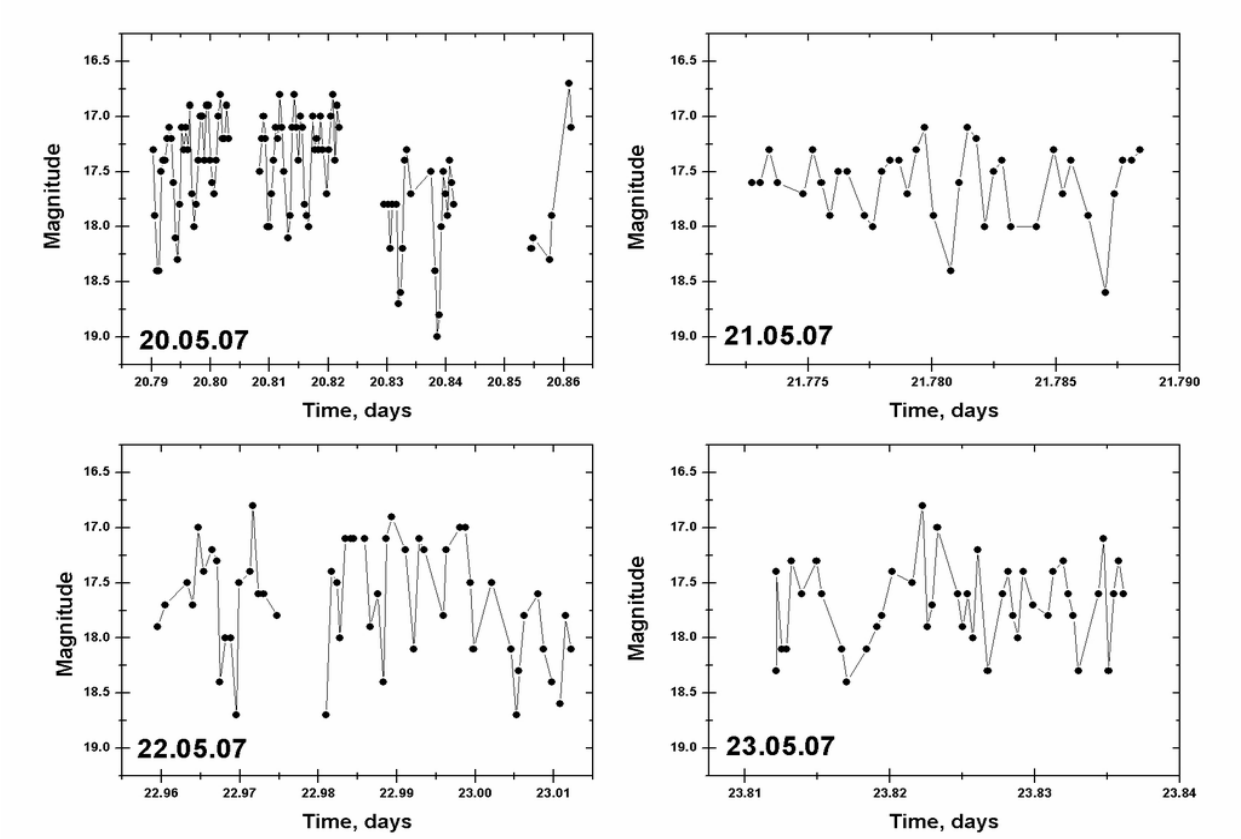

Fig. 4. Brightness changes of the unknown small-size GEO object, detected in Terskol observatory.

NEW EQUIPMENT IN ZVENIGOROD OBSERVATORY

Zvenigorod observatory is located in 40 km from Moscow ($\varphi = +55^0\,41'$ N, $\lambda = 2$ h 27 m E, H = 180 m). The observatory is one of the oldest optical satellite tracking stations and operates since 1959 (Fig. 5). Most of the satellite tracking instruments (there are 8 optical instruments with the aperture more than 20 cm) now not used in space debris researches.

Photographic camera VAU for the satellite observations was installed in 1969. VAU has Maksutov's system optics witch installed on three-axis mount (Fig. 6). High accuracy tracking speed is possible in four bands: 0 – 6, 6 – 60, 60 – 600, 600-6000 arcsec per sec. Now we have replaced front guide-telescope of VAU with wide-angle Hamilton's camera produced by A. Sankovitch in OOO "Suntel-M" (with the CCD-camera Fli PL9000). The parameters of the VAU and new Hamilton's camera are given on the table 2.

Fig. 5. A view of the Zvenigorod observatory of INASAN.

Fig. 6. VAU camera of the Zvenigorod observatory. Origin view before installation of the Hamilton's camera.

Table 2. Parameters of the VAU and Hamilton's camera.

	VAU (1969-2005)	Hamilton's camera (2009)
D of main mirror	100cm	50cm
Aperture	50 cm	50 cm
Focal length	70 cm	125 cm
Detector	Film	CCD-CAMERA FLI PL9000
CCD size	-	3056 x 3056 pixels
Pixel size	-	12 x 12 mkm
Field of view	30 x 5 deg	1.65 x 1.65 deg
Detection threshold on GEO	15 mag	Up to 18 mag

SUMMARY

New techniques for space debris researches being developed in the Institute of Astronomy in 2008. Wide angle 50-cm aperture telescope with the 3 K x 3 K CCD camera installed on the three axis tracking mount of VAU camera in Zvenigorod observatory. Now it is possible to observe faint space debris in GEO, GTO, HEO and MEO. Zeiss-2000 telescope of the Terskol observatory is equipped by new CCD camera FLI PL 4301 (2 K x 2 K, pixel size 24 mkm x 24 mkm) witch increase an efficiency of the space debris's observations four-five times.

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