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OBSERVATION OF SPACE DEBRIS IN TARIJA'S OBSERVATORY, BOLIVIA IN THE FRAME OF THE PROGRAM ISON (INTERNATIONAL SCIENTIFIC OPTICAL NETWORK)

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RESUMEN

El Observatorio Astronómico Nacional de Tarija, Bolivia con los telescopios que cuenta y en cooperación con la Red Internacional (ISON) en septiembre y octubre de 2005 llevaron a cabo observaciones experimentales de detección de basura espacial en la órbita más poblada, la geoestacionaria, debido al mayor número de satélites que se han puesto en órbita. A partir de octubre de 2006 se realizan observaciones regulares con el Astrógrafo de 23 cm y cámara CCD; posteriormente se instaló un nuevo y especial telescopio para este fin, el Sigma Ori 25. A la fecha se están realizando trabajos en mejoras de la parte mecánica y óptica además de la automatización del Zeiss 600 para incluirlo en este programa de observación.

ABSTRACT

The National Astronomical Observatory of Tarija, Bolivia with its telescopes and in cooperation with the International Network (ISON), carried out experimental observations of space debris detection in September and October 2005 in the most populated orbit, the geostationary one, which is where most satellites have been launched. From October 2006 regular observations are carried out with the Astrograph of 23 cm and the CCD camera. Later, a new and special telescope for this purpose was installed: the Sigma Ori 25. At present work is underway on improvements in the mechanical and optical automation of the Zeiss 600 for inclusion in this monitoring program.

Key Words: space vehicles

1. OBSERVING SPACE DEBRIS

The observation and investigation of artificial objects in orbits near our planet started from the moment the first artificial satellite "Sputnik 1" by the former USSR was launched on October 4, 1957. These observations were made in order to determine model parameters of movement, dynamic studies of these devices and the improvement of astrometric and photometric methods. But then there were no systematic research on the problem of filling an orbit around the Earth's with space debris.

Space debris is the multitude of other useless objects that orbit the earth in different orbits. They include, old satellites, which have ceased operations and cannot correct their orbit, the resulting fragments of exploded spacecraft, rockets, and ever more fragments of collisions, which create a threat too dangerous for future space flight.

Space debris is dangerous especially for active satellites located in geostationary orbits, which are becoming more numerous. These are satellites used for television transmission of communication, satellite links, and satellites used to monitor our planet, as well as weather satellites, etc. For this reason the study of these objects is important and astronomical methods provide the accuracy needed. As a general rule all active satellites are useful: they can correct their orbits within certain limits, knowing that if a piece of space debris approaches this active satellite, it is possible to avoid the collision, and, as the flight controller at an airport direct the satellite to avoid collisions.

For this reason is necessary to regularly monitor these fragments because their orbits change under the action of gravitational fields, solar wind action and also and also by the action of collision or approach with meteorites.

Considering the increasing problem of space debris, the Russian Academy of Sciences in February 2001 commissioned the Research Institute of Applied Mathematics Keldysh of Moscow to plan and to create a center for collection, conservation, calculation and analysis of information on space debris. For this purpose ISON was organized.

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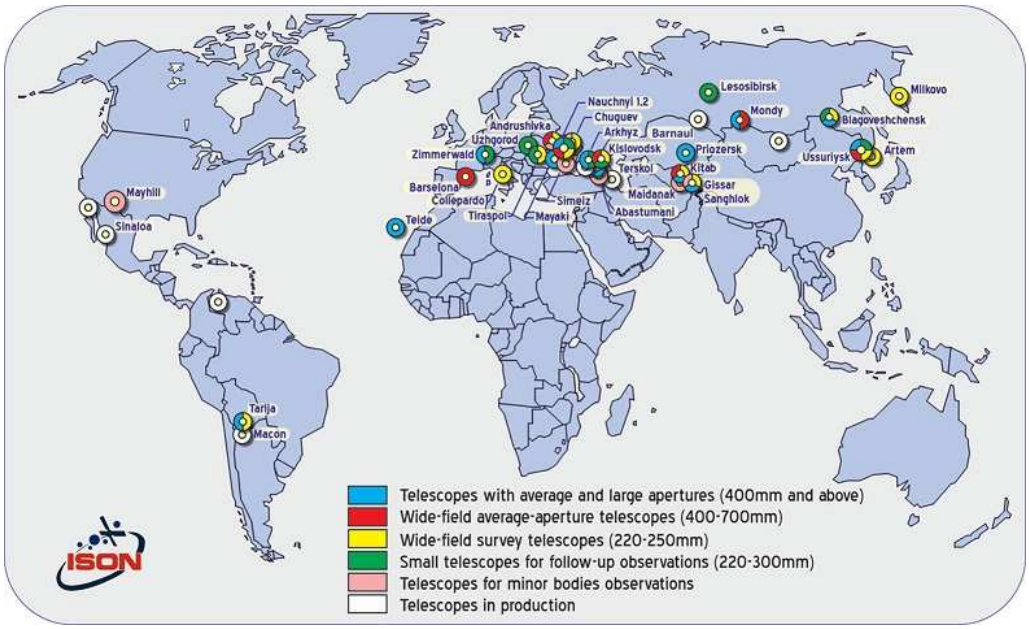

Fig. 1. ISON - International Scientific Optical Network.

2. INTERNATIONAL SCIENTIFIC OPTICAL NETWORK (ISON)

• It is an open, non-government scientific project having as goals
- to provide reliable scientific output on space debris, asteroids and GRB afterglows,
- to support the astronomical observatories of Former Soviet Union (FSU) countries and to involve amateur astronomers in scientific activities,
- to improve the international collaboration between FSU observatories and scientific organization in other countries,

• This cooperation already joins 23 observation facilities of various affiliations (Academy of Sciences, Universities, Scientific Institutions, Commercial Companies, Privates) coordinated by the Keldysh Institute of Applied Mathematics of the Russian Academy of Sciences (KIAM).

3. MAJOR TASKS OF ISON

The major tasks of ISON are as follows. Participation in the control of outer space. Observation and study of near-Earth asteroids. Continuous observation of fragments of space debris in the whole geostationary zone. Uniform supply of the data stream independent of the season (installation of monitoring stations in the Southern Hemisphere). Improving the quality of work in discovering and monitoring these objects.

4. ISON INTERNATIONAL COOPERATION

• ISON collaborates now with institutions of 11 countries – Bolivia, Georgia, Moldova, Italy, Russia, Spain (ESA), Switzerland, in September and October 2005 Tajikistan, Ukraine, USA, Uzbekistan (Figure 1).

• Preparatory work has started to involve Armenia, Kazakhstan, Mexico, Mongolia, Venezuela.

• Negotiations are being carried out with Argentina, Brazil, Latvia, Vietnam, Organization of United Nations.

5. ISON STRUCTURE AND TASKS

Optical facilities can be separated in four subsets:

• a subsystem for surveys of the GEO region (down to 16 m)

• a subsystem for tracking the high orbit faint (fainter than 16 m) space debris at GEO and GTO

• a subsystem for tracking bright GEO and HEO objects

• a subsystem for asteroid research

Current primary tasks are: regular GEO monitoring, new GEO and GTO faint objects, discovering and tracking, maintenance of as complete GEO objects database as possible, KIAM coordinates activities and analysis of measurements.

6. PRINCIPAL STAGES OF THE PROJECT ISON

– May 2001, first observations in Pulkovo.
– August 2004, experimental observations of space

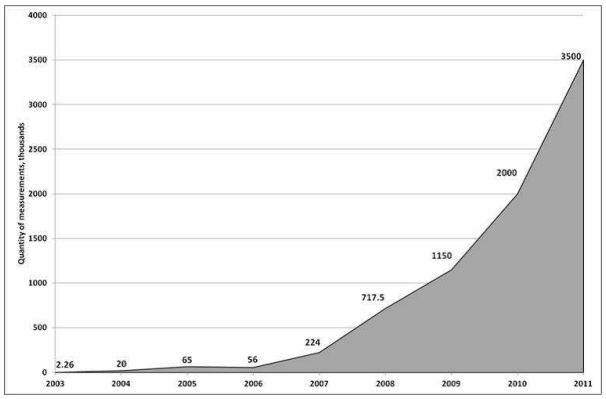

Fig. 2. Quantity of measurements accumulated by ISON instruments (by year).

debris fragments in Crimea and start of the international campaign of observations.
– 2005–2006 CCD cameras supply and manufacture of new telescopes.
– 2007–2008 beginning of regular observations, covering the entire geostationary orbit (Agapov & Molotov 2008).
– 2009–20010 creation of the organization "Scientific Center Technical Project" that gives major impulse to the project ISON.

In 5 years, establishment of the Global ISON, becoming a great tool for observation of space debris, involving 27 observatories in 12 countries with different telescopes (19 cm to 2.6 meters), 25 new telescopes and 10 mounts were manufactured and installed. CCD cameras were purchased and 40 software appropriate to the project were developed. We achieved the observation of the whole area in the 360° orbit. A regular search for new asteroids was carried out. It was planned to double the productivity of the network-based ISON installation of new telescopes (see Figure 2; Agapov & Molotov 2011).

7. OBSERVING SPATIAL DEBRIS FROM TARIJA'S OBSERVATORY

The space debris is a problem increasingly delicate. An unknown quantity, but certainly a growing junk is surrounding the Earth. With the telescopes that our observatory has and with the support of the group of investigators of Russia "Pulkovo cooperation in optical observations" in September and October 2005 we performed experimental observations of detection of these wastes in the most populated orbit, the geostationary one, since it contains the major number of satellites that have put in orbit. Debris is also present in the polar orbits, though in minor numbers.

Fig. 3. Telescope Astrograph-23.

Fig. 4. Telescope Sigma Ori-25.

Today at the Observatory of Tarija we are making regular observations of these objects with CCD cameras for the project ISON in the framework of collaboration in this field. In this way all the work related to the analysis, measurement and obtaining result of these observations is carried out. All this

Fig. 5. Telescope Zeiss-600.

information is evaluated in the Institute of Applied Mathematics of Moscow.

8. EQUIPMENT

The observatory is located in the canton Santa Ana province of Tarija's department. Latitude: $-21°35'46''$ Longitude: $-64°37'27''$, located 15 km southeast of the city of Tarija at a height of 1866 meters above sea level.

Experimental observations to track space debris initially used the 23-cm astrograph (see Figure 3) f: 228 cm, CCD camera FLI IMG 1001E, 1024×1024 pixel, 24×24 micron, field of view $37' \times 37'$, 2.7 scale $''$/pixel (Molotov et al. 2007); currently regular observations with the telescope Sigma Ori (see Figure 4), optical system Hamilton, diameter of 250 mm, 625 mm focal length, field of view $3.3° \times 3.3°$, CCD camera FLI PL 9000 3056×3056 pixel, 12×12 micron (Agapov & Molotov 2011) are carried out.

At this time work is underway on improvements in the mechanical and optical as well as on the automation of the telescope Zeiss 600 for inclusion in the observing program Asteroid space debris (see Figure 5).

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