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Observations of Asteroids in International Scientific Optical Network

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Introduction

The International Scientific Optical Network (ISON) was established in 2004 to carry out regular monitoring of the population of artificial objects at high altitude orbits (mainly GEO). Now the network joins 23 observatories in 10 countries, which are located at different longitudes and latitudes of the globe (Molotov et al., 2009).

Since 2006 the photometric observations of asteroids has been started in frame of ISON to increase the network scientific output. The main targets of these observations are near-Earth asteroids (NEAs) as hazardous objects pose a threat for the Earth civilization. The observations are aimed to investigate physical properties of the asteroids and astrometric positions. The network is also involved into projects on searching binary asteroids, support of asteroid radar research and investigation of the YORP effect. In last two years the project was also directed to be involved in follow-up and discovery asteroids and comets, especially NEAs in frame of the Asteroid Hazard problem.

Capabilities of our network to obtain astrometry and photometric data can be used in frame of the project GAIA for doing observations of newly discovered asteroids and comets.

1. ISON Project

1.1 *The Aims of the ISON Project*

- Monitoring of man-made space debris (primarily high-geostationary orbits, high-elliptical, circular type of GLONASS and GPS) by means of carrying out astrometric and photometric observations of orbiting objects (i.e. the study of their orbital and physical properties), prediction long-term evolution of this state, taking into account various factors, identify the sources of formation of small debris, identifying objects of

potential sources of risk to the functioning for operational spacecrafts. This is the main task.

- Tracking of NEAs: to do the discovery, refinement of orbital parameters and to study their physical properties.
- A gamma-ray burst optical “afterglow” observations.

1.2 Telescopes in the network

More than 25 wide-field telescopes were made and installed at different observatories of the network. The diameters are from 12.5 up to 50 cm, with field of view on several degrees.

The old telescopes with diameters from 60 cm up to 2.6 m have been modernized and using in the network. Most of these telescopes have been equipped with modern CCD-cameras, mainly manufactured by firm Finger Lakes Instrument (FLI) in USA.

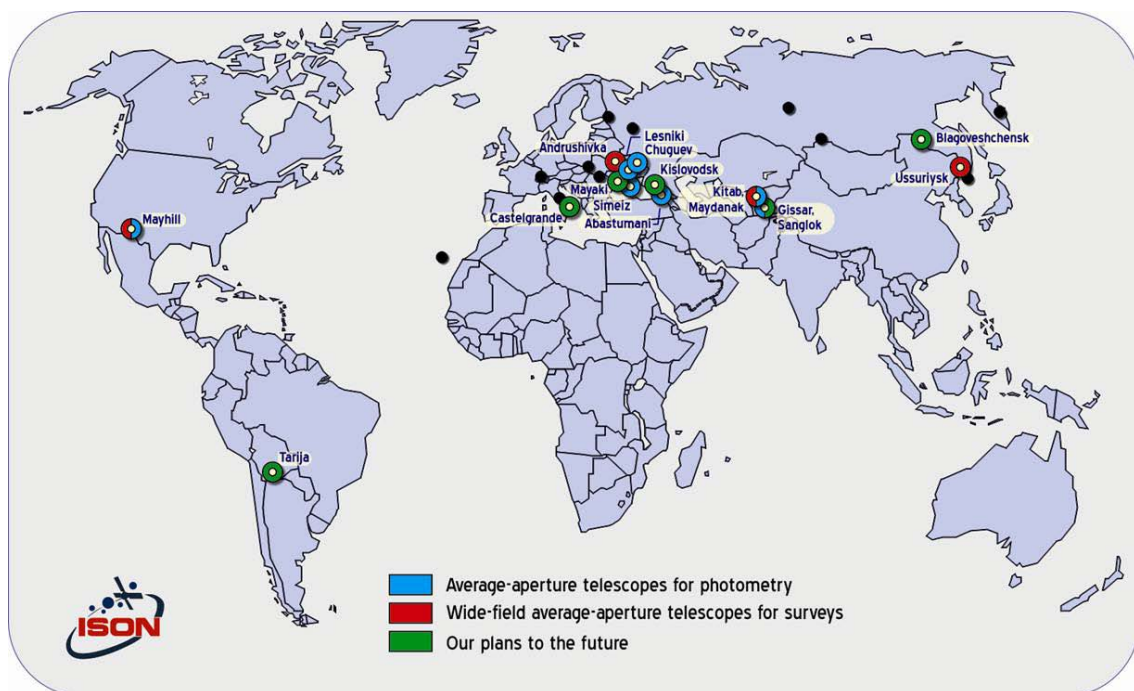


Fig. 1 – Map of observatories in the network involved in asteroid’s observations. Tree colors show telescopes involved in photometry and searching NEAs, and also future plans of the ISON.

2. Kharkiv Program: CCD Observations of Near-Earth Asteroids

CCD observations of NEAs were started at the Chuguev Observing Station of the Kharkiv National University in frame of cooperation with the Institute for Planetary Exploration (DLR, Berlin). The joint project aimed at solving the Asteroid Hazard problem was started. It was the first European initiative in this direction: establishing European Near-Earth Asteroid Observatory (EUNEASO). The 0.7-m telescope was equipped with CCD camera and began carrying out photometry and astrometry of NEAs in 1995. Since 1996 the Program is carried out jointly with the Crimean Astrophysical Observatory (CrAO). The 1-m telescope with CCD camera is used at Simeiz Observatory (Department of CrAO).

Main aims of the Program are to obtain physical parameters of NEAs by photometry: rotation properties, surface properties, diameters, and shape models, and to do follow-up astrometry and photometry of newly discovered NEAs (Krugly et al., 2002).

Up to 2005 in frame of the Program it has been observed more than 100 NEAs and obtained in result:

- more than 500 lightcurves
- rotational periods for 60 (45 for the first time)
- absolute magnitudes for 60
- binary asteroids observations (6)
- constrained photometric models (6)

3. Asteroid observations in frame of ISON

3.1 Asteroid Photometry

Since 2006 the Asteroid Group at the Institute of Astronomy of the Kharkiv National University cooperates with ISON. Now several ISON's observatories are involved in asteroid photometry (see Fig. 1). The process of creating a subnet for photometry is in progress. This subnet includes 2.6-m telescope of CrAO (Nauchnyi, Crimea, Ukraine), 2-m telescope of the Rozhen Observatory (Bulgaria), 1.5-m and 60-cm telescopes of the Maidanak Observatory (Uzbekistan), 1-m telescope of Simeiz Observatory (Crimea, Ukraine), 70-cm telescope of Chuguev Observatory (Ukraine), 70-cm telescope of Gissar Observatory (Tajikistan), 70-cm telescope of the Kiev Comet Station (Ukraine), 1.25-m and 70-cm telescopes of Abastumani Observatory (Georgia).

The main directions of the photometric researches:

- Physical properties of the NEAs
- Observations of newly discovered NEAs and Potentially Hazardous Asteroids (PHAs)
- Searching for binary asteroids and determining parameters of the binary systems
- Support in optics of asteroid's radar observations
- Investigation of the Yarkovsky-O'Keefe-Radzievskii-Paddack effect (YORP effect) – the effect's influence on rotations of asteroids

3.3 Subset of ISON for NEA Searching

Since 2010 in frame of ISON the asteroid's surveys have been started in two sites:

- Andrushivka Observatory: 60-cm telescope (field 1°, upgraded in April 2010);
- ISON New Mexico Observatory: 46-cm telescope (1.65°, worked since July 2010).

Also the surveys are planned to start at the Kitab Observatory: 40 cm telescope (2.3°, February 2011), and at the Ussurijsk Observatory: 50 cm telescope (1.8°, February 2011).

In results of the first months observations at the ISON New Mexico Observatory: about 3000 sq. degrees of the sky were surveyed, thousands asteroids were measured, hundreds asteroids were rediscovered, and tens of the main-belt asteroids, two Mars-crossers, and one NEA (2010 RN80) were discovered. Statistic of the asteroid astrometric observations at the Andrushivka and the ISON New Mexico observatories is included in Table 1.

Table 1 –Statistic of observed and discovered asteroids within ISON surveys

ISON-NM (H15)	Number of measurements	Measured objects	Discovered objects	Observing nights
August	7 777	1 861	7	19
September	9 502	2 232	6	16
October- November	25 545	5 943	81	59

TOTAL:	42 824	10 036	94	94
Andrushivka (A50)	Number of measurements	Measured objects	Discovered objects	Observing nights
August	<i>1 167</i>	367	2	10
September	<i>3 768</i>	1 196	3	9
October- November	6 643	1 997	14	14
TOTAL:	11 578	3 560	19	33

4. Conclusion

Directions of ISON improvements and outlook:

- Since 2010 the ISON participates in the Roscosmos' project "Automated System for Prediction and Warning on the Dangerous Situations in the Near-Earth Space". A few more observatories will be established and several telescopes installed.
- Formation of two new subsets for NEA observations – for searching observations and photometry.
- Establishing a few more observation facilities in Western/South Hemisphere. In 2010 ISON's expeditions visited Argentina, Bolivia, Brazil, Mexico, Venezuela, and Mongolia, and have a plan to visit Chile and South Africa.
- Modernization of old telescopes (with an aperture from 60-cm up to 2.6 m) and/or their equipping with CCD cameras.

We hope to be involved in the Gaia Follow-Up Network for observations of Solar System Object and to make a contribution to the study of the Solar system bodies within this project.

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