

**Russian Academy of Sciences** 

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Keldysh Institute of Applied Mathematics

## Program of international scientific cooperation in field of space debris observations using optical facilities

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#### International Scientific Optical Network (ISON)

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

 Cooperation already joins 23 observation facilities of various affiliation (Academy of Sciences, Universities, Scientific Institutions, Commercial Companies, Privates) coordinated by the Keldysh Institute of Applied Mathematics of the Russian Academy of Sciences (KIAM)

## **ISON International Cooperation**

- ISON collaborates now with institutions of 11 countries - Bolivia, Georgia, Moldova, Italy, Russia, Spain (ESA), Switzerland, Tajikistan, Ukraine, USA, Uzbekistan
- preparatory works started to involve Armenia, Kazakhstan, Mexico, Mongolia, Venezuela,
- Negotiations are carried out with Argentina, Brazil, Latvia, Vietnam, Organization of United Nations



#### International scientific optical network



# Forms of collaboration with ISON project

- Participation in regular ISON coordinated observations
- Joint observation campaigns to exchange the obtained results
- Arrangement of ISON observations for specific scientific goal or program for further joint publications
- Providing of software, elaborated under ISON project for further coordinated activities
- Installation of telescopes, elaborated under ISON project
- Modernization of non-operational obsolete telescopes
- Production of telescope under grant for future joint observations



### Standart ISON telescopes: 19-cm VT-78e, 25-cm ORI-25, 40-cm ORI-40





### Samples of collaboration: 50-cm ORI-50 in Ussuriysk under grant of MFTI and 22-cm ORI-22 in Collepardo





## Modernization of Zeiss-600 in Tarija (Bolivia) and Sanghlok (Tajikistan)











# EOP-1 – standart space debris observatory under Roscosmos grant



### Facilities of EOP-1 created under Roscosmos grant







# 50-cm and 65-cm telescopes elaborated under Roscosmos grant



# Planned positions of dedicated optical facilities under Roscosmos grant



### АСПОС ОКП Сегмент мониторинга опасных ситуаций в области ГСО, ВЭО и СВО

Центр сбора, обработки и анализа научной информации по объектам техногенного происхождения

### **ISON structure and tasks**



#### **Optical facilities form three subsets:**

- subsystem for surveys of the GEO region (down to 16<sup>m</sup>)
- subsystem for tracking of the high orbit faint (fainter than 16<sup>m</sup>) space debris at GEO and GTO
- subsystem for tracking of bright GEO and HEO objects
- subsystem for asteroid research

<u>Current primary tasks:</u> regular GEO monitoring, new GEO and GTO faint objects discovering and tracking, maintenance as complete GEO objects database as possible

KIAM coordinates activities and analyze measurements

#### Samples of Coverage in GEO surveys for two 22-cm surveys telescopes – in Ussuriysk and Crimea (Nauchniy-1)



Right Ascension – Declination 2009/09/01-2010/03/01 Ussuriysk Hour Angle – Declination 2008/01/01 – 2008/12/01 Nauchniy-1

### Observed Individual GEO Objects Number (by night, Jan 2009 - Aug 2010)



#### Distribution of 1530 GEO Objects by Period and Inclination



## Distribution of 1530 GEO objects by RAAN and Inclination

Distribution of GEO objects by RAAN and Inclination



RAAN, °

# Distribution of 1699 HEO and MEO objects by Period and Inclination



## Distribution of 1699 HEO and MEO objects by Period and Inclination





Area-To-Mass Ratio, m2/kg



## Distribution of High AMR objects by period and inclination



## **Directions of asteroid research**

- Searching new asteroids
- Follow-up of NEA
- Photometry of NEA
- Discovering and investigating double NEA
- Investigation of YORP effect
- Improvement of data on NEA selected as radar target











#### Telescopes for photometry of NEA













#### **Photometry of NEAs**







NEA 2010 RN80, Comet Elenin C/2010 X1, 400 main belt asteroids were discovered in 2010. more 100 night of photometry of

### Next grant of Roscosmos is on the way

- Elaboration of two EOP-2 (65-cm,40-cm, 4x19 cm)
- Modernization of 2.6-m and 1-m Schmidt telescope of Buryakan observatory in Armenia (FOV of ZTA2.6 will be 1.3 degree, of AZT-10 will be 2.6 degree)
- Beginning of producing the 80-cm telescope
- Designing of 1.5-m telescope on base of AZT-33VM for North Caucasus

### Modernization of Buryakan observatory, Armenia







