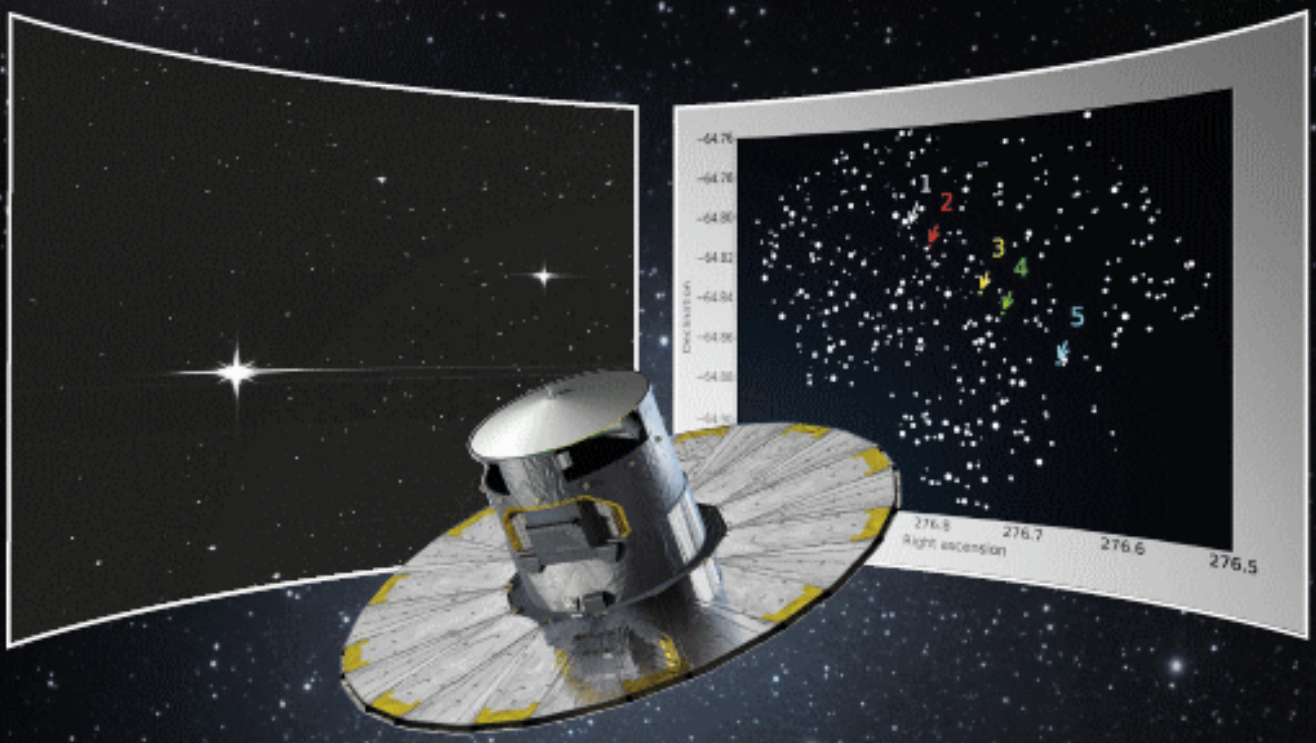
Welcome to the third

Gaia-Fun-SSO Workshop



GAIA

FOLLOW-UP NETWORK
FOR THE SOLAR SYSTEM OBJECTS

#3

IMCCE · Paris Observatory

From November 24 to November 26, 2014

77, avenue Denfert-Rochereau, 75014 Paris

cnrs · gala · Observatoire de la Côte d'Azur · Action Spécifique GAIA · European Science Foundation

Summary

Scientific rationale

The observation of Solar System Objects (SSO) by the Gaia space astrometry mission will be constrained by a scanning law. Many detections of interesting objects may occur with no possibility of further observations by the probe. These objects will then require complementary ground-based observations. Among them, previously unknown Near-Earth Objects, fast moving towards the Earth or going away from it could be found. Several objects discovered by Gaia could also be Inner-Earth Objects, as the probe will observe at rather low Solar elongations.

In order to confirm from the ground the discoveries made in space and to follow interesting targets, a dedicated network is organized, the Gaia Follow-Up Network. This task is performed in the frame of the Coordination Unit 4 of the Gaia Data Processing and Analysis Consortium (DPAC), devoted to data processing of specific objects. The goal of the network will be to improve the knowledge of the orbit of poorly observed targets by astrometric observations on alert. This activity will be coordinated by a central node interacting with the Gaia data reduction pipeline all along the mission.

In 2010 and 2012, we had organized the first two workshops in order to initiate the network and to meet the participants. In 2014, almost one year after the launch of Gaia, we organize the third Gaia-FUN-SSO workshop in Paris in order to discuss further the coordination of the network of observing stations, to discuss the prelaunch training observations which have been performed and to prepare the network for the operating phase of the alert mode. During this workshop, the participants will have the opportunity to be informed about the status of the Gaia mission, about the alert process for SSO and the ground-based data processing. But they will also be invited to present their activities in relation with this program, or their equipment, instruments and observing sites. Large time slots will be reserved for discussions.

PROGRAM

Monday November 24

9:15-10:00 Registration

10:00 Welcome address by M. Claude Catala, President of Paris Observatory

10:10 Opening and practical information (Paolo Tanga & William Thuillot, co-chairmen)

Session 1 : General context
Chair: W. Thuillot

10:25 Gaia status
by Timo Prusti (invited)

11:00 Coffee break

11:20 Updates on Gaia observations of Solar System
by Paolo Tanga

11:55 Interrelations between asteroid populations
by Mikael Granvik (invited)

12:30 The European NEO Coordination Centre and the Gaia opportunity
by Ettore Perozzi and the ESA SSA NEO Team (invited)

13:05 Lunch (Paris Observatory restaurant)

Chair: D. Hestroffer

14:20 Gaia as a Transient Survey
by Lukasz Wyrzykowski, (invited)

14:55 The bumpy first year of GBOT
by Martin Altmann (invited)

15:30 The Gaia-FUN-SSO network : status and *objectives*
by William Thuillot, B. Carry, P. David, J. Berthier, D. Hestroffer

16:00 Coffee break

16:30 Discussion 1: general context of the Gaia mission and Science Alert

17:15 End of day 1

Tuesday November 25

Session 2: Gaia-FUN-SSO context
Chair: P. Tanga

9:25 The Gaia FUN SSO pipeline
by Benoit Carry, Pedro David, William Thuillot, Jérôme Berthier

10:10 The Gaia-FUN-SSO observations campaign of Apophis: a preliminary test for the network
by David Bancelin, William Thuillot, Anatoliy Ivantsov, Josselin Desmars, Marcelo Assafin, Siegfried Eggl, Daniel Hestroffer, Patrick Rocher, Benoit Carry, Pedro David and the Gaia-FUN-SSO team

10:35 On visual encounters between asteroids and background stars
by Anatoliy Ivantsov, Eggl S., Hestroffer D., Thuillot W., Assafin M.

11:00 Coffee break

11:30 Gaia FUN SSO triangulation observations of 2014 HQ124
by Siegfried Eggl, E. Gerlach, S. Boettger, W. Thuillot, A. Baransky˙, A. V. Devyatkin, Bashakova, S. A. Rusov, O. V. Shulga, Y. Sybiryakova, Y. Kozyryev,N. Kulichenko,,V. Vovk˙

11:55 The SBG Telescope of the Astronomical Observatory of the Ural Federal University: Opportunities for Gaia-FUN-SSO
by Polina Zakharova and Eduard Kuznetsov

12:20 Serbian-Bulgarian mini-network telescopes and Gaia-FUN-SSO
by Goran Damljanovic and Svetlana Boeva

12:45 Astrometry and Photometry of Karin Asteroid Family Members
by Zeki Eker, Mirel Birlan, Murat Kaplan, Orhan Erece, Gurkan Aslan, Marcel Popescu, Alin Nedelcu

13:10 Lunch (Paris Observatory restaurant)

Chair: E. Perozzi

14:30 Turkish Facilities to meet Gaia Solar System TOO Observations
by Erece O., Zeki Eker, Murat Kaplan, Gurkan Aslan, Mirel Birlan

14:55 Pulkovo observations in last training campaigns of Gaia FUN SSO
by Denis Gorshanov, Devyatkin A.V., L'vov V.N., Tsekmeister S.D., Petrova S.N., Martyusheva A.A., Slesarenko V.Yu., Naumov K.N., Sokova I.A., Sokov E.N., Zinoviev S.V.,

Karashevich S.V., Ivanov A.V., Lyashenko A.G., Rusov S.A., Kouprianov V.V., Bashakova E.A., Melnikov A.V.

15:20 ISON participation in Gaia-FUN-SSO campaigns
by Yurij *Krugly, I. Molotov, V. Voropaev, L. Elenin, R. Inasaridze, V. Rumyantsev, A. Baransky, V. Kouprianov, I. Belskaya, A. Sergeev, V. Shevchenko, I. Slyusarev, N. Gaftonyuk, O. Burkhonov, Sh. Ehgamberdiev, K. Ergashev, A. Aliev, E. Litvinenko, Yu. Ivashchenko, D. Varda, E. Sinyakov, T. Namkhai, T. Kokina, N. Minikulov, S. Abdulloev, V. Nevsky, A. Matkin, A. Ivanov, M. Krugov, A. Kusakin, V. Kudak*

15:45 POSTER: Capabilities of ISON observatories for GAIA-FUN-SSO support
by Elena Pavlova, G. Borovin, I. Molotov, M. Zakhvatkin, L. Elenin, Yu. Krugly, V. Rumyantsev, M. Krugov, R. Inasaridze, V. Ayvazian, O. Burkhonov, Sh. Ehgamberdiev

16:00 Coffee break

16:30 Discussion 2: the goal and activity of the Gaia-FUN-SSO network

17:30 End of day 2

Tuesday 25 November - 19:00-21:00

Cocktail in the Cassini Hall,

1st Floor of the
Paris Observatory historical building (see the map below)

Wednesday November 26

Session 3: Gaia-FUN-SSO context and related observations
Chair: A. Cellino

9:20 Observations of NEAs with the Lijiang 2.4m telescope
by Zhang Xi-Liang

9:45 Perspectives of polarimetry for follow-up observations of Gaia's asteroids
by Irina Belskaya and Yurij Krugly

10:10 Polarimetric observations of NEAs at RTT150. First results
by Irek Khamitov, Selcuk Helhel, Gizem Kahya, Suleyman Kaynar,Rustem Gumerov

11:35 Precision of astrometry measurements made using CoLiTec software for asteroids survey
by Sergii Khlamov, A. Ivantsov, V. Savanevich, A. Bryukhovetskiy, L. Elenin, M. Bezkrovniy, N. Sokovikova, Ia. Movsesian

11:00 Coffee break

11:20 Asteroid observations for mass determination at RTT-150 in 2003-2014
by Nadia Maigurova, Y. Chernetenko, L. Gudkova, R. Gumerov, I. Khamitov, O. Kochetova, G. Pinigin

11:45 Observations of small-size and low-elongation NEAs in RI NAO
by Yevgeniya Sybiryakova, O. Shulga, Ye. Kozyryev, N. Kulichenko, V. Vovk

12:10 Method of Determining Small Bodies' Orbits Based on an Exhaustive Search of Orbital Planes
by Dmitrii Vavilov D. and Yuri Medvedev

12:35 Determination of small Solar system bodies orbits elements on astrometrical observations with OMT-800 telescope
by Volodymyr Troianskyi, A.A. Bazey, V.I. Kashuba, V.V. Zhukov.

13:00 Lunch (Paris Observatory restaurant)

Chair: B. Carry

14:15 Astrophysics in Kazakhstan: past, present and future
by Vira Godunova, M. Andreev, O. Sergeev, V. Tarady, V. Reshetnyk

14:40 Astrophysics in Kazakhstan: past, present and future
by Chingis Omarov

15:05 Asteroid – comet monitoring
by Aldiyar Agishev

15:30 discussion 3: supplementary points, recommendations and conclusion

16:00 End of day 3 and closure of the meeting

MAP OF THE PARIS OBSERVATORY CAMPUS

Entrance to the Cassini Hall (1st floor)

Paris Obs. Entrance

Entrance of the Meeting room Salle de l'Atelier

LIST OF THE COMMUNICATIONS

(alphabetic order of the first author's name)

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   by Agishev A.,
2. The bumpy first year of GBOT (invited)
   by Altmann M.
3. The Gaia-FUN-SSO observations campaign of Apophis: a preliminary test for the network
   by Bancelin D., W. Thuillot, A. Ivantsov, J. Desmars, M. Assafin, S. Eggl, D. Hestroffer, P. Rocher, B. Carry, P. David, J. Berthier and the Gaia-FUN-SSO team,
4. Perspectives of polarimetry for follow-up observations of Gaia's asteroids
   by Belskaya I.N. and Krugly Yu.N.
5. The Gaia FUN SSO pipeline
   by Carry B., P. David, W. Thuillot, J. Berthier
6. Serbian-Bulgarian mini-network telescopes and Gaia-FUN-SSO
   by Damljanovic G. and S. Boeva
7. Gaia FUN SSO triangulation observations of 2014 HQ124
   by Eggl S, E. Gerlach, S. Boettger, W. Thuillot, A. Baransky, A. V. Devyatkin, Bashakova, S. A. Rusov, O. V. Shulga, Y. Sybiryakova, Y. Kozyryev,N. Kulichenko,,V. Vovk
8. Astrometry and Photometry of Karin Asteroid Family Members
   by Eker Z., M. Birlan, M. Kaplan, O. Erece, G. Aslan, M. Popescu, A. Nedelcu
9. Turkish Facilities to meet Gaia Solar System TOO Observations
   by Erece O., Zeki Eker, Murat Kaplan, Gurkan Aslan, Mirel Birlan
10. Follow-up observations of NEAs at the Terskol Observatory
    By Godunova V., M. Andreev, O. Sergeev, V. Tarady, V. Reshetnyk
11. Pulkovo observations in last training campaigns of Gaia FUN SSO
    by Gorshanov D.L., Devyatkin A.V., L'vov V.N., Tsekmeister S.D., Petrova S.N., Martyusheva A.A., Slesarenko V.Yu., Naumov K.N., Sokova I.A., Sokov E.N., Zinoviev S.V., Karashevich S.V., Ivanov A.V., Lyashenko A.G., Rusov S.A., Kouprianov V.V., Bashakova E.A., Melnikov A.V.
12. Interrelations between asteroid populations (invited)
    by Granvik M.
13. Polarimetric observations of NEAs at RTT150. First results
    by Khamitov I., S.Helhel, G.Kahya, S.Kaynar,R.Gumerov
14. On visual encounters between asteroids and background stars
    by Ivantsov A., Eggl S., Hestroffer D., Thuillot W., Assafin M.
15. Precision of astrometry measurements made using CoLiTec software for asteroids survey
    by Khlamov S., A. Ivantsov, V. Savanevich, A. Bryukhovetskiy, L. Elenin, M. Bezkrovniy, N. Sokovikova, Ia. Movsesian
16. ISON participation in GAIA-FUN-SSO campaigns
    by Krugly Y, I. Molotov, V. Voropaev, L. Elenin, R. Inasaridze, V. Rumyantsev, A. Baransky, V. Kouprianov, I. Belskaya, A. Sergeev, V. Shevchenko, I. Slyusarev, N. Gaftonyuk, O. Burkhonov, Sh. Ehgamberdiev, K. Ergashev, A. Aliev, E. Litvinenko, Yu. Ivashchenko, D. Varda, E. Sinyakov, T. Namkhai, T. Kokina, N. Minikulov, S. Abdulloev, V. Nevsky, A. Matkin, A. Ivanov, M. Krugov, A. Kusakin, V. Kudak
17. Asteroid observations for mass determination at RTT-150 in 2003-2014

by Maigurova N, Y. Chernetenko, L. Gudkova, R. Gumerov, I. Khamitov, O. Kochetova, G. Pinigin

18. Astrophysics in Kazakhstan: past, present and future
by Omarov C.

19. Capabilities of ISON observatories for GAIA-FUN-SSO support (poster)
by Pavlova E., G. Borovin, I. Molotov, M. Zakhvatkin, L. Elenin, Yu. Krugly, V. Rumyantsev, M. Krugov, R. Inasaridze, V. Ayvazian, O. Burkhonov, Sh. Ehgamberdiev

20. The European NEO Coordination Centre and the Gaia opportunity (invited)
by Perozzi E. and the ESA SSA NEO Team

21. Gaia mission status (invited)
by Prusti T.

22. Observations of small-size and low-elongation NEAs in RI NAO
by Sybiryakova Ye, O. Shulga, Ye. Kozyryev, N. Kulichenko, V. Vovk

23. Updates on Gaia observations of Solar System object
by Tanga P.

24. The Gaia-FUN-SSO network : status and objectives
by Thuillot W., B. Carry, P. David, J. Berthier, Hestroffer D

25. Determination of small Solar system bodies orbits elements on astrometrical observations with OMT-800 telescope
by Troianskyi V.V., A.A. Bazey, V.I. Kashuba, V.V. Zhukov.

26. Method of Determining Small Bodies' Orbits Based on an Exhaustive Search of Orbital Planes
by Vavilov D. and Medvedev Y.

27. Gaia as a Transient Survey (invited)
by Wyrzykowski L.

28. The SBG Telescope of the Astronomical Observatory of the Ural Federal University: Opportunities for Gaia-FUN-SSO
by Zakharova P. and Kuznetsov E.

29. Observations of NEAs with the Lijiang 2.4m telescope
by Zhang X.-L.

Abstracts

(Ordered list by name of first author)

1. Asteroid – comet monitoring

Agyshev A.,
The Division of Astronomy, Al-Farabi Kazakh national University, Kazakhstan

Works on discovering and studying of asteroids and comets approaching the Earth orbit (ACE) are carried out all over the world and directed, first of all, to cataloging of big ACE for which telescopes of average sizes (with apperteurs from 50 cm to 1 m) are used. Such observations are carried out for astrometric support of newly discovered ACE that is necessary for these bodies cataloging. Also regular observations on defining ACE coordinates, especially, potentially hazardous for the Earth with defining and maintenance of high accuracy of their orbital parameters are conducted.
Photometric ACE observations which are implemented at these bodies brightest moments during their close approach to the Earth are aimed to define asteroids physical properties such as shape, sizes, surface properties and rotation parameters. Systematic observations within the project will be directed to studying of dual ACE and also detecting of new dual systems among ACE. Contemporary scientific problem for ACE researches is determined by the fact that studying of these bodies physical properties noticeably falls back from total amount of discovered ACE. In particular, at present rotation periods of nearly 300 ACE are known but over 12 thousand are discovered. Knowledge of hazardous asteroids physical properties is necessary for developing and creating protection systems for preventing such bodies fall onto the Earth. Obtained within the project data about ACE physical properties will be published in peer-reviewed scientific journals (in scientific journals with impact-factor) and further on - posted in international databases.
Conducting review observations with CCD - cameras enables to observe big sky regions with deep penetration that gives the possibility to implement all asteroids high accurate astrometry in the field of the telescope and detect new celestial bodies – asteroids and comets. Obtained electronic shots with CCD -cameras will be exposed to operative processing and further on objects positioned and photometric measurements in the field of the telescope.This sky scanning methodology and celestial bodies detecting are the most progressive ones among existing and common all over the world.

2. The bumpy first year of GBOT - (invited)

Altmann M.
Zentrum fűr Astronomie der Univ., Heidelberg, Mőnchhofstr.12-14, 69120 Heidelberg, Germany

One day after the launch of Gaia it became clear, Gaia was going to be 3 magnitudes fainter than expected, and we would have to reassess the whole GBOT programme. Was it still feasible at all, what telescopes could we continue to use, do we need to change our strategy, our methods, etc. Therefore GBOT immediately went into a one year phase of reassessment, starting with dealing with the most pressing question, the viability of such an undertaking. When this was established both in theory and in practice the more tedious phase of fine tuning our approach began while in parallel GBOT resumed its regular data taking. The reassessment

phase was chosen to last one year, so that all kinds of situations the spacecraft presents us during its orbit around the L2 and thus also along the ecliptic part of the sky could be taken into account. While this phase is still ongoing we can now say that with some compromise GBOT is working, and we are now starting to prepare ourselves for the first Gaia astrometry. I will report on the unexpected events the GBOT group had to cope with during this first year of Gaia.

3. The Gaia-FUN-SSO observations campaign of Apophis: a preliminary test for the network

Bancelin D.[1,2], W. Thuillot[2], A. Ivantsov[3,2], J. Desmars[4,2,5], M. Assafin[5], S. Eggl[1,2], D. Hestroffer[2], P. Rocher[2], B. Carry[2], P. David[2], J. Berthier[2] and the Gaia-FUN-SSO team
[1] *Institute for Astrophysics (IfA), University of Vienna, Türkenschanzstrasse 17, A-1180 Vienna, Austria*
[2] *IMCCE-Paris Observatory, 77 avenue Denfert-Rochereau, France*
[3] *Faculty of Aerospace Engineering, Technion–Israel Institute of Technology, Technion City, 3200003 Haifa, Israel*
[4] *Observatório Nacional, Rua José Cristino 77, Saõ Cristovão, Rio de Janeiro CEP 20.921-400, Brazil*
[5] *Observatório do Valongo/UFRJ, Ladeira Pedro Antonio 43, CEP 20.080-090 Rio de Janeiro - RJ, Brazil*

The Potentially Hazardous Asteroid (99 942) Apophis will approach the Earth to within one tenth of a lunar distance in 2029. In order to predict Apophis' orbit after such a deep close encounter, we need to improve our knowledge of its orbital characteristics as well as the one of its non-gravitational accelerations such as the magnitude of the Yarkovsky effect. High precision astrometry is an important mean to achieve this goal. In this work we present the analysis of new astrometric observations performed during 2012-2013 by the Gaia Follow-Up Network for Solar System Objects (Gaia-FUN-SSO). All astrometric positions were reduced with the Platform for Reduction of Astronomical Images Automatically (PRAIA), using the USNO CCD Astrograph Catalogue 4 (UCAC4) as the reference catalogue. 2732 astrometric measures have been performed and treated in a consistent way. 2103 new unpublished astrometric positions are obtained and will be provided to the Minor Planet Center for community use.

4. Perspectives of polarimetry for follow-up observations of Gaia's asteroids

Belskaya I.N. and Krugly Yu.N.
Institute of Astronomy, Kharkiv Karazine National University, Ukraine

Polarimetric observations are diagnostic for asteroid's albedo and taxonomy. At the phase angles larger 35-40 deg even a single polarimetric measurement can give a prompt assessment of an asteroid's geometric albedo. We will discuss possible applicability of polarimetry for near-Earth asteroids discovered by Gaia.

5. The Gaia FUN SSO pipeline

Carry B., P. David, W. Thuillot, J. Berthier
IMCCE-Paris Observatory, 77 avenue Denfert-Rochereau, France

The astrometric alerts triggered by the observation of unknown moving objects by Gaia will be treated by the DPAC DU459 task, host at IMCCE. We will present the overall scheme of the alert pipeline, from the orbital elements to handy ephemeris delivered through a web portal.

6. Serbian-Bulgarian mini-network telescopes and Gaia-FUN-SSO

Damljanovic G. and S. Boeva
Astronomical Observatory, Belgrade, Republic of Serbia

We started with Serbian-Bulgarian mini-network of 5 telescopes at 3 sites since mid-2013 in line with the Gaia mission (ESA). The telescopes are: 60/600 cm Cassegrain ASV, 200/1600 cm Ritchey-Chretien Rozhen, 60/750 cm Cassegrain Rozhen, 50/70 cm (F=172 cm) Schmidt-camera at Rozhen, and 60/750 cm Cassegrain at Belogradchik AO. In the near future (during the next year), a new 1.4m telescope will be installed at ASV within the frame of the Belissima project (http://belissima.aob.rs). The sites are: the Astronomical Station Vidojevica (ASV) of Astronomical Observatory in Belgrade (AOB) - Serbia, the Rozhen Observatory of Institute of Astronomy with National Astronomical Observatory (NAO) of Bulgarian Academy of Sciences (BAS) - Bulgaria, and the Belogradchik AO - Bulgaria. Also, within the frame of bilateral cooperation between the Serbian Academy of Sciences and Arts and BAS, GD defined a 3-year joint research project (started in 2014) "Observations of ICRF radio-sources visible in optical domain" which partly deals with the Gaia-FUN-TO and Gaia-FUN-SSO. Some informations (telescope, CCD camera, etc.) of mentioned stations and results are presented, here.

7. Gaia FUN SSO triangulation observations of 2014 HQ124

Eggl S.[1] , E. Gerlach[2], S. Boettger[2], W. Thuillot.[1], A. Baransky.[3] A. V. Devyatkin.[4], Bashakova.[4], S. A. Rusov.[4], O. V. Shulga.[5], Y. Sybiryakova.[5], Y. Kozyryev.[5],N. Kulichenko.[5],V. Vovk.[5]
[1]*IMCCE, Paris Observatory, France*
[2] Lohrmann Observatory, Dresden, Germany
[3]*Astronomical Observatory of Kyiv University, Ukraine*
[4]*Pulkovo Observatory, St.Petersburg, Russia*
[5]*Nikolaev Astronomical Observatory, Ukraine*

We explore the merits of triangulation based orbit improvement for Near Earth Objects that have close encounters with the Earth. In the framework of a Gaia FUN SSO observation campaign between June 8th and June 11th 2014 simultaneous observations from different observatories were conducted during the Earth flyby of NEO 2014 HQ124. Here, we present preliminary results regarding the predicted and achieved improvement of the orbit of HQ124.

8. Astrometry and Photometry of Karin Asteroid Family Members

Eker Z.[1], Mirel Birlan[2], Murat Kaplan[1], Orhan Erece[1,3], Gurkan Aslan[1], Marcel Popescu[4], Alin Nedelcu[4]
[1]*Akdeniz University, Turkey*
[2]*Paris Observatory, France*
[3]*TUBİTAK National Observatory, Turkey*
[4] *Astronomical Institute* of the Romanian Academy, *Bucharest, Romania*

Karin family of asteroids is composed by approximately 100 hundred objects. Backward integrations show that the break-up of the parent body occurred approximately 6 million years ago. Spectroscopic campaigns of some of the most massive asteroid of Karin family reveal homogeneity of their surface and associate their surface properties to S-type taxonomic class of asteroids. Our observational program aims to increase the knowledge of physical properties of Karin family and thus strengthen the statistics concerning its physical parameters. Photometry of family members will allow not only characterizing theirs synodical periods but also to determine parameters such as pole orientation and reconstruct their shapes from rotational light curves. Astrometry of asteroids recorded on the images was also performed and reported to the Minor Planet Center (MPC). Faint asteroids were also discovered and reported to the MPC. This exercise of identification of new objects of the Solar System is an excellent training of doing good quality astrometry thus becoming operational for the futures Gaia alerts and follow-up of new discoveries from the ground. The presentation will give few examples of photometric targets among Karin family of asteroids using the 1 meter telescope facility in Turkish National Observatory (TUBITAK) as well as the astrometry of few newly discovered objects.

9. Turkish Facilities to meet GAIA Solar System TOO Observations

Erece O.[1,3], Zeki Eker[1], Murat Kaplan[1], Gurkan Aslan[1], Mirel Birlan[2]
[1]*Akdeniz University, Turkey*
[2]*Paris Observatory, Franc*
[3]*TUBİTAK National Observatory, Turkey*

The three telescopes of TUBİTAK National Observatory (TUG) dedicated some of its limited amount of observing time to GAIA target of opportunity (TOO) observations. Operated by Russian (Kazan University, Kazan and Russian Academy Of Sciences, IKI, Moscov) and Turkish (TUG) cooperation, the RTT150 telescope with 150 cm aperture and 17.8 arcsec/mm spatial resolution is reserved just for GAIA TOO observations 5 days in a year. Ritchey Chretien Cassegrain focus RTT150 telescope is able to do interchangeably spectroscopy, photometry, and astrometry. The other two telescopes are fully operated by Turkish. The T100 telescope with 100 cm aperture and 0.32 arcsec/pixel resolution is dedicated 80 hours per year, while T60 telescope with 60 cm aperture and 0.51 arcsec/pixel resolution is promised to allow 15% of its observing time to be used for TOO observations which will follow up the GAIA alerts. Activities and preparations and eligibility of a newly established group of astronomers who are interested in GAİA Solar System TOO observations will be summarized.

10. Follow-up observations of NEAs at the Terskol Observatory

Godunova V., M. Andreev, O. Sergeev, V. Tarady, V. Reshetnyk
ICAMER Observatory of NASU, Kiev, Ukraine

Starting in 2003, the facilities of the Terskol Observatory have been heavily used for follow-up astrometry, photometry and spectroscopy of NEAs. Objects with V magnitudes down to 21 have been observed during their close approaches to the Earth. In 2003-2014, positions of more than 200 NEAs were detected; an accuracy of about 0.2–0.3 arcsec was achieved. Astrometric observations have been continuously reported to the Minor Planet Center. Appropriate software developed has been applied to derive asteroid's properties from photometric and spectrophotometric observations. The application of different methods allowed us to estimate rotation periods of NEAs, as well as to classify some of them. In this paper, the different aspects of monitoring and studies of Earth-approaching asteroids will be presented; the results and some findings will be discussed.

11. Pulkovo observations in last training campaigns of GAIA FUN SSO

Gorshanov D.L., Devyatkin A.V., L'vov V.N., Tsekmeister S.D., Petrova S.N., Martyusheva A.A., Slesarenko V.Yu., Naumov K.N., Sokova I.A., Sokov E.N., Zinoviev S.V., Karashevich S.V., Ivanov A.V., Lyashenko A.G., Rusov S.A., Kouprianov V.V., Bashakova E.A., Melnikov A.V.
Pulkovo Astronomical Observatory, Russian Academy of Sciences, Saint-Pertersbourg, Russia

ZA-320M and MTM-500M telescopes of Pulkovo astronomical observatory made observations of asteroids in the frame of GAIA FUN SSO last training campaigns. For (367943) Duende = 2012 DA14 (February 2013), color indices were obtained and two fragments of light-curve were observed. Modeling of rotation of the asteroid on the base of the light-curve observations shows changes of rotational period and axis inclination (tumbling). Calculations of orbital evolution of the asteroid show that it changed between three modes of orbital motion relative to the Earth including quasi-satellite mode. For 2013 TV135 asteroid (October – November 2013), five fragments of light-curve were observed. Rotational period, slope parameter and absolute magnitude were estimated. For 2014 HQ124 asteroid (9-th of June 2014), the light-curve fragment of 4.5 hours long was obtained. Part of the CCD frames was observed for campaign of synchronous observations of the asteroid for triangulation. Astrometric positions for all three asteroids were obtained from the observations.

12. Interrelations between asteroid populations (invited)

Granvik M.
Department of Physics, PO Box 64, University of Helsinki, 00014 Helsinki , FINLAND

All but the largest asteroids are collisional fragments of the planetesimals that were formed in the early solar system. The asteroid population that we observe today is usually divided into distinct subpopulations. The differences between the subpopulations give us insight into the

evolutionary path of the entire asteroid population. I will first present observations of the different asteroid populations in terms of their orbit and size distributions. Then I will discuss the mechanisms that connect these apparent subpopulations and use main-belt objects (MBOs) and near-Earth objects (NEOs) as an example. Finally, I will present the newest results of modeling the NEO population and touch upon Gaia's role in bringing these population models to the next level of complexity.

13. Polarimetric observations of NEAs at RTT150. First results

Khamitov I.[1,2], S.Helhel[1,3], G.Kahya[1], S.Kaynar[1],R.Gumerov[2]
[1]*TÜBİTAK National Observatory, Antalya,Turkey*
[2]*Kazan Federal University, Kazan, Russia*
[3]*Akdeniz University, Antalya, Turkey*

We present Polarimeter for measuring linear polarization of light sources compatible with FOSC family instruments based on Double Wedged Wollaston and integrated into RTT150 observational system. Observations of unpolarized and strongly polarized stars shown the instrumental systematic errors of polarization degree is 0.4% and position angle is 1.5˚. We present results of polarimetric and photometric observations of three faint NEAs with high proper motion in period of theirs close approaches: 276049, 333578 and 163132. Due to that observations were performed at large phase angles from 40 to 100 degrees for different asteroids the measured linear polarisation degree makes it possible to differentiate the taxonomy classes of observered sources. The visual magnitudes and proper motions of asteroids are 16m-17m and 3”-10”/min. Assuming that the mean inverse angle is 20 degree we estimated slope parameter h and from well known relation the albedo was calculated and together with present photometry we estimated the diameters of asteroids. The applications of new device at RTT150 to the GAIA-FUN-SSO are disscused.
Polarimeter design project is supported by TÜBİTAK (Grand No. 113F263).

14. On visual encounters between asteroids and background stars

Ivantsov A. [1], Eggl S. [2], Hestroffer D. [2], Thuillot W. [2], Assafin M. [3]
[1]*Faculty of Aerospace Engineering, Technion - Israel Institute of Technology, Technion City, 3200003 Haifa, Israel*
[2]*IMCCE – Paris Observatory, 77 avenue Denfert-Rochereau, 75014 Paris, France*
[5]*Observatório do Valongo/UFRJ, Ladeira Pedro Antonio 43, CEP 20.080-090 Rio de Janeiro - RJ, Brazil*

Our ability to predict the orbital motion of asteroids crucially depends on the accuracy of astrometric measurements. The limited angular resolution of ground-based observations can be a source of identification errors, especially when fast moving objects cross background stars during a sequence of recorded images. During automatic image processing, visual overlaps may lead to misidentifications or bad positioning which in turn cause a degradation of the astrometric accuracy. In practice such measurements should either be weighted lower in the orbital fitting process, or eliminated entirely from the set of observations. Here, we present results from a search of close visual encounters between asteroids and background stars of comparable magnitudes. Asteroid observations over the past 25 years collected in the Minor Planet Center database have been scanned and visual encounters with stars from the UCAC4

and USNO-B1.0 catalogues have been recorded. The identification of close visual encounters allows us to remove observations of asteroids within two arcseconds of stellar images. Such a procedure can be shown to improve the orbits of near-Earth asteroids, and it can facilitate the dynamical linking of the newly discovered objects.

15. Precision of astrometry measurements made using CoLiTec software for asteroids survey

Khlamov S.[1], A. Ivantsov[2,3], V. Savanevich[1,4,] A. Bryukhovetskiy[5], L. Elenin[6], M. Bezkrovniy[7], N. Sokovikova[1], Ia. Movsesian[1]
[1]*Kharkiv National University of Radioelectronics, Kharkiv, Ukraine*
[2]*Faculty of Aerospace Engineering, Technion - Israel Institute of Technology, Technion City, 3200003 Haifa, Israel*
[3]*IMCCE – Paris Observatory, 77 avenue Denfert-Rochereau, 75014 Paris, France*
[4]*Main Astronomical Observatory of the National Academy of Sciences of Ukraine, Kyiv, Ukraine*
[5]*Kharkiv representative of the general customer - State Space Agency of Ukraine, Kharkiv, Ukraine*
[6]*Keldysh Institute of Applied Mathematics RAS, Moscow, Russia*
[7]*Zaporizhzhya Institute of Economics and Information Technologies, Zaporizhzhya, Ukraine*

The image processing and astrometry reduction of asteroid surveys given by series of images can be made efficiently with the dedicated software. This possibility is provided by the CoLiTec software that allows not only to detect asteroids, but also to perform astrometric measurements in real time, http://www.neoastrosoft.com/. Reliability of 100% for detection of moving objects is retained up to the lower limit of SNR equal to 3 in case of a minimum series of four frames, and decreases to 50% for SNR equal to 2 at the same conditions. The detected objects by CoLiTec had speed from 0.8 pixels/frame for the comet ISON C/2012 S1 to 40 pixels/frame for the NEA 2012 CD29. The CoLiTec software makes use of multiprocessor mode for performing astrometry reduction. Visual control with user-friendly interface is used to increase the reliability of the asteroid identification. The field of view can be quite large, up to 10 degrees. At present, the CoLiTec is in use for automated asteroid detection in the following observatories: Andrushivka Astronomical Observatory (Kiev, Ukraine) [A50], ISON-NM (Mayhill, New Mexico, USA) [H15], ISON-Kislovodsk (Russia) [D00] and ISON-Ussuriysk (Russia) [C15]. It was used for making more than 1,500 preliminary discoveries of asteroids, including 4 NEAs, 21 Trojan asteroids of Jupiter and one Centaur. It allowed to reduce about 600,000 observations, within which four comets were discovered: C/2010 X1 (Elenin), P/2011 NO1 (Elenin), C/2012 S1 (ISON), P/2013 V3 (Nevski). Also, the observatory ISON-NM, equipped with a 45-cm telescope and CoLiTec software, got the 7th rank worldwide in the amount of asteroid both observations and preliminary discoveries in general statistics of 2011 and 2012. This paper describes astrometric reduction of the frame using the UCAC4 catalog and provides an analysis of its results. There was made a comparison of precision got with the CoLiTec and Astrometrica software. The analysis showed the benefits of the CoLiTec software especially in the case of wide field of view and low quality imaging. One of the future goals is developing frame storage and publication software. This software will allow to maintain a frame archive and make search for frames by specified coordinates. External access to the archive is provided via the own web interface and the Aladin software. It allows receiving additional frames from

the such external resources as SDSS and 2MASS. The software has been implemented with the use of VO technologies, including the SIAP (Smart Image Access Protocol). Also, considerable attention will be given to the possibility of individual astrometric reduction for the particular telescopes thus allowing increase in astrometry precision.

16. ISON participation in GAIA-FUN-SSO campaigns

Krugly Y[1], I. Molotov[2], V. Voropaev[2], L. Elenin[2], R. Inasaridze[3], V. Rumyantsev[4], A. Baransky[5], V. Kouprianov[6], I. Belskaya[1], A. Sergeev[1], V. Shevchenko[1], I. Slyusarev[1], N. Gaftonyuk[4], O. Burkhonov[7], Sh. Ehgamberdiev[7], K. Ergashev[7], A. Aliev[7], E. Litvinenko[6], Yu. Ivashchenko[8], D. Varda[9], E. Sinyakov[9], T. Namkhai[10], T. Kokina[11], N. Minikulov[12], S. Abdulloev[12], V. Nevsky[13], A. Matkin[14], A. Ivanov[15], M. Krugov[16], A. Kusakin[16], V. Kudak[17]
[1]*Chuguev Observatory, Institute of Astronomy, Kharkiv National University, Ukraine*
[2]*Keldysh Institute of Applied Mathematics, RAS, Moscow, Russia*
[3]*Abastumani Astrophysical Observatory, Ilia State University, Tbilisi, Georgia*
[4]*Crimean Astrophysical Observatory, Nauchy, Crimea*
[5]*Lisnyky Observatory, Taras Shevchenko National University, Kyiv, Ukraine*
[6]*Pulkovo Observatory, RAS, St.-Petersburg, Russia*
[7]*Maidanak Observatory, Ulugh Beg Astronomical Institute, ASRUz, Tashkent, Uzbekistan*
[8]*Andrushivka Observatory, Main Astronomical Observatory, NASU, Kyiv, Ukraine*
[9]*Blagoveschensk Station, State Pedagogical University, Blagoveschensk, Russia*
[10]*Huraltogot Observatory, Research Center of Astronomy and Geophysics, Ulan-Bator, Mongolia*
[11]*Astronomical Center, Autonomous University of Sinaloa, Culiacan, Mexico*
[12]*Gissar Observatory, Institute of Astrophysics, ASRT, Dushanbe, Tajikistan*
[13]*ISON-Kislovodsk, Astronomical Scientific Centre, JSC, Russia*
[14]*ISON-Ussuriysk, Ussuriysk Astrophysical Observatory, RAS, Russia*
[15]*Astronomical Observatory, Kuban State University, Krasnodar, Russia*
[16]*Tain-Shan Observatory, Fesenkov Astrophysical Institute, Alma-Ata, Kazakhstan*
[17]*Uzhhorod Observatory, Uzhhorod National University, Ukraine*

More than 15 observatories of the International Scientific Optical Network (ISON) are planning to participate in the supporting observations of Solar System objects newly detected by Gaia space mission. To prepare for this kind of work several ISON's observatories took part in the test campaigns for observations of near-Earh asteroids in 2011-2014. We measured astrometric positions for all selected for observations asteroids and sent the data to the MPC. For some of these asteroids we carried out accurate photometric observations to analyze their rotation properties and to search for possible binary systems. The obtained results will be presented and analyzed from the point of view of the ISON network capabilities to participate in Gaia support campaigns. We will also discuss the prospects of participation of the recently opened observation stations within the ISON network.

17. Asteroid observations for mass determination at RTT-150 in 2003-2014.

by Maigurova N[1], Y. Chernetenko[2], L. Gudkova[1], R. Gumerov[3], I. Khamitov[4], O. Kochetova[2], G. Pinigin[1]
[1]*Nikolaev Astronomical Observatory, Ukraine*
[2]*Institute of Applied Astronomy Russian Academy of Sciences, Russia*

[3]*Kazan State University, Russia*
[4]*TUBITAK National Observatory, Turkey*

Positional observations of the 231 asteroids were performed in 2004-2013. The CCD observations were performed with the Russian-Turkish telescope (RTT150, D=1.5 m, F=1:7.7) and were reduced to HCRF equatorial positions using reference stars taken from the UCAC2-4 and USNOB1.0 catalogs. Accuracies of 84mas in right ascension and 68mas in declination were achieved for well-exposed images (R –magnitudes (10-17.5)) which degrade to about 150mas for the faintest asteroids R ~20.5. The residuals of asteroid observations have shown the systematic biases in star positions of the USNO B1.0 and UCAC catalogs. These observations provide a large database of accurate topocentric and homogeneously determined positions and magnitudes for specially selected 96 perturbed asteroids which can be used to calculate dynamical masses for asteroids. Comparison of mass values and their errors of the 21 large perturbing asteroids using observations at RTT150 and without one are presented.

18. Astrophysics in Kazakhstan: past, present and future

Omarov C.
Fessenkov Astrophysical Institute, Kazakhstan

Astronomical observations in Kazakhstan are carried out for over 60 years. The advantage of the geographical location makes it possible to set and conduct programs of stationary ground-based observations, that from the most observatories of other countries are difficult or impossible. Today astrophysical research in Kazakhstan is being developed in theoretical and observational aspects. In particular, computational astrophysics and stellar dynamics is gaining more momentum due to international collaboration. Meanwhile one of the main project in observational research is to build a new 3,6 ground telescope and to participate in the international space project "World Space Observatory - Ultraviolet".

19. Capabilities of ISON observatories for GAIA-FUN-SSO support (poster)

Pavlova E.[1], G. Borovin[1], I. Molotov[1], M. Zakhvatkin[1], L. Elenin[1], Yu. Krugly[2], V. Rumyantsev[3], M. Krugov[4], R. Inasaridze[5], V. Ayvazian[5], O. Burkhonov[6], Sh. Ehgamberdiev[6]
[1] *Keldysh Institute of Applied Mathematics, Russian Academy of Sciences*
[2] *Institute of Astronomy, Kharkiv National University*
[3] *Crimean Astrophysical Observatory*
[4] *Fesenkov Astrophysical Institute, Almaty, Kazakhstan*
[5] *Kharadze Abastumani Astrophysical Observatory, Ilia State University*
[6] *Maidanak Astronomical Observatory, Ulug Bek Astronomical Institute UzAS*

Since 2009 the International Scientific Optical Network (ISON), coordinated by the Keldysh Institute of Applied Mathematics (KIAM RAS), is consistently implementing a research program called ASPIN (Asteroid Search and Photometry Initiative). The ASPIN goals are to search of small bodies in the Solar system: study of orbital and physical parameters of NEAs; discovery and follow-up of new objects; creation of new telescopes and sophisticated software to search for asteroids. In frame of this Initiative is planned to involve several 0.4 - 2.6 m telescopes to confirm the observations of Solar system objects which will be discovered by Gaia. Among which the telescopes are included the 2.6 m Shain Telescope

at the Crimean Astrophysical Observatory, the 1 m Zeiss Telescope (the Eastern one) at the Tien-Shan Observatory of the Fesenkov Astrophysical Institute and the other. In the report capabilities of ISON observatories will be presented to be used for Gaia observations support.

The main interest for ISON network (that now comprises more than eighty telescopes on five continents) is the optical observations of space debris and artificial satellites. The observing objects in frame of ISON include also the space observatories in high apogee orbits like for Spektr-R mission (Radioastron), to provide the ballistic optimizing control.

We also describe main ballistic aspects for a spacecraft orbiting near the L2 Lagrange point of the Sun-Earth system. A libration point of mission design always assumes a certain orbital accuracy, which is required for motion prediction and planning maneuvers to maintain station. While standard slant range and Doppler observations are used to measure only radial parameters, fairly easy accessible optical observations of right ascension and declination provide the missing data of direction to the spacecraft. The report contains assessments of how the utilization of angles observations impacts on the accuracy of orbit determination of a spacecraft near L2 point.

ISON observatories can be equipped with a robotic telescope control software - KDS, which can observe Gaia alerts in near-realtime mode. This system already testing at ISON-NM Observatory (MPC code: H15) for gamma-ray bursts alerts. KDS system works with VOEvent sockets - receiving and processing alerts in XML format and can be shortly upgraded for the Gaia alerts.

ISON-NM Observatory already joined to Gaia-FUN observing campaigns, including observations of two NEAs (1996 FG3 and 2013 TV135). ISON-NM doing our survey work since July 2010. For this time, observatory already made 492,000 astrometric observations, which was sent to MPC. Obtained 1469 provisional designations of asteroids, discovered 4 NEAs, 2 Centaurs, 21 Jovian Trojans and 2 comets.

20. The European NEO Coordination Centre and the Gaia opportunity (invited)

Perozzi E. and the ESA SSA NEO Team
Deimos, Spain

An operational approach to NEO hazard monitoring has been developed at European level within the framework of the Space Situational Awareness Program (SSA) of the European Space Agency (ESA). Through federating European assets and profiting of the expertise developed in European Universities and Research Centers, it has been possible to start the deployment of the so-called SSA NEO Segment. This initiative aims to provide a significant contribution to the worldwide effort to the discovery, follow-up and characterization of the Near Earth Object population. A major achievement has been the inauguration in May 2013 of the ESA NEO Coordination Centre located at ESRIN (Frascati, Italy). The goal of the NEOCC Precursor Service operations is twofold: to make available state-of-the-art information on the NEO population and to contribute to optimize the NEO observational efforts. This is done by maintaining and improving a Web Portal publicly available at http://neo.ssa.esa.int and by performing follow-up observations through a network of collaborating telescopes and facilities. Within this framework a summary of the first two years of NEOCC operations is presented, including collaborations with the Gaia-FUN-SSO; the perspectives given by the Gaia mission operations are also discussed.

21. Gaia mission status (invited)

Prusti T.
European Space Agency

Gaia is in routine phase since July 2014. The first period of scanning through the high density regions have been completed and Gaia is now observing fields closer to the nominal stellar densities. The bright end of nominal observations has been moved from G=6 mag to G=2-3 mag. In addition all stars brighter than G=3mag are observed with a special non-intrusive imaging mode so that sub-milliarcsec astrometric parameters can also be deduced to the brightest objects on the sky. The work is still on-going to determine the optimum parameters for the faint end of Gaia and the status of that work will be presented.

22. Observations of small-size and low-elongation NEAs in RI NAO

Sybiryakova Ye, O. Shulga, Ye. Kozyryev, N. Kulichenko, V. Vovk
Research Institute "Nikolaev Astronomical observatory" (RI NAO), Nikolaev, Ukraine

Observations are carried out with using of KT-50 telescope (D=0.5m, F=3.0m) and combined observation method [1]. The telescope equipped with CCD-camera Apogee Alta U9000 (3kx3k) and camera rotator (special device that rotate of CCD-camera around of optical axis of telescope). Field of view of the telescope is 0.7°x0.7°. Since 2008, 4000 positions of 219 near earth asteroids have been obtained on KT-50 telescope. Use of the combined method allowed us to obtain observations of 12 NEAs with diameter less than 140 m (all observations obtained on the distance from the Earth less than 0.05 a.u.). In 2014 observations of 3 low-elongation NEAs with solar elongation less than 45° were obtained. 62 potentially hazardous asteroids were observed. The follow-up observation of 4 candidate NEOs with apparent motion higher then 5.6?/min are conducted in RI NAO. The observations of NEAs 2014HQ124, 2013 TV135, 2002 GT, Apophis and 2005YU55 were obtained within the framework of the GAIA-FUN-SSO campaigns of observation.

[1]. Shulga O. Kozyryev Y., Sybiryakova Y. Observation of NEO having high apparent rates with Mobitel telescope\\ Proc. Of Gaia follow-up network for solar system objects workshop held at IMCCE- Paris observatory, France, 2011, P. 97–100

23. Updates on Gaia observations of Solar System object

Tanga P.
Lagrange Lab. - Observatoire de la Côte d'Azur, Nice, France

With this presentation we will review the current status of Solar System object observations with Gaia, especially concerning the plans for the activation of the alerts. Gaia is currently scanning the sky with the Nominal Scanning Law, that will remain constant for a long part of the mission duration. Known problems of straylight and mirror contamination don't affect strongly the astrometry of the observed sources. We were able to identify and study the properties of Solar System object observations and the dedicated data reduction pipeline will soon run routinely, producing data for the ground based network.

24. The Gaia-FUN-SSO network : status and objectives

Thuillot W., B. Carry, P. David, J. Berthier, Hestroffer D.
IMCCE-Paris Observatory, France

The Gaia-FUN-SSO network for the ground based follow-up of Solar System Objects has been set up starting from 2008. Since this date many participants joined it and several have contributed to training campaigns. Now, almost three months after Gaia entered into the operation phase, this network is still awaiting the Solar System Objects alerts but is ready to react. In this talk we recall the structure, the goals and the status of this activity.

25. Determination of small Solar system bodies orbits elements on astrometrical observations with OMT-800 telescope

Troianskyi V.V., A.A. Bazey, V.I. Kashuba, V.V. Zhukov.
Astronomical observatory of Odessa National University, Ukraine

From the beginning of operation in late 2012 of the new telescope OMT-800 [1] we were able to receive high-precision differential astrometrical observations of geostationary objects, asteroids and comets brighter than 21 Mag. In this work, the technique of calculation of orbits elements and forecasting of a trajectory of the movement of geostationary objects and asteroids is considered. For every object, we determine approximate orbits elements using any three observations with classical methods of Gauss and Laplace. Than the orbits elements are clarifies using all observations with method of differential correction [2]. We compare the received position vector to data of Minor Planet Center [3] and use it for an ephemeris calculation. The differential equations of celestial motion are solved by numerical integration with Everhart's method in the Cartesian coordinates [4]. In dynamical model of the motion gravitational potentials from eight major planets, the Moon and 343 most massive small bodies are considered. Also oblateness of the Sun, Earth, Moon, Jupiter and Saturn are considered. At numerical integration, an initial position vector of major planets and the Moon are taken from the DE431Jet Propulsion Laboratory numerical theory [5].

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5. http://ipnpr.jpl.nasa.gov

26. Method of Determining Small Bodies' Orbits Based on an Exhaustive Search of Orbital Planes

Vavilov D. and Medvedev Y.
Institute of applied Astronomy of Russian Academy of Science

We have developed a new method for determination of small bodies' orbits in the Solar system using their positional observations. In this method the exhaustive search for heliocentric orbital planes of a small body is used. For each plane we obtain the geocentric distances of a small body at times of observations. The orbital elements are determined by the Gauss method using two heliocentric positions (generally positions for the first and the last observations). The obtained sets of elements are used to calculate the rms between the observed and calculated positions. Then we choose the plane which gives the least rms. Afterwards the elements associated with this plane are improved using the differential method taking into account all significant perturbations. The orbits of 34 randomly selected newly discovered asteroids were calculated by proposed method and coincide with orbits published in Minor Planet Center. The classical Gauss method for determination the orbit of an asteroid using 3 optical observations failed for 11 of them.

Reference: Yu. S. Bondarenko, D. E. Vavilov, and Yu. D. Medvedev *Method of Determining the Orbits of the Small Bodies in the Solar System Based on an Exhaustive Search of Orbital Planes*, Solar System Research, 2014, Vol. 48, No. 3, pp. 212–216.

27. Gaia as a Transient Survey (invited)

Wyrzykowski L.
Warsaw University Astronomical Observatory, Poland

I will describe the activities which turn Gaia mission into an all-sky transient survey with near-real-time data analysis, detections and classifications of transient astrophysical objects. Those include: supernovae, novae, microlensing events, tidal disruption events, and others. Some first results will be presented as well as the organization of the ground-based follow-up observations.

28. The SBG Telescope of the Astronomical Observatory of the Ural Federal University: Opportunities for Gaia-FUN-SSO

Zakharova P. and Kuznetsov E.
Ural Federal University, Russia

Regular astrometric observations of small bodies of the Solar System are conducted using a SBG telescope of the Astronomical Observatory of the Ural Federal University (AO UrFU). The four-axis telescope with a 788 mm focal length is equipped with a Schmidt optical system and a 500 mm diameter main mirror. An Alta U32 CCD camera with a KAF-3200ME-1 CCD matrix containing 2184 × 1472 elements, each of size 6.8 × 6.8 μm is mounted at the main telescope focus. The scale of the CCD image is 1.8 arcsec/pixel. The field of view of the system is 65 × 44 arcmin. The precision timing system uses a 12-channel GPS receiver Acutime 2000 GPS Smart Antenna. Initially, the SBG telescope was supplied with photo plates as radiation receivers. The astrometrical processing of the CCD observations of minor planets from the telescope is carried out in the Astrometrica software. There are same results for campaigns of observation. The asteroid 2013 TV135 was observed in October 2014. The asteroid 2007 HB15 was not detected because it was very faint object for SBG telescope. The NEO 2014 HQ124 was not observed because the sky was very light in nautical twilight near a day of summer solstice. Several asteroids were observed by the SBG telescope for other

programs of observation. With the SBG telescope it carried out observations of large number of the Small Solar System bodies and other objects. This telescope can efficiently participate in Gaia-FUN-SSO Network.

29. Observations of NEAs with the Lijiang 2.4m telescope

Zhang Xi-Liang
Yunnan Observatories / CAS, China

Introduce the Lijiang 2.4m telescope and give the astrometric results of some NEAs observed with it.

LIST OF THE REGISTERED PARTICIPANTS

1. Aldiyar Agishev (Al-Farabi Kazakh nat. univ., aldyiyar_agyshev@mail.ru)
2. Martin Altmann (ZAH Heidelberg, Germany, maltmann@ari.uni-heidelberg.de)
3. Jean-Eudes Arlot (IMCCE, Paris Observatory, France, arlot@imcce.fr)
4. David Bancelin (IMCCE, Paris Observatory, France, bancelin@imcce.fr)
5. Irina Belskaya (Inst. Astron., Kharkiv National Univ., Ukraine, irina@astron.kharkov.ua)
6. Philippe Bendjoya (OCA, France, bendjoya@unice.fr)
7. Mirel Birlan (IMCCE, Paris Observatory, France, birlan@imcce.fr)
8. Benoît Carry (IMCCE, Paris Observatory, France, bcarry@imcce.fr)
9. Alberto Cellino (Torino Observatory, Italy, cellino@oato.inaf.it)
10. François Colas (IMCCE, Paris Observatory, France, Francois.Colas@imcce.fr)
11. Goran Damljanovic (Astron. Obs., Belgrade, Rep. Serbia, gdamljanovic@aob.bg.ac.rs)
12. Pedro David (IMCCE, Paris Observatory, France, david@imcce.fr)
13. Siegfried Eggl (IMCCE, Paris Observatory, France, siegfried.eggl@imcce.fr)
14. Zeki Eker (Akdeniz Univ., Dept Space Sc.Techn., Antalya, Turkey, eker@akdeniz.edu.tr)
15. Orhan Erece (Akdeniz Univ., Spa. Sc.Tech., Antalya, Turkey, orhanerece@gmail.com)
16. Vira Godunova (ICAMER Observatory,NASU, Ukraine, v_godunova@bigmir.net)
17. Denis Gorshanov (Pulkovo observatory, Russia, dengorsh@mail.ru)
18. Mikael Granvik (Dep. of Physics, University of Helsinki, Finland, mgranvik@iki.fi)
19. Selcuk Helhel (Akdeniz Univ., Antalya, Turkey, selcuk.helhel@tubitak.gov.tr)
20. Daniel Hestroffer (IMCCE, Paris Observatory, France, hestro@imcce.fr)
21. Anatoliy Ivantsov (Technion , Israel Inst. Tech., Haifa, Israel, ivantsov@tx.technion.ac.il)
22. Gizem Kahya (TUBITAK National Obs., Turkey, gizem.kahya@tubitak.gov.tr)
23. Süleyman Kaynar (TUBITAK National Obs., Turkey, suleyman.kaynar@tubitak.gov.tr)
24. Irek Khamitov (TUBITAK National Obs., Turkey, irek_khamitov@hotmail.com
25. Sergii Khlamov (Kharkiv National Univ. of Radio Electronics, serik2010@yandex.ru)
26. Irina Kovalenko (IMCCE, Paris Observatory, France, ikovalenko@imcce.fr)
27. Yurij Krugly (Inst. Astron.,Kharkiv Nat. Univ., Ukraine, yurij_krugly@yahoo.com)
28. Maria Kudryashova (IMCCE, Paris Observatory, France, mkudryashova@imcce.fr)
29. Eduard Kuznetsov (Ural Federal University, Russia, eduard.kuznetsov@urfu.ru)
30. Nadia Maigurova (Nikolaev Observatory, Ukraine, nadia4mai@yahoo.com)
31. Chingis Omarov (Fessenkov Astrophysical Institute, chingis.omarov@gmail.com)
32. Thierry Pauwels (Koninklijke Sterrenwacht van Belgi, thierry.pauwels@oma.be)
33. Elena Pavlova (Keldysh Inst. of Applied Math., Moscow, Russia, elenae312@gmail.com
34. Ettore Perozzi (Deimos Space, Spain, ettore.perozzi@deimos-space.com)
35. Gennadiy Pinigin (Nikolaev Observatory, Ukraine, gpinigin@ya.ru)
36. Dumitru Pricopi (Astron. Inst. of the Romanian Academy, dpricopi@aira.astro.ro)
37. Timo Prusti (ESA, ESTEC, the Netherlands, tprusti@rssd.esa.int)
38. Jean-Pierre Rivet (OCA, France, jean-pierre.rivet@oca.eu)
39. Vasilij Rumyantsev (Crimean Astrophysical Observatory, rum@crao.crimea.ua)
40. Davesh Path Sariya (ARIES, India, devesh@aries.res.in)
41. Marian Doru Suran (Astron. Institute of the Romanian Academy, suran@aira.astro.ro)
42. Yevgeniya Sybiryakova (Nikolaev Astron. observatory, Ukraine, evg_sibir@mail.ru)
43. Paolo Tanga (OCA, France, Paolo.Tanga@oca.eu)
44. William Thuillot (IMCCE, Paris Observatory, France, thuillot@imcce.fr)
45. Volodymyr Troianskyi (Astron. Obs. of Odessa University, v.troianskyi@onu.edu.ua)
46. Dmitrii Vavilov (Inst. of Applied Astron. of Russian Acad. Sc., Russia, dj_vil@bk.ru)
47. Lukasz Wyrzykowski (IoA, Cambridge, UK & Warsaw, Poland, wyrzykow@ast.cam.ac.uk)
48. Polina Zakharova (Ural Federal University, Russia, polina.zakharova@urfu.ru)

49. Xiliang Zhang (Yunnan Observatories,CAS, China, zhangxiliang@ynao.ac.cn)

Committees

The members of the Scientific Organizing Committee are:

- W. Thuillot, co-Chair, IMCCE, France, (thuillot (at) imcce.fr)
- P. Tanga, co-Chair, OCA,France, (Paolo.Tanga (at) oca.eu)
- B. Carry, IMCCE, Paris Observatory, France (bcarry (at) imcce.fr))
- A. Cellino, Torino obs., Italy, (cellino (at) oato.inaf.it)
- D. Hestroffer, IMCCE, Paris Observatory, France (hestro (at) imcce.fr))
- F. Mignard, OCA, France, (francois.mignard (at) oca.eu)
- E. Perozzi, Deimos, Spain (ettore.perozzi (at) deimos-space.com)
- L. Wyrzykowski, University of Warsaw, Poland (wyrzykow (at) ast.cam.ac.uk)

The members of the Local Organizing Committee are:

- D. Hestroffer (chair, Daniel.Hestroffer@imcce.fr),
- W. Thuillot (co-chair, William.Thuillot@imcce.fr),
- R. Amhidez,
- K. Mesloug,
- F. Noctulle

Contact:

Mail: gaia-fun-sso@imcce.fr Web: http://www.imcce.fr/hosted_sites/gaiafun2014/

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