

DIVISION A / WORKING GROUP ASTROMETRY BY SMALL GROUND-BASED TELESCOPES

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TRIENNIAL REPORT 2012-2015

1. Introduction

At the XXVIth IAU General Assembly in 2006 the Division I (now Division A) decided to create the WG on Astrometry by Small Ground-Based Telescopes (WG-ASGBT). Its scientific goals are to foster the follow-up of small bodies detected by the large surveys including the NEOs; to set-up a dedicated observation network for the follow-up of objects which will be detected by Gaia; to contribute to the observation campaigns of the Sun, mutual events of natural satellites, stellar occultations, and binary asteroids; and to encourage teaching astrometry for the next generation. The present report gives the main activities carried out in these areas with small telescopes (diameter less than 2 m). Further information is also available on the web site <http://www.imcce.fr/astrom/astrom.html>

2. Research developments within the past 2012-2015 triennium

The members of the working group reported on their recent activities in astrometry by small ground-based telescopes carried out by themselves or their team. We summarize these reports below.

M. Assafin (Obs. do Valongo, Rio de Janeiro, Brazil) reported on the activity of the Rio astrometric group. Astrometry of natural satellites of giant planets, including irregular ones, is performed at the 1.6 m and 0.6 m of the Pico dos Dias Observatory (IAU code 874). This group also gives important contributions to the international campaigns of observation of the mutual events of the satellites lead by IMCCE, recently for the 2014-2015 events with Galilean satellites. A strong effort by the group is done in the collaboration with B. Sicardy (Paris Observatory) for the predictions of stellar occultations by Pluto, transneptunian and Centaur objects. This also involves observations with 40 cm to 2 m diameter telescopes by Chilean and Spanish colleagues. Many works have been published based on these observations (see Sicardy et al., Assafin et al., Braga-Ribas et al., Camargo et al., 2012-2015).

W. Thuillot reported that, during the last triennial at IMCCE-Paris Observatory, himself and his collaborators have developed several astrometric activities related to the planetary natural satellites and to the asteroids. Between June 2011 and May 2015, IMCCE has coordinated a FP7 European project entitled ESPaCE (European Satellite Partnership for performing Ephemerides) involving seven European institutions (see <http://espace.oma.be>). The goal of this project is in particular to provide new accurate astrometric data both from ground-based and space-based archives and to compute new ephemerides on this basis. A data base, named ESPaCE-NSDB, including more than 17 000 astrometric measures of the Martian, Jovian, Saturnian, and Uranian satellites has been set up. A part of these observations is issued from the digitizing of photographic plates with the DAMIAN machine at the Royal Observatory of Belgium, in particular those performed at the USNO 66-cm refractor. Another part is composed of mutual events (Galilean moons, Saturnian and Uranian moons) observed by small telescopes during the last periods of these events. New ephemerides of these satellites have been performed. ESPaCE-NSDB and the new ephemerides will be made public soon. Several publications are issued from this work (Thuillot et al. 2014, Arlot et al. 2012, 2013, 2014, Robert et al. 2011, 2014).

Otherwise, in order to prepare the follow-up of the Gaia mission concerning the detection of new Solar System Objects (SSO), Dr. Thuillot also reports that IMCCE had set-up a ground-based network of observing stations named Gaia-FUN-SSO in the framework of the Gaia DPAC consortium. A total of 57 observatories declared their interest and registered, 80 telescopes could be involved. Training observations were organized for astrometry observations during the close approaches of Near-Earth Asteroids (Bancelin et al. 2012, Todd et al. 2013). The network is ready to react when Gaia alerts will be triggered. Two new Gaia-FUN-SSO workshops have been organized in 2012 and 2014 in Paris Observatory (see http://www.imcce.fr/hosted_sites/gaiafun2014/). A third workshop is programmed to November 2015 also at the Paris Observatory.

F. Taris reported on the AGN observations with small robotic telescopes for the link between the future Gaia-CRF and the ICRF. In the radio domain the morphology of an extragalactic radio-source (structure with size up to the mas level) is correlated to its flux variability (jets). The effect of source structure on position as been studied and has been found as large as tens of milliarcseconds (mas). In the same way the variability in the optical domain is probably an indication about some underlying astrophysical phenomena. These phenomena could be at the origin of a modification of the morphology of the targets. As the position of the photo-center is directly linked to this morphology, it is of great importance to study the magnitude/morphology variations.

During the last years the SYRTE department of Paris observatory was engaged in the observation of AGN for the link of the future Gaia-CRF to the ICRF. Both reference systems would have similar uncertainties about the coordinates of the constituting targets. The observations were made with large facilities (2m-Rozhen, NOT, 2p2, CFHT) for studying the morphology of the targets but also with small robotic telescopes (TAROT in France and Chile, TJO in Spain). The later are used with the goal of monitoring the magnitude of the targets. The observations were analyzed by Taris et al. 2011, 2013, 2015. The laboratory is also engaged in the building of a robotic telescope that would be dedicated to the observation of AGN for the reference systems.

T. Pauwels reported on the Royal Observatory of Belgium activities in the framework of this WG. Nights were spent for astrometric observations of minor planets, with 167 positions of minor planets published in the Minor Planet Circulars since July 1, 2012. It is worth mentioning that an asteroid first detected at the Royal Observatory of Belgium, 2012 BS67, was used to test the Gaia-FUN network.

G. Damjanovic reported on some of his activities at the Astronomical Observatory in Belgrade (AOB, Serbia). He studied ICRF objects (QSOs), visible in the optical domain, to be used in the link between the ICRF with the future Gaia CRF, in cooperation with the Paris Observatory. He also worked with WEBT (Whole Earth Blazar Telescope) objects in the field of Extragalactic Astronomy, to investigate the AGN-Active Galactic Nuclei, in cooperation with the Torino Observatory. And he also observed objects in the Gaia-FUN-TO (Gaia-Follow-Up Network for Transients Objects) for photometric alerts, in cooperation with L. Wyrzykowski (Cambridge). The obtained results can be seen in Damjanovic et al. (2014) and Vince & Damjanovic (2014, *Serb. Astron. J.* 188). They are in line with morphology and photometry investigations of ICRF objects and 105 objects presented by Bourda et al. (2011), about WEBT objects. Some further papers are prepared for press, like the one involving Gaia-FUN-TO objects; some results were also presented at a few conferences.

The telescopes used for the optical observations are: 1) the 60 cm ASV one (Astronomical Station Vidojevica of AOB, Serbia; 2) the 60 cm Belogradchik AO (Bulgaria) one; 3) the 2 m Rozhen one (Institute of Astronomy with National Astronomical Observatory of Bulgarian Academy of Sciences, Bulgaria); 4) the 1.5 m LFOA (Leopold Figl Observatorium fuer Astrophysik of Vienna University, Austria).

R. Teixeira (Observatório Abrahão de Moraes, IAG/USP, Brazil) reported on new observations with the CCD Meridian Circle of the Abrahão de Moraes observatory in Valinhos, São Paulo state, Brazil. Astrometric and photometric observations of pre-main

sequence (PMS) stars and of stars from the TW Hydrae forming region were made. He also reported on the observation of artificial satellite space debris in collaboration with the Shanghai observatory using a 16-inch MEADE telescope installed at the Abrahão de Moraes observatory.

W. van Altena (Yale Southern Observatory) reported on the continuation of observations in preparation for an improved and expanded SPM5 catalog with the 51-inch Double Astrograph at El Leoncito, Argentina, run in collaboration with the Observatorio Astronómico Félix Aguilar of the Universidad Nacional de San Juan, Argentina. Observations are extending the coverage north of the -21 degree declination limit of the SPM4 and replacing second-epoch photographic plate coverage with new CCD frames being taken by observer Federico Podestá. After 52 years of collaboration between the YSO and the Universidad Nacional de San Juan, Yale has donated the double astrograph and all associated facilities to the UNSJ. It is anticipated that observational programs directed towards the SPM5 will continue and that the UNSJ will expand its use of the double astrograph.

3. Teaching and public outreach activities within the past 2012-2015 triennium

R. Teixeira (Observatório Abrahão de Moraes, IAG/USP, Brazil) reported that an 11-inch Celestron telescope operated by remote control via internet is being used for school teaching (targets are children and teenagers). Another two 12-inch MEADE telescopes are also available for scientific outreach for the general public.

M. Assafin reported that the Bollen and Chivens 0.6m telescope and the 0.6m Zeiss one at the Observatório do Pico dos Dias, LNA, Itajubá, Brazil, IAU code 874, are used one week per semester for teaching activities for graduating and pos-graduating students.

W. Thuillot reported on the realization of the "Second Astrometry Spring School on the Observation of Solar System Bodies and Data Reduction" in China between 12-16 November 2012. The local Organizing Committee was composed by Dr. William Thuillot, IMCCE-Paris Observatory, France (Chairman), Dr. Kaixian Shen, National Time Service Center of China (Co Chairman), Dr. Jean-Eudes Arlot, IMCCE-Paris Observatory, France, Dr. Daniel Hestroffer, IMCCE-Paris Observatory, France, Dr. Alain Vienne, IMCCE-Paris Observatory, France, Dr. Anatoliy Ivantsov, Nikolaev Observatory, Ukraine Dr. Anatoliy Ivantsov, Nikolaev Observatory, Ukraine, Dr. Zeki Eker, TÜBİTAK National Observatory, Turkey, Dr. Zhenghong Tang, Shanghai Astronomical Observatory, China, and Dr. Qingyu Peng, Jinan University, China.