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

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TRIENNIAL REPORT 2015-2018

1. Introduction

The ASGBT (Astrometry by Small Ground Based Telescopes) Working Group was set up in 2006 during the XXVIth IAU General Assembly in Prague by the Division 1 (Fundamental Astronomy). Since then it has been successively extended, the last time by Division A during the XXIXth IAU General Assembly held in Honolulu in 2015.

The goal of this WG is to update and maintain information on astrometric programmes and activities carried out with small telescopes, to diffuse news through these pages and by e-mails, to facilitate the collaborations and to help for the coordination of the activities, when possible, in astrometry from ground-based telescopes. These telescopes are generally easier to access than the larger ones and allow us to carry out observational programs on medium and long term. Thanks to that they are precious tools to contribute to the advance of our knowledge of the celestial bodies: many Solar System objects and some astrophysical objects. More generally, the small telescopes due to their number and their geographical spread, are very efficient for observation in network. This is a strength which is successfully applied for coordinated programs.

2. Developments within the past triennium

W. Thuillot reports that in this period IMCCE, Paris Observatory, France, worked in the following domains related to astrometry by small based ground telescopes: validation and follow-up of the Gaia discoveries of Solar System Objects, exploitation of astrometric observations of natural satellites, organisation and participation to a campaign of observation of mutual events.

A Follow-Up Network, Gaia-FUN-SSO, has been set up for the reaction on alert when new Solar System Objects are detected by Gaia. In order to train the network, several observations on alert had been organized during Near-Earth Objects approaches (Thuillot & al., 2015). Starting from October 2016, an alert pipeline is operating (Tanga & al., 2016) and transforms the Gaia data from L2 into topocentric data which are diffused at the address https://gaiafunsso.imcce.fr. More than 1500 alerts have been triggered in one year and 41 candidates have been reported. The astrometric data is sent to the Minor Planet Center in order to feed the asteroid database. The most productive observatories are Haute-Provence, Odessa-Mayaki, Terskol and Caussols, all operated with telescopes smaller than D=2m.

IMCCE has also coordinated the FP7 project ESPaCE (European Satellites Partnership for Computing Ephemerides) until mid 2015. This project allowed for gathering and exploiting astrometric data on natural satellites from small telescopes, for use in studies of the dynamics of several natural satellites: Saturnian satellites (Thuillot & al., 2016) Mars satellites (Robert & al., 2015), irregular satellites (Gomes & al., 2015).

In 2015 a new campaign of observation of mutual events (eclipses or occultations among satellites) of the Galilean satellites was organised and coordinated by IMCCE and the Sternberg Astronomical Institute in Moscow (Saquet & al., 2018). These photometric observations serve for astrometric purposes. They are performed by small telescopes and lead to very accurate astrometric measurements that feed the dynamical development of the natural satellite models. This campaign provided more than 600 lightcurves and also equatorial positions of the Galilean satellites with better than 50 mas precision.

Jean-Eudes Arlot continued with his project of digitizing old photographic plates of natural satellites with a new precise scanner machine under the auspices of the IMCCE - Observatoire de Paris, France. Dan Pascu from USNO made a huge contribution on this respect by allowing for the loaning of a 30-year photographic plate archive of planetary moons to IMCCE. It includes the moons of Mars, satellites I-V of Jupiter and satellites I-VIII of Saturn. The 13-year plate archive of the Satellites of Saturn taken at Johannesburg by Alden and OConnell was also loaned. In addition, a 20-year CCD archive of the inner moons of Jupiter and Saturn, Uranus I-V and Neptune I-II was also furnished.

N.Zacharias reports that the USNO Robotic Astrometric Telescope (URAT) has been successfully moved to Cerro Tololo in October 2015 and since then has taken over 188,000 exposures (each 28 sq.deg). The main goal is to supplement Gaia with observations of bright stars (up to Sirius) through a neutral density spot filter.

The URAT Parallax Catalog south (UPCs) was completed after 2 years of observing at Cerro Tololo, giving trigonometric parallaxes of 916 newly discovered stars within 25 pc (Finch, Zacharias & Jao, submitted), following the UPC north data release by Finch & Zacharias (2016). The UCAC5 catalog by Zacharias & al. (2017) was published as CDS catalog I/340 combining UCAC data with Gaia DR1 to obtain new proper motions.

The US Naval Observatory acquired a new 1m, fully robotic telescope (DST = Deep South Telescope) to be used for astrometry at Cerro Tololo beginning in late 2018.

Observations of bright stars in the northern sky are ongoing with the UBAD project using the 1.55m telescope at the Naval Observatory Flagstaff Station.

USNO continues with astrometric observations for supporting the observation of stellar occultations by Pluto and other transneptunian objects.

W. van Altena reports that the 50 cm double astrograph, its equipment and all of associated facilities at El Leoncito, Argentina, were officially donated by the Yale Southern Observatory to the Universidad Nacional de San Juan on March 15th, 2015 at the completion of their principal research investigation, the Southern Proper Motion survey. The UNSJ is continuing their observational programs under the direction of Carlos E. Lopez. William Van Altena's recent book "Astrometry for Astrophysics: Methods, Models, and Applications" keeps being a valuable resource for graduate students as well as for astronomer researchers.

G. Damljanovic reported the establishment of a new site, the ASV (Astronomical Station Vidojevica of the Astronomical Observatory of Belgrade, Serbia), with a new 1.4 m telescope from mid-2016 (made by ASA, Austria) under the scope of the BELISSIMA FP7 project (see www.aob.rs). There, there is also a new 60 cm telescope from 2010. The "Serbian-Bulgarian mini-network telescopes" (now, 6 telescopes) was also put into operation. All these instruments are collecting useful data. For Gaia astrometry, about 35 ICRF2 QSOs were observed during 2015-2017 for morphology investigations using the 2m Rozhen telescope at Bulgaria. For the GAIA-FUN-TO (Gaia-Follow-Up Network for Transient Objects), from 3000 alerts released by the Gaia Science Alerts group between 2014 - 2017, 45 objects were observed with near 1650 CCD images via the "Serbian-Bulgarian mini-network telescopes". During 2017, about 10 objects were observed (some of them in multiple epochs) with the WEBT (Whole Earth Blazar Telescope), see Carnerero & al. (2017) and Raiteri & al. (2017a). A few papers about these objects were published, including one in Nature by Raiteri & al. (2017b).

F. Taris reports that Paris Observatory's SYRTE Department is engaged in the observation of AGN for the link of the future Gaia-CRF to the ICRF. These observations have been obtained with a set of optical telescopes spread worldwide. All these observations provided the basis of analysis published in Taris & al. (2016) and Taris & al. (2018) and references therein. These observations are currently continuing on a regular basis. In order to obtain long and well sampled time series of magnitudes, the SYRTE Department has the project of building a 1m-class robotic telescope in the French Alps, near the Italian border. This new telescope will be dedicated to the observation of quasar magnitudes and asteroid astrometry. Time will be also devoted to teachers. The anticipated site (Saint-Vran, $44^o41'49"$, $6^o54'25"$, alt. 3000m) was discovered during the 1970's when, at that time, the French government wanted to have a 3.5m telescope in France. This telescope will later become the 3.6m CFH Telescope on top of the Mauna Kea in Hawaii. In 2015 the SYRTE Department has conducted a seeing monitoring campaign and has recovered, with modern instruments, the results obtained 40 years before concerning this parameter. It was found that the mode seeing is 0.7" and the median is 1.0" (500.000 measurements during 2015-2017). In September 2017 SYRTE also robotized a small 50cm telescope to implement tests to demonstrate the feasibility of the project. This telescope already provided images and will be ready to observe on a regular basis during spring 2018. Studies are also in progress about the morphology of AGNs, but they are based on observations obtained with large facilities.

A. H. Andrei reports that Sun observations are continuing with dedicated heliometers and networks around the world. Currently, the heliometer at the National Observatory of Rio de Janeiro is facing technical problems, which can be solved exactly because small instruments are easier to be dealt with even with few resources.

R. Teixeira reports the observation of artificial satellites with the MEADE 40cm of the Abrahão de Moraes Observatory of the University of São Paulo. The observations

were made using a CCD camera in drift scan mode coupled to a rotator developed by colleagues at the Shanghai Observatory. These observations are part of a larger project in collaboration with colleagues from various institutions around the world for the astrometry of fast moving objects such as artificial satellites, debris and Near-Earth Asteroids.

T. Pauwels reports that the telescope at Ukkel, Belgium, has undergone a major maintenance in 2017. They are reviewing which observations will be resumed and which will not at the Ukkel Schmidt Telescope. The primary goal of installing a CCD camera on the telescope, now 20 years old, was to do astrometry of minor planets. At that time, it was still possible to discover plenty of new asteroids at magnitude 16 and 17. Nowadays, the knowledge of the asteroid population is almost complete up to magnitude 20, which is about the limit magnitude of the equipment, and known objects are routinely observed elsewhere. Other kinds of observations, such as mutual phenomena of the Jupiter satellites and stellar occultations by minor planets are still possible and useful, and they may switch primarily to such observations in the future, although the equipment is not really optimal for such fast acquisition rates.

M. Assafin and R. Vieira Martins report on the astrometric use of 0.6m to 2.2m class telescopes at Brazil, Chile, Australia, France and Spain in support to the observation of mutual phenomena between Jupiter Galilean satellites and stellar occultations by Pluto, the dwarf planets Makemake and Haumea, and many other transneptunian objects and Centaurs (including Chariklo and Chiron). Astrometric observations of natural and irregular satellites of giant planets were also done with these instruments. In this triennium many publications resulted from the astrometric efforts carried out by their group, see for instance Camargo & al. (2015), Desmars & al. (2015), Gomes-Junior & al. (2016) and Dias-Oliveira & al. (2017), with highlight for the Nature paper by Ortiz & al. (2017).

3. Closing remarks

Telescopes with D $<$ 2m remain quite necessary to perform alert observations and long term campaigns, which are impossible or very difficult to be carried out with larger instruments. Take as examples the successful Gaia-FUN-SSO activity on alert for asteroid discovery, and the astrometry of natural satellites for dynamics and ephemerides.

The efficiency of small instruments is steadly enhancig thanks to growing investments in high-sensivity detectors by the observatories and visitor observers. Moreover, the forthcoming second release of the Gaia catalogue will bring a remarkable improvement in the astrometry with small telescopes.

Our WG is a useful tool to diffuse information among astrometry groups. In the future this WG can be made to more actively exchange information, coordinate campaigns and set up telescope networks. Actually, first efforts have already been started toward these goals.

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chair and vice-chair of Working Group

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