

**DIVISION A
WORKING GROUP**

**ASTROMETRY BY SMALL
GROUND-BASED TELESCOPES**

*ASTROMETRIE PAR PETITS
TELESCOPES AU SOL*

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TRIENNIAL REPORT 2021-2024

1. Background

This Working Group belongs to the IAU Division A on Fundamental Astronomy. It has been initiated during the XXVIth General Assembly of the IAU in Prague, in August 2006 by Division I Fundamental Astronomy (until 2012). Since it has been extended every triennium, and, at present, it comprises of 24 members.

The goal of this continuously active Working Group is to update and maintain information on astrometric programmes and activities carried out by small telescopes, to diffuse news through web 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.

The Working Group webpage is maintained by William Thuillot and hosted at IMCCE, Paris Observatory, http://iau_wgnps.imcce.fr which is gratefully acknowledged.

2. Developments within the past triennium

Jean-Eudes Arlot (IMCCE, Paris Observatory, France) reported on the observation of mutual events of the Galilean satellites which provide high-quality data allowing to reach an unprecedented resolution in the satellites' dynamical models. A worldwide campaign of observations of the mutual events of the Galilean satellites was conducted by IMCCE, Paris, France and Sternberg Astronomical Institute, Moscow University, Moscow, Russian Federation in 2021. The magnitude of the Galilean satellites was sufficiently bright to allow observations with very small telescopes that increased the possibility of their observations. 37 observers from 18 different sites of observation observed 85 phenomena in spite of many difficulties: the campaign had to be conducted only during the occurrence of the events (when the Earth and the Sun pass through the equatorial plane of Jupiter) and during the opposition of Jupiter as seen from the Earth. Unfortunately, the maximum of events occurred during the conjunction of Jupiter with the Sun. A publication of the results is in preparation.

As well, Jean-Eudes Arlot reported on the ongoing digitizing project of photographic plates at IMCCE, Paris Observatory, France. From 1890 to 1990, astronomical observations were taken mostly using photographic plates at small telescopes with apertures from 30 cm-refractors to 2 m-telescopes. The project will consider some of these plates, reduction of them using new accurate star catalogues such as GAIA for astrometry, so it will be possible to measure the past observations with today's accuracy. The works conducted at the present time are related to natural satellites astrometry and *Be*-stars spectroscopy.

Marcelo Assafin and Roberto Vieira-Martins reported on the astrometric and photometric use of the T0.6m and T1.6m telescopes at the Observatorio do Pico dos Dias (OPD), Brazil. Dozens of nights at each telescope were used to observe small bodies, mostly TNOs, dwarf planets and natural satellites of Jupiter and Uranus, but also Jupiter Trojan asteroids. TNO observations were dedicated for the prediction and observation of stellar occultations. The Uranus system was observed with the technique of mutual approximations between the main satellites (Santos-Filho et al., 2019). Astrometry of Jupiter irregular satellites was also made. They observed 5 mutual events of the Galilean satellites plus one of Thebe that were visible at OPD for the 2021 season (Catani et al. (2023)).

Goran Damjanovich (Astronomical Observatory in Belgrade, Republic of Serbia) reported about observations of 31 double and multiple stars, as well as several GAPS and ERS objects for Gaia astrometry and photometry at 2 m Rozhen telescope (Bulgaria). In addition, 13 Gaia Alerts objects, 13 Whole Earth Blazar Telescope ones and 26 double and multiple stars were observed using the lucky-imaging technique by means of the 40 cm, 60 cm and 1.4 m telescopes of the Astronomical Station Vidojevica, (Damjanovic et al. (2023) and Jovanovic et al. (2023)).

François Taris (SYRTE, Paris Observatory, France) reported about the ELIXIR project (imageur de plusieurs degrés carrés pour explorer l'univers) that is further development of two former projects related to 1 m robotic telescope located in the French Alps and 60 cm robotic instrument in Haute-Provence. The ELIXIR will make it possible to image the entire visible sky approximately every two nights. Scientific goals of this project are multiple: observation of AGN for linking the reference systems (supported by SYRTE) and for preparation of CTA, observation of the transient sky (supported by LAM as part of the SVOM mission), and, finally, observation of asteroids and exoplanets (co-supported by IMCCE of Paris Observatory and the Observatoire de la Côte d'Azur as part of the Gaia and CHEOPS missions). The construction of three telescopes (60 cm, F/1.5, FoV=6 deg², *griz*, and H_{α} filters) with a particularly innovative optical design was completed in December 2023. They will see their first lights at the Haute-Provence Observatory site in the summer of 2024. Three CMOS wide-field cameras, one per telescope, will be necessary to achieve the scientific goals of this project and will produce 1.25 PB of data every 5 years.

Charlie Thomas Finch (U.S. Naval Observatory, USA) reported that astrometric and photometric observations continue with the Deep South Telescope (DST) after a long pause in 2020 due to the COVID-19 pandemic with 10,298 exposures taken in 2021 and 17,639 exposures taken in 2022. The main goal is to monitor a select list of extragalactic celestial reference frame sources (AGN, QSOs) to better understand the radio-optical position offsets. As a secondary project, they are also looking at implementing a bright star photometry program on the optical arm of DST taking advantage of the Marana camera capabilities. The principal instrument (Sophia 4K CCD) is still down for repairs. They plan to have the 4K back on DST by mid-year. The IR camera for the optical IR port

on DST is ready to be installed. This will support an ICRF photometric characterization and monitoring effort and allow for southern-sky imaging of infrared-bright objects.

William Thuillot (IMCCE, Paris Observatory, France) reported on the activity related to astrometry by small ground-based telescopes, focused on monitoring Gaia alerts for Solar system objects (SSOs). As soon as Gaia detects an uncatalogued mobile source, an alert is triggered via a public website to the Gaia-FUN-SSO network. At the time of writing, more than 500 uncatalogued SSOs, either newly detected or with imprecise orbits, have been observed and their astrometry have been submitted to the IAU Minor Planet Center. These observations were made by telescopes of one meter diameter or less at the Las Cumbres Global Telescope, Observatoire de Haute-Provence, C2PU at Calern-OCA, Terskol, Kyiv Comet Station, Odessa-Mayaki, Abastumani (Carry et al., 2021).

The IAU Focus Meeting 10 “Synergy of Small Telescopes and Large Surveys for Solar System and Exoplanetary Bodies Research”, <https://iaufm10.org>, supported by the Working Group was successfully held at the XXXI IAU General Assembly in Busan, Republic of Korea on August 2-11, 2022. In total, there were 49 talks communicated to the participants by 48 scientists from 27 countries within two days. The scientific organising committee comprised of three members of this Working Group (Marcelo Assafin, Anatoliy Ivantsov, and William Thuillot).

3. Conclusion and future plans

Small telescopes with apertures less than 2 m are still useful for getting accurate astrometric measurements of bright Small Solar System Bodies, natural satellites and extragalactic sources either through direct imaging or using photometric measurements of mutual events.

Follow-Up networks, observational campaigns that are *using small telescopes* have shown their high efficiency in collecting observations of moving or/and transient objects. Extension of the observational sites in longitude and latitude increases chances of getting “clear sky” necessary for successful monitoring of the objects of interest.

The Working Group facilitates sharing of information and experience, coordination of campaigns and setup of telescope networks.

Anatoliy Ivantsov and Marcelo Assafin
Chair and Co-Chair of the Working Group

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