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# Gaia contribution to the dynamics of Solar System Objects

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## Abstract

The ESA astrometric mission Gaia has been launched in December 2013. It is currently in its commissioning phase, with the first scientific data expected to be downloaded in June 2014. Gaia has the capability to observe, in addition to about one billion of stars, a large number of solar system objects (SSO) [1]. The satellite and telescope will continuously scan the sky during 5 years, providing high precision astrometry and photometry for about 300,000 asteroids (and several tens of planetary satellites and comets), as well as modest imaging for a fraction of them. The nominal limiting magnitude is expected to be V≤20, however the end of the commissioning will show the actual performances for the faint targets.

## 1. Solar system astrometry by – and with – Gaia

We will present some direct scientific outcome from the astrometry of the bodies in the various classes (NEOs, MBAs, Trojans, Centaurs and TNOs, comets and satellites). Important to notice is that Gaia will provide unprecedented high precision astrometry of Solar System Objects directly in an absolute reference frame (the Gaia catalogue by construction). Even if the actual Gaia performance are below the nominal expectations, it is worth noticing that the astrometry of SSO will be less severely affected; Gaia still providing astrometry at the mas level at the fainter end. Besides, the limiting magnitude is mostly defined by the downlink and buffering capabilities, more than the SNR limit from the telescope, that in any case is less strong for astrometry compared to RVS instrument.

Our presentation will encompasses astrometry of moving and resolved bodies from an essentially 1D signal, and, by combining the 5 years data, orbit determination and/or improvement, asteroid mass determination from close encounter and binary asteroid observations, evaluation of non gravitational forces (comets and NEOs), local test of general relativity (GR), reference frames linking.

Besides of the direct observations of SSOs, Gaia will also contribute to the study of their dynamics by combining longer-term observations. This is particular true for the planetary satellites which dynamics is governed by long period effects. High precision astrometry provides dissipation estimates in the major planet [2], to which Gaia data will contribute. Astrometry of planetary satellites is also needed to derive planetary solutions and ephemerides for the outer planets such as INPOP at IMCCE or DExx at JPL [3]. Indeed planets pseudo-positions (or their centre of mass) can be derived from the knowledge of the satellites system's dynamics, better than any direct observation of the resolved planet itself. Last, extension to longer time basis is generally interesting for the study of secular effects as the one encountered in GR.

## 2. Ground-based follow-up network of observations: the Gaia-FUN-SSO network

We will also present the ground-based support for follow-up in alert of critical object, and will touch upon the scientific exploitation for planetary satellites dynamics, stellar occultation and other applications through a combination of the ground-based and space-based data.

In case of detection of new Solar System objects by Gaia, or in case of uncertainty in the identification of a moving object, the daily data processing system will trigger an alert to a Follow-Up Network. This network, Gaia-FUN-SSO, has been set up and is monitored by IMCCE. The alerts will be disseminated among the network's members with the goal to retrieve the object and reinforce the orbital parameters. Rough information from Gaia and, in case of detection from the ground, data from the network are sent to the Minor Planet Center in order to feed the auxiliary data used by the probe during the mission. A wiki page available at https://www.imcce.fr/gaia-fun-sso/ gives a short description of the network and a registration form.

## 3. Exploitation of the Gaia reference star catalogue: the NAROO project

The arrival of the Gaia reference star catalogue will completely modify the ground-based astrometry of the solar system objects. Currently, the accuracy of such astrometric observations is limited by the reference star catalogue to about 50 mas. The use of the Gaia catalogue will allow us to have a better astrometry of SSOs by re-reducing the available observations. Indeed, the proper motion of stars in the Gaia catalogue will be good enough to ensure an accuracy of 1 mas for star of magnitude 14 and 2 mas for magnitude 16 one century ago. Then thanks to old observations made on photographic plates we will be able to observe moving solar system objects in the past with today accuracy allowing improvement of their dynamics. This new reduction will need to digitise photographic plates and would be applied to natural planetary satellites, asteroids and comets. Pre-discoveries of objects could be made on Schmidt plates either for asteroids or for comets. Preliminary tests have been made using the UCAC2 catalogue on the Jovian satellites showing positive results [5].

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