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Science alert mode for the Solar System Objects with the Gaia mission

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Abstract

Since the last decade, the number of newly discovered Near-Earth Asteroids (NEAs) has exponentially increased thanks to recent advances in ground-based astronomical surveys (LINEAR, CATALINA, etc ...). In a close future (past spring 2013), the European satellite Gaia will continously scan the sky in order to make a three dimensional map of our Galaxy. During its 5-years scanning, the satellite will observe some known objects but also some unidentified objects. We do expect some NEAs to be discovered by the satellite. But Gaia is not a follow-up mission and as a consequence, the newly discovered objets can rapidely be lost if no recovery process is done from Earth.
We present here a strategy of recovery for the science alert mode of Gaia. This strategy will have to deal with the number of alerts expected and the way to recover them from Earth. We will also present the advantage of combining space and ground-based data.

1. Introduction

Gaia is a future astrometric mission scheduled for spring 2013. The main aim of this mission is to make a three dimensional map of our Galaxy. There are a lot science outcomes from this mission : a better understanding of the star formation and the history of the Milky Way; study on stellar astrophysic, the Galactic struture, Binaries and Brown Drawfs, Solar System; test of Fundamental Physics.
As far as our Solar System is concerned, the satellite will map hundred thousands of Minor Belt Asteroids (MBA) and Near-Earth Objects (NEO) down to magnitude $V = 20$. Thanks to an unprecedented astrometric accuracy (0.3–5 mas on a transit basis) this mission will be useful for the orbital determination and orbital improvement.
During its 5-years mission the satellite will continously scan the sky with a special nominal scanning law. We estimate that only 30 % of the known population of Near-Earth Asteroids (NEA) would be observed by the satellite. We do also expect some new objects to be observed and discovered. Because of the scanning law, at the epoch of these discoveries, the satellite will generally provide only two observations separated by approximately $\Delta t \sim$ 1.5 hours. The problem is that the satellite, when observing new objects, will not follow them and they can be rapidely lost. So in order not to be lost, a Gaia Follow-up Network for Solar System Objects (Gaia FUN-SSO) is being organized in order to be ready for potential alerts [1]. For this purpose, 19 observing sites equipped with 29 various telescopes, including robotic telescopes and Schmidt telescopes, on a large geographical coverage have agreed to join this ground-based network. The goal will be to observe on alert, to detect the moving object and to provide complementary astrometric measurements. We foresee also possible photometric follow-up in case of the detection of a cometary activity.

2. Science alert mode for the Solar System Objects

The Gaia Data Processing and Analysis Consortium (Gaia DPAC) is the community structure responding the ESA Announcement of Opportunity. It involves a community of more than 400 scientists and software engineers, and is formed around a set of Coordination Unit (CU) and the unit responsible on the solar system objects processing is CU4 (manager: D. Pourbaix and P. Tanga; deputy: F. Mignard).
In the Gaia DPAC, there are two pipelines for the Solar System Objects (SSOs): a long-term processing providing orbit improvement, physical properties and global parameters and a short-term (daily) processing working on 24-48h for indentifying anomalous and/or unknown asteroids (see Fig. 1)
In a first approach, using a synthetic population of NEAs [2], we do expect a small number of alerts ($\sim$ 1 alert every 4 days) by comparing the number of known

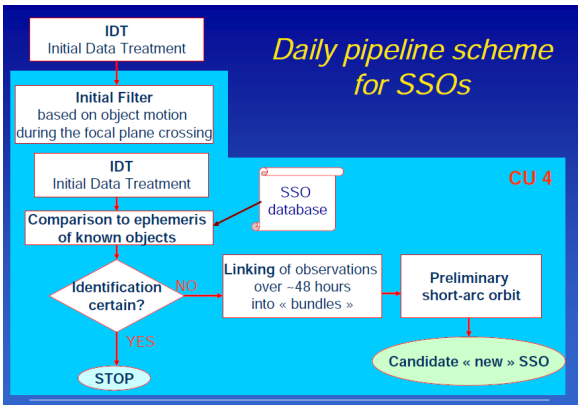

Figure 1: Daily pipeline scheme for SSOs in the Gaia DPAC.

and synthetic NEAs that will be observed by the satellite during the 5-years mission (see Fig. 2).

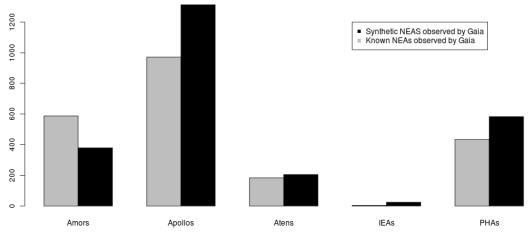

Figure 2: Number of NEAs and synthetic NEAs that will be observed by the satellite during the 5-years mission.

When a new NEA is discovered a strategy of recovery can be undertaken as represented in Fig. 3: The coordinates of the newly observed objects will be sent to Earth (within no less than 24 hours) and a preliminary short arc orbit will be computed using Statistical Ranging method [3] yielding to an (α,δ) prediction on the sky plane. With this approach we can know how long the asteroid can still be recovered. When it is recovered, it will be followed at least during one night and preferably more, in order that an improved ephemeride will be provided. The astrometric measurements will be sent to the Minor Planet Center and will permit later to the Gaia data processing to ensure the identification of the object during a subsequent scan. Beyond this goal, we foresee the detection of peculiar objects with interesting dynamics behavior, in particular inner Earth asteroids, due to the capacity of Gaia to observe at rather low Solar elongation (45 degrees). We will also analyse the effect of combining very accurate space-based data with ground-based data.

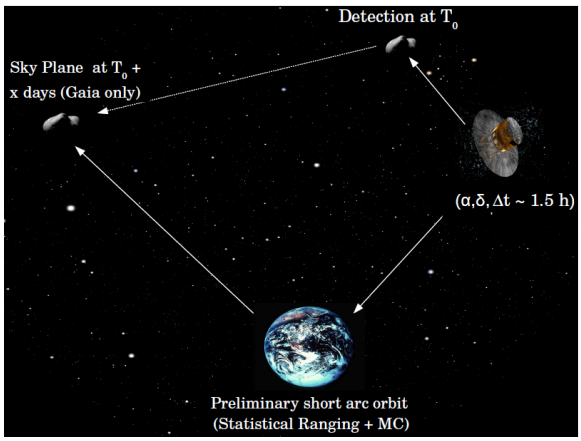

Figure 3: Strategy of recovery for newly discovered objects using only Gaia data

3. Summary and Conclusions

Even if Gaia will not be a big NEA discoverer, there is a need of the science community to support the Gaia mission in order to be ready for this opportunity of discovering new NEAs. Among them, there could be some threating Potentially Hazardous Asteroids (PHAs) and we can not afford to lose them if no Gaia FUN-SSO is organized (for further information, get in touch at gaia-fun-sso@imcce.fr).

Acknowledgements

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References

[1] Thuillot, W., Hestroffer, D., Tanga, P., Complementary ground-based observations for Solar System applications, GAIA: At the Frontiers of Astrometry, C. Turon, F. Meynadier and F. Arenou (eds) EAS Publications Series , 45 237-242, 2010

[2] Bottke, W.F., Morbidelli, A., Jedicke, R., Petit, J.M., Levison, H.F., Michel, P. and Metcalfe, T.S., Debiased Orbital and Absolute Magnitude Distribution of the Near-Earth Objects, Icarus 156, 399-433, 2002

[3] Virtanen, J., Muinonen, K. and Bowell, E., Statistical Ranging of Asteroid 0rbits, Icarus 154, 412-431, 2001 2000.