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DETECTION OF NEW ASTEROIDS BY GAIA

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Abstract. We present our results about the detection of new asteroids by Gaia. Since the end of 2016, an alerting system is operating and it reacts when unknown and moving objects are detected by the probe. In spite of the short length of the orbital arcs observed by transits in the Gaia focal plane, it is possible to calculate preliminary orbital beams and to determine search areas for a ground-based observatory. On the basis of these data, the Gaia-FUN-SSO network of observatories, set up for this task, is able to validate the detections and to consolidate the asteroid orbits.

Keywords: Gaia, Solar System Objects, asteroids, alerts, follow-up, astrometry

1 Introduction

The Gaia satellite, during its rotating sky scans, performs measures of all light sources of magnitude brighter than 20.7 and, among these sources, it can detect moving objects compared to stars. These Solar System Objects (SSO) are essentially asteroids. A specific task has been dedicated to the triggering of alerts in the short term data processing in order to deal with these detection, to broadcast public alerts and to validate the detection thanks to ground-based observatories (Tanga et al. 2016). Thus, in addition to the data on asteroids published during the DR2 in April 2018 (Gaia Collaboration et al. 2018), there is therefore a continuous publication of Gaia detections of asteroids not yet known and cataloged. These alerts are regularly accessible to the network of Gaia-FUN-SSO observatories via a website to encourage a follow-up of these new objects (Thuillot & Dennefeld 2018) .

2 The process

In case of detection of a new Solar System Object by Gaia and validation from the ground, all the astrometry measurements are sent to the Minor Planet Center to feed its database and are subsequently used to update the Gaia reference catalog of asteroids. The Gaia observations are performed for short arcs of the asteroid orbits which, despite a high precision, make impossible the determination of a reliable and unique orbit. Therefore a statistical approach is used and a bundle of possible orbits is computed (Muinonen et al. 2016) which leads to projected positions of the new asteroid on the sky. As shown in Fig. 1 our web site provide this information under the format of a skymap on a daily basis at the address: `https://gaiafunsso.imcce.fr`.

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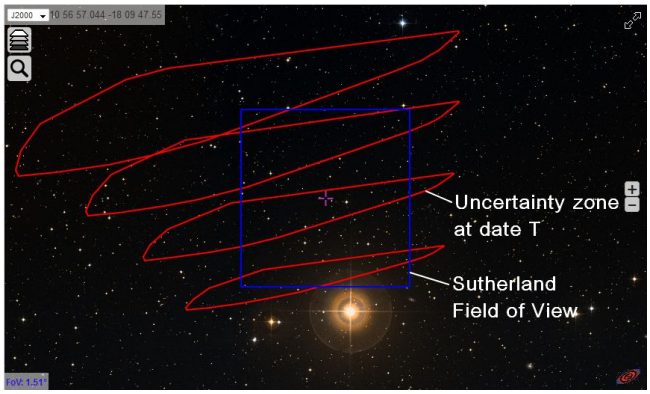

Fig. 1. Gaia-FUN-SSO website: Skymap providing at different dates the zone to search from the ground for the new asteroids detected by Gaia

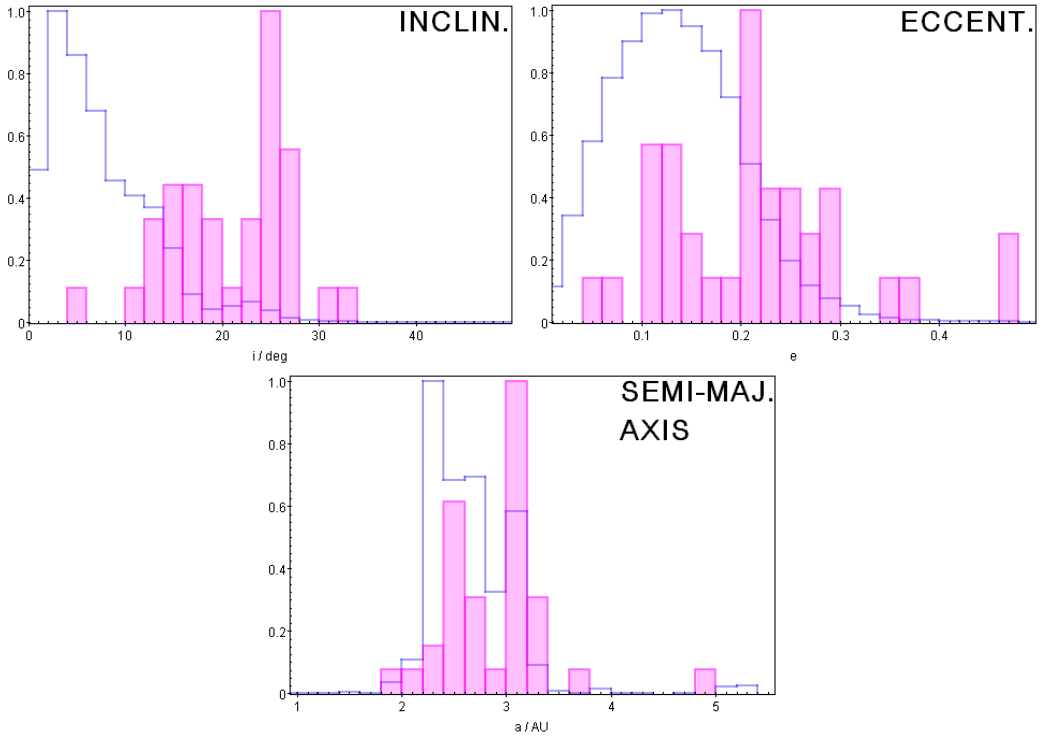

Fig. 2. Normalized histogram of the detected asteroids inclinations to ecliptic, histogram of the excentricities and histogram of the semi-major axis compared to the ones of all the population (line)

3 Results obtained

The task is rather challenging. Since the end of 2016, more than 4500 alerts have been triggered but only 150 new asteroids have been detected from the ground and 55 are validated: i.e. we got ground-based measurements dynamically compliant with the Gaia ones. These are essentially objects of the main belt, located between Mars and Jupiter. Most part of the detections were performed by the following observatories:

- Haute-Provence Observatory with the 1.2m telescope, Saint-Michel, France;
- Las Cumbres Observatory Global Telescope Network, Cal. USA, which provides a network of 1m telescopes located at Cerro Tololo in Chile, at Siding Spring in Australia, and at SAAO Sutherland in South Africa;
- Kiev Comet Station, with a 0.7m telescope, Ukraine;

- Odessa Mayaki Observatory, with a 0.8m telescope, Ukraine;
- Terskol Observatory with the 2m telescope, Kabardino-Balkarie, Russie;
- C2PU, a 1m telescope at Calern, Caussol plateau, Côte d'Azur Observatory, France.

Starting from Nov. 2018, we considered well stabilized the alert system for SSOs and we have systematically provided every Gaia data and ground based astrometry of the new detected and validated asteroids to the Minor Planet Center. Once this center is able to check the orbit, these new asteroids receive a standard provisional designation. Recently, four objects (2018 YK4, 2018 YL4, 2018 YM4, 2019 CZ10) have received designations and, unlike many other detections, Gaia was the first to observe them. These detections were validated from the ground by observations performed by the Gaia-FUN-SSO network. The European Space Agency (ESA) published on 29 April 2019 a newsletter on this subject at the address: `http://www.esa.int/spaceinimages/Images/2019/04/`

From the study of our sample of new asteroids detected by Gaia, as shown in Fig. 2 we see that they are statistically more on highly inclined orbits. We probably can account that this is partly due to the higher observation density of high ecliptic latitude zones explored through the scanning law. But this means also that this kind of asteroids are still missing in the databases. Gaia will complete our knowledge of the asteroid population even for MBAs brighter than 20.7 mag.

4 Conclusion

Many new Solar System Objects are detected by Gaia on a quasi daily basis. They require ground based validation and follow up. Observers are welcome to participate to the Gaia-FUN-SSO network for this goal. On date almost 150 new objects have been confirmed. Our first analysis shows that Gaia detects mostly high inclination and high eccentricity objects which helps for a better knowledge of the asteroid population.

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