Solar System Object alerts
Gaia-FUN-SSO activity

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- In collaboration with DPAC-CU4 members

- and the following observers:

Purpose

- To validate and exploit the Gaia detection of new moving objects
- To feed the SSO orbital data base used by Gaia (through MPC)
- To Optimize the Gaia identification of SSO
- Contribution to a better knowledge of the Solar System Structure

Detection of SSO is the basis for further studies on origin and evolution of the Solar System:

- Dynamical and physical characterization of peculiar objects
- Dynamical or physical families
- Taxonomy studies
- Threats to the Earth (NEOs)
- …
The means

- Triggering alerts for Ground based observations
- Geographical coverage => network of observatories (Gaia-FUN-SSO)
- Observations on alert on best effort basis
- Loop for feeding the Gaia auxiliary data base for identification

Diagram:

- Detection
- CU4-SSO chain
- Dissemination of alerts
- Gaia-FUN-SSO network
- Minor Planet Center data base
SSO-ST & Gaia-FUN-SSO activity

- In operation since mid-October 2016
- ~ Daily processing and diffusion of SSO alerts
- Triggering at best 48h after detection in space
- Short arc observed in space => bundle of possible orbits computed by a statistical ranging method (MCMC)
- Some difficulties to overcome...
SSO-ST & Gaia-FUN-SSO activity

- Identification of moving objects
  Artifacts (star spikes, …)
  Crowdy fields

- Transformation of coordinates
  Parallax effect
  Short arcs
  daily attitude solution 70-100 mas

Statistical ranging
MCMC => bundle of orbits
Oszkiewiczs 2009, Muinonen 2015
SSO-ST & Gaia-FUN-SSO activity

- Dissemination of “ephemerides” at https://gaiafunssso.imcce.fr
- When success: ground based astrometric data are sent to MPC by the observers
The web site

https://gaiafunsso.imcce.fr

Gaia Follow-Up Network for Solar System Objects

Goal

The Gaia Follow-Up Network for Solar System Objects (Gaia-FUN-SSO) has been set up in the framework of a task (DU459) of the Coordination Unit 4 (Object processing) of the Gaia Data Processing and Analysis Consortium (DPAC). Its goal is to coordinate ground-based observations on alert triggered by the data processing system during the mission for the confirmation of newly detected moving objects or for the improvement of orbits of some critical targets. Gaia will scan the sky following a pre-defined scanning law and such ground-based observations are required to avoid the loss of newly detected Solar System objects and to facilitate their subsequent identification by the probe.

These pages provide an access to the alerts, including the ephemeris to help finding the targets, for the registered members of the Gaia Follow-up network. The network currently consists in about 50 observers in 27 observing sites, spread all over the world (November 2016).

Workshops

Three Gaia-FUN-SSO workshops dedicated to the astrometric follow-up of the Solar System Objects have already been organized in 2010, 2012 and 2014 in Paris Observatory. Discussions has been held about this network and the tasks to be accomplished, the capabilities of the observing sites and the preliminary actions already performed.

- Proceedings of the 2010 workshop have been published and can be freely downloaded here.
- Proceedings of the 2012 workshop have been published and can be freely downloaded here.
- Proceedings of the 2014 workshop have been published and can be freely downloaded here.

Registration

To get a full access to these pages and to share data, you must be registered as active participant of this observing network. For this registration, please use this form. This network needs to have a large geographical coverage: if you are interested, do not hesitate to contact us!

Please report bugs here in project “Gaia-FUN-SSO”, or contact us at gaia-fun-ssso@moos.fr.
The web site

Public alerts: geocentric coordinates – restricted to research area < 1 sq. deg.

Potential discoveries of Solar System Objects by Gaia

This page lists all the calls, dubbed alerts for follow-up observations on Solar System Objects recently discovered by the ESA Gaia mission. In this public page, only alerts for targets brighter than V=20.5 and for which the search area on sky is smaller than 1 square degrees are listed, as seen from the geocenter. You can obtain detailed information on each alert in the Details pages (the buttons). If you want more options, especially if you plan to contribute to the network, please Register.

<table>
<thead>
<tr>
<th>List of active alerts</th>
<th>Selected alerts: 4/9</th>
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<tbody>
<tr>
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</tr>
</tbody>
</table>

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The web site

If registered: topocentric coordinates – all the current alerts for the site

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Potential discoveries of Solar System Objects by Gaia

This page lists all the alerts, dubbed alerts for follow-up observations on Solar System Objects recently discovered by the ESA Gaia mission, currently visible for the criteria you specified for your instrument (VTOHP). You can obtain detailed information on each alert in the Details pages and report the results (positive, missed) of your observations in the Report pages (see links in the table).

If you observed an alert which is no longer listed below, use this link to report observations.

<table>
<thead>
<tr>
<th>ID</th>
<th>Begin</th>
<th>End</th>
<th>$V_{mag}$</th>
<th>RA</th>
<th>Dec</th>
<th>Area</th>
<th>Name</th>
<th>Report</th>
<th>Details</th>
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Please report bugs here in project "Gaia-FUN-SSO", or contact us at gaia-fun-ssoc@mcco.fr.
Detailed information on alert

Information on the alert:

Object Information:
- Gaia ID: 419467176
- Database ID: 10140
- Name: GAA120
- Magnitude (V): 19.6
- Date of observation: 11/13/2066

Sky map:
- Field of View: 12x12 arcmin
- Most probable zone (blue)
- Zone to explore if not in the FoV (red) on date 1 and on date 2

Ephemerides:
https://gaiafunsso.imcce.fr
Minor Planet Center Statistics

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• Stats MPC at http://www.minorplanetcenter.net/iau/lists/ArchiveStatistics.html
• Number of new asteroids: still increasing => ~20 000 objects/year
Minor Planet Center Statistics

Galache et al., 2015
Gaia SSO-Short Term activity

- 1 year of Gaia measurement
- ESA simulation of the scanning law effect
- Heterogeneous exploration – mainly out of the ecliptic
Gaia SSO-Short Term activity

- 1 year of unknown **object data processed** by SSO-ST
- Total of ~43 000 alerts
- Average: 828/week  118/day
- All declinations & right ascensions
- Actually much less for one specific observatory
Thousands of alerts processed since Oct. 2016
Filtering of candidates with nb. Transits > 3
1700 alerts published from Nov. 2016 to Nov. 2017
Average of 5 alerts/day for various RA and DEC
Periodical peaks of activity
Gaia SSO-Short Term activity

Histogram of magnitudes

- 1700 alerts published from Nov. 2016 to Nov. 2017
- Mainly magnitudes 20, 20.5
Gaia SSO-Short Term activity

- large number of registered observers: ~140
- But several observers/site and several do not register their instrument
- Total of detections on date: 13 detections on alert from the ground
- 11 objects received a designation from MPC
- Most of them: Gaia alerts allowed MPC to confirm previous detections
- 3 are dynamically compliant with the Gaia data

<table>
<thead>
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<th>Odessa</th>
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</table>
Conclusion

• Since Oct. 2016, new SSO are detected by Gaia.
• The (quasi-) daily dissemination is operating
• Many observers are registered
• but we need more feedback from them (even if negative obs.)
• soon in operation:
  ✓ precision of the alerts - an improved algorithm will be implemented to publish smaller « red zones »
  ✓ Estimated apparent velocity will be published
  ✓ Ranking of the new objects candidates

Observers are still welcome!

See https://gaiafunsso.imcce.fr