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Asteroid observations by Gaia, in the Data Release 2: properties and known issues

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Abstract

The Gaia mission (ESA) published in the Gaia DR2 the astrometry and photometry for 14.099 asteroids. Epoch observations are in the number of nearly 2 millions. This is a small fraction of the total amount of data that Gaia is collecting on the Solar System, but it is representative of the exceptional performances.

We will briefly review the properties of the solar system data published in DR2, and their known limitations or issues. Practical suggestions for the community about the best approaches to exploit the extreme accuracy will be provided.

1. General properties

The Gaia DR2 includes a selection of solar system object observations obtained during the nominal operations of Gaia, from 5 August 2014 to 23 May 2016.

All of these objects belong to the "small solar system bodies" category and were known when Gaia observed them. No planetary satellites, comets, or minor planets brighter than G=10 are present in DR2. Among dwarf-planets, a few observed transits were selected for (136472) Makemake, only.

The vast majority of the DR2 sample (14.099 objects in total) is then represented by Main Belt asteroids.

The DR2 release for asteroids mainly focus on the main driver of Gaia: ultra-precise astrometry. On the base of the orbital fitting, only 1% of outliers was eliminated.

The photometric performance is at a few mmag level of uncertainty, but a check of internal consistency between the unfiltered G magnitude and the (unpublished) red/blue integrated fluxed showed that several anomalous data had to be rejected. The treatment of photometry will be strongly improved for the forthcoming data releases.

2. Astrometric quality

The main strength of Gaia DR2 for asteroids is certainly the quality of the astrometry: for 96% of the observations, post-fit orbital residuals are in the [-5, 5] mas interval, and for 52% they are within [-1, 1] mas.

It must be stressed that all the positions measured by Gaia are absolute and referred to the same reference system built by the global astrometric solution and linked to the observed distance quasars.

Of course, there is a trend of variation of accuracy as a function of brightness, that can reach G~20.5 at the faintest limit.

This result represents an impressive performance to be compared to the average uncertainty of ~400 mas for the CCD observations available at the Minor Planet Center. Only the few 1000s positions by radar ranging can approach similar performances, but for nearby Earth crossers only.

3. Data access and use

The asteroid observations are distributed by mean of the ESA archive (http://gea.esac.esa.int/archive/) where the whole DR2 data set and documents can be found.

Due to the peculiar properties of Gaia data, potential users have to consider in depth the documentation and the data release articles. For instance, the error model has highly correlated RA and Dec uncertainties, and must be carefully understood for any application.

4. Conclusions and perspectives

The DR2 asteroid sample represent a first, limited release, with respect to the expected total observed population, of more than 300.000 asteroids.

Derived parameters (asteroid orbits, masses), reflectance spectra and other object categories will appear only in future releases.

The quality of the DR2 astrometry (and in part, photometry) is extremely high and nearly two orders of magnitude better than the average observations archived at the Minor Planet Center.

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