Gaia local test of General Relativity
With Gaia and Solar System Objects

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Gaia, asteroids and orbits —

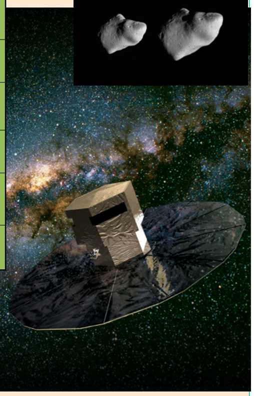
Gaia —
ESA astrometric space mission has been **launched on 2013 December 19th** — is the successor of the pioneering Hipparcos/Tycho (1899-1993; 1997). This new mission is however much more ambitious considering the number of observed targets, the limiting magnitude, the kind of measures performed (mosaic of CCDs, spectro-photometry, radial velocity), the high precision photometry, and high accuracy ***global astrometry***. All positions are directly derived in an absolute reference frame materialised by the QSOs

Asteroids —
Gaia will provide systematic survey of the whole sky down to magnitude 20, including observations of many solar system objects, mainly **asteroids**. (≈300,000), but also comets and satellites, etc. Gaia will also supersede Hipparcos with the catalogues that it will enable to construct (orbital elements, masses, diameters, taxonomy, spin state, …). The **photometric** and **astrometric** data will eventually provide the scientific harvest for SSOs [1].

Orbits —
The astrometric precision for a single observation is of the order of 0.2–5 mas, unprecedented for such SSOs! This will yield refined orbits and enable detection of non-gravitational forces and other small perturbations or accelerations, including the relativistic effects.

Gaia mission: a few numbers for asteroids

Launch date	Dec 2013
Observing mode	scanning law, 5years(+1)
Number of asteroids	≈ 300.000 (V≤20)
Aver. Numb. observations	≈ 60/object
Solar elongation	45° ≤ L ≤ 135°
Astrometric precision (1CCD)	AL ~0.2 - 5 mas
Photometric precision (1CCD)	≈ 0.001 mag



The Gaia satellite has been launched on 2013 December 19th

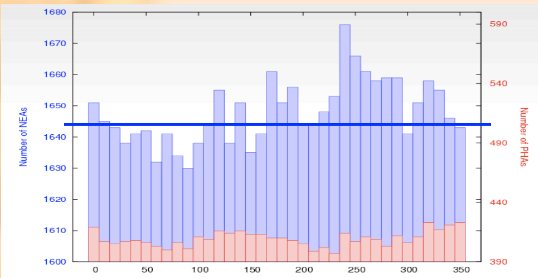
Astéroids & local tests of GR —

The satellite will observe many asteroids including about 1600 Near Earth Objects (NEOs), main belt asteroids, Jupiter Trojans and objects beyond the orbit of Saturn. Test of GR can be obtained through the determination of PPN parameters among others.

In particular one can derive:
- ➢ PPN β (simultaneously to J_2)
- ➢ Solar quadrupole J_2 (no stellar model)
- ➢ Variation of G ; $d(GM_O)/dt$
- ➢ Link of reference frames, dynamically non-rotating (SSO) to kinematical one (QSO)

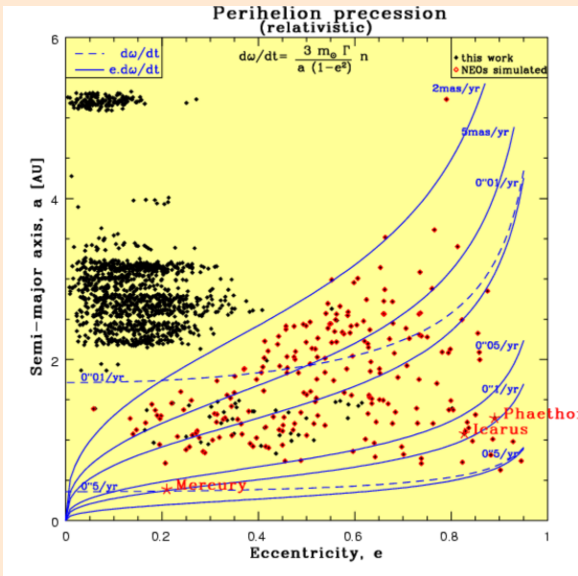
Lense-Thirring effect:
- ➢ test of possible biais from LT, ongoing work

Future work will involve:
- ➢ combination with other high quality data (Hipparcos, radar [2]) over longer time span
- ➢ test of SEP from motion of Trojans asteroids [3]
- ➢ testing alternative theories [4]



Number of (known) NEOs that Gaia will observe, depending on the actual scanning law initial conditions that will be set at end of Septembre 2014. About 1600 NEOs including 400 PHAs will be regularly observed during the mission.

Relativistic effect in the (a,e) orbital plane on the perihelion precession. NEOs with high eccentricity are as much sensitive to this effect as Mercury. Gaia will probe the whole plane enabling to derive simultaneously the PPN parameter β and the Solar quadrupole J_2.



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