Asteroid mass determination with the Gaia mission.

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To date we can count only 21 asteroid masses derived from direct measurements with a precision estimated better than 10% and 41 at a 50% mark [1]. The method of derivation is based on the analysis of the gravitational perturbations of massive asteroids on another objects lying in the Solar-System, mainly smaller asteroids, and in special cases, a planet (e.g. Mars) or a spacecraft (e.g. Near-Shoemaker). Our knowledge of asteroid masses is obviously poor knowing that in many cases, the results are strongly corrupted by systematic errors, and, thus, the estimated errors are underestimated. However, their interest continuously increases for understanding the physics of asteroids [2], [3] and for increasing the accuracy of modern solar system ephemerides knowing that the uncertainties on masses are, at present, the main source of error for the orbit determination of Mars [4], and, will be in the near future for the other inner planets.

The ESA astrometric mission Gaia [5], due for launch in late 2011, will observe a very large number of asteroids ($\sim$ 300,000 down to the magnitude 20), most from the main belt, with an unprecedented positional precision (at the sub-milliarcsecond level) and should mark a new breakthrough in our knowledge of asteroid masses. Gaia will be the witness of very large number of close approaches between asteroids to be analysed what forced us to reassess the method for deriving masses. A global solution involving simultaneously all the perturbers and the smaller targets should yield about 150 masses with a precision better than 50 percent. In addition, this number should be increased thanks to additional ground-based observations—before and after the mission—of target asteroids for which the encounter with a perturber will occur at the edge of the observation coverage of Gaia.

Here, we briefly present the different steps of this method, and give a list of asteroids for which the mass can be derived. The expected precision of masses by the time of mission's completion is estimated using realistic simulations of the Gaia observations (geometry, time sequence, magnitude). We then give an estimation of the new masses that we could derive thanks to ground-based observations and the future development that we plan to do for obtaining a better assessment of errors on the computations.

References

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