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Two problems in solar systems dynamics, possible solutions and future

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In this contribution, two major aspects of the new challenges of the solar system dynamics are presented. These two aspects are related to the precision of observations and the lacks of modelizations in orbit computations.

The first part of this contribution presents the impact on the solar system dynamics of the zonal and regional errors of astrometric and stellar catalogues currently used as reference frames by observers and theoreticians. An example of such impact is given by presenting the new results obtained with the monotoring of 40 ICRF optical counterparts (Fienga et Andrei [3]). These results show how the ties between reference frames could be a critical question for accurate celestial mechanics. This is illustrated with the new orbit of the Saturn satellite, Phoebe (Fienga et al., [5]). Some perspectives and possible consequences of such surveys are presented as well.

The second part deals with the analyse of the present limitations of the planetary ephemerides. Some possible solutions and perspectives for the future French ephemerides are discussed. As it was demonstrated by (Standish and Fienga [4]), the perturbations of the Mars orbit by the asteroids are difficult to modelize and they present now the main limitation of the present theory of Mars motion. Different aspects of the results are reminded. However, a more important part of this presentation is dedicated to the introduction of possible solutions and perspectives. Two ways of solving this problem can be chosen. The first one deals with the lack of modelization of the asteroid perturbations. As it was firstly introduced by Plakhov in 1968, computed by Mayo [7], Bange [1] and Krasinsky [6], a possible model of the mass distribution of the main belt asteroids as a torque can be set up. This solution gives a more elegant description than the present modelization but it will not solve completely the major difficulty of this question, i.e. the accurate estimation of the masses of the main asteroids. The second complementary path for solving the problem of the asteroid perturbations is the accurate mass determinations. To do so, as it was demonstrated for example by Michalak [8], Viateau and Rapaport [10] and Bange [2], the close–encounters over a small arc

of orbit could give a good estimation of asteroid masses. On the other hand, the present improvements of stellar and astrometric catalogues combined with the use of very accurate and powerful algorithms of astrometric reduction (Fienga and Andrei [3]) could garantie a very accurate determination of an arc of asteroid orbits. These very accurate orbit determinations would allow to estimate detectable mutual perturbations. We define a detectable mutual perturbation when the perturbation of an asteroid orbit induced by some other asteroid produce variations in right ascension and declination bigger than 0.1 arcsecond.

In conclusion, a program of asteroid observations prepared by simulations of mutual perturbations is introduced. This program will gather all the phenomena which could be observed from the ground before, during and after the GAIA mission.

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