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# The invariable plane of the solar system

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## Abstract

The invariable plane of the solar system is defined as the plane perpendicular to the total angular momentum of the system and passing through its centre of mass. The idea of using the invariable plane as a reference plane in the study of the dynamics of solar system bodies goes back at least to Laplace [3]. The latest study on this plane dates back to Burkhardt [2]. The aim of this work is to determine at best the orientation of the invariable plane with respect to both the ICRS and the equinox-ecliptic of J2000.0, and to evaluate the accuracy of its determination. Such a determination is of fundamental interest in the topic of solar system studies, as suggested by the WGCCRE 2009 [1] for the determination of planet's and satellites' rotational elements. Using the long-term numerical ephemerides DE405, DE406 [6] and INPOP10a[4] over their entire available time span, we compute the total angular momentum of the solar system, as well as the individual contribution of each planet. We then deduce the orientation of the *invariable plane* for each ephemeris, and establish their relative differences. Preliminary results can be found in [5]. Here we update them with more accurate data, and a more complete analysis of the problem, taking into account the effect of the dwarf planet (1) Ceres as well as two of the biggest asteroids, (4) Vesta and (2) Pallas. Moreover, we give the orbital elements (inclination, longitude of the ascending node) with respect to the invariable plane.

As given its accuracy of determination, and its fundamental dynamical meaning, the invariable plane provides a permanent natural reference plane that should be used when studying solar system dynamics, instead of the ecliptic. Thus, we recommend referring to it when working on long-term dynamics.

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