

## COMMISSION X2

## SOLAR SYSTEM EPHEMERIDES

### *ÉPHÉMÉRIDES DU SYSTÈME SOLAIRE*

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## TRIENNIAL REPORT 2018-2021

### 1. Introduction

Commission X2 was created in 2015, merging the functions of the previous Commission 4 “Ephemerides” and Commission 20 “Positions and Motions of Minor Planets, Comets and Satellites”.

Its purpose is to support the development of high precision ephemerides, and the products/services that disseminate them, for all solar system bodies: planets, dwarf planets, asteroids, comets, distant objects, natural satellites of planets and of asteroids. The ephemerides include position, velocity, and orientation for bodies other than the Earth.

The first meeting of the commission took place at the occasion of the 2018 General Assembly; there have not been other chances for meetings of interest to the whole commission in the triennium, also because of the worldwide Covid pandemics occurring in 2020-21.

### 2. Past triennium

The telescopic surveys aimed at the discovery of small solar system bodies, in particular near-Earth asteroids, have greatly increased their effectiveness in the last years, and the task of providing ephemerides for the known bodies, as well as for the newly discovered ones, has become increasingly challenging.

In this respect, an important issue for the commission is the transition that has taken place at the Minor Planet Center from the use of the old 80-column format for observations (known as the MPC1992 format) to the new Astrometry Data Exchange Standard (ADES), that was approved by Commission 20 at the IAU General Assembly of 2015.

ADES addresses the shortcomings of the MPC1992 format, allowing a full characterization of each individual astrometric observation, something that was impossible in the limited space of the MPC1992 format, and that in turn translates into better orbit solutions, allowing a much better modelling of the small body motions, as well as more precise ephemerides.

The Minor Planet Center started accepting ADES-format observation submissions in July 2018 (Minor Planet Electronic Circular 2018-N52), and in February 2021 has started the publication of all observations in the same format (Minor Planet Electronic Circular 2021-D81).

Another important issue is the possibility of discovering potential impactors of the Earth, and of refining their orbits until an impact in the coming decades can be excluded, or ascertained, if that is the case.

In this respect, one of the aims of the campaign carried out at the occasion of the 2021 close encounter with the Earth of (99942) Apophis has been of particular interest. In fact, it has been possible to verify that, even discarding all the observations done between 2004 and mid-2020, the astrometry gathered during the current apparition would have been sufficient to exclude a collision in 2029. The other major result has been a further refinement of the orbit, that now enables to exclude Apophis collisions with the Earth for more than a century.

### 3. Future activities

It is expected that the discoveries of asteroids and comets will continue to increase in the coming years, driven by near-Earth asteroid surveys, but also by the starting of the operations of the Vera Rubin Observatory (previously known as the Large Synoptic Survey Telescope), an extremely powerful instrument among whose goals is a full inventory of the small solar system objects.

In this respect, the transition to ADES that has recently taken place is particularly important, since the vast increase in the number of discoveries could stress the ability of the Minor Planet Center to quickly produce reliable orbits and ephemerides, also in view of the recent discoveries of new classes of small bodies, like interstellar objects and apparently asteroidal objects coming from the Oort Cloud.

These matters will be discussed at the next major meeting of interest to the commission membership, the IAU Symposium 364 “Multi-scale (time and mass) Dynamics of Space Objects”, that will take place in Iași, Romania, 18-22 October 2021, either in hybrid form (i.e., partly in-presence, partly online), or fully online, if the current Covid-related situation would not improve.

Giovanni B. Valsecchi  
*President of the Commission*