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ESPACE, European Satellite PArtnership

for Computing Ephemerides

W. Thuillot(1), V. Lainey(1), **V. Dehant(2),** J.E. Arlot(1), J.P. De Cuyper(1), L.I. Gurvits(3,7), H. Hussmann(4), J. Oberst(5), P. Rosenblatt(1), J.C. Marty(6), and B. Vermeersen(7)
(1) IMCCE, Paris Observatory, (2) Royal Observatory of Belgium, (3) Joint Institute VLBI in Europe, Dwingeloo, The Netherlands, (4) DLR, Berlin, Germany, (5) Tech. Univ. Berlin, Germany, (6) Observatoire Midi-Pyrénées/CNES, France, (7) Delft University of Technology, The Netherlands
(v.dehant@oma.be / Tel: +32-2-3730266 / Fax: +32-3-3749822)

Abstract

The EC FP7 project entitled European Satellite PArtnership for Computing Ephemerides (ESPaCE) aims at strengthening the collaborative activities in the domain of the development of ephemerides and reference systems for natural satellites and spacecraft. An important part of the project addresses the extraction and analysis of astrometric data from observations by spacecraft not yet applied to dynamical solutions. They will be combined with ground-based astrometry in order to improve constraints on the dynamics and the physics of the objects. We will use all these data to provide improved ephemerides for natural satellites and spacecraft and to characterize the rotation properties of selected satellites. We also intend to investigate new technologies relevant to our aims, in particular Very Long Baseline Interferometry (VLBI) and Laser Ranging (LR) techniques. Another important part of the project will include merging (for the first time in Europe) the natural satellite astrometry data with spacecraft data in a global inversion. All the results and documents will be made available using standard formats (VO standard, SPICE kernels) for the use by space agencies and scientific community.

1. Work programme, methodology, milestones

The goal of the project is to improve rotational and orbital models of natural satellites and spacecraft by taking advantage of possible synergies as well as exploiting space data unused so far for ephemeris purposes. Several work packages (WP) will permit to perform this work. WP2 will be devoted to the radioscience data, WP3 will deal with the Laser Ranging method for spacecraft tracking; WP4 is dedicated to the VLBI investigation to be applied to the spacecraft tracking and planetary positioning, WP5 will concern the digitizing of old photographic observations of natural satellites; WP6 concerns the astrometry and will allow us to get and to format the accurate astrometric data from several sources to make them ready to be used; WP7 aims at determining a shape and gravity model for the Martian satellite Phobos, establishing coordinate systems for Phobos, the Moon and the icy satellites and developing a rotation model for the natural satellites; WP8 is dedicated to spacecraft and natural satellite ephemerides and aims at providing dynamical models of natural satellites and orbits of spacecraft by exploiting the astrometric data issued from the other WPs, ephemerides are issued from these models; WP9 aims at setting up standard public reservoirs for the data issued from the other WPs: astrometric data, rotation data, topography, ephemeris SPICE kernels; WP 10 aims at setting up standard methods and tools to access the databases in the frame VO or SPICE contexts; and WP11 on Education and Outreach aims at developing web pages, educative tools and documents, related to the whole activities and results of the ESPaCE proposal.

2. Foreseen partnerships and collaborations

At first, strong collaborations will be reinforced between the partners of the ESPaCE project. Each of the partners has high expertise in specific and

complementary domains and this project is the opportunity to enhance this expertise and apply it to the setting up of a European laboratory network in the domain of the dynamics and ephemerides, useful for example for the future space missions. In addition, collaborations are foreseen with external experts, in particular with N. Emelianov from Sternberg Astronomical Institute (SAI, Russia), D. Pascu from the United States Naval Observatory (USNO, USA), Cheng Li Huang from Shanghai Observatory (SHAO, China), L. Zelenyi, A. Zakharov, N. Eismont, and V. Nazarov, from the Space Research Institute of the Russian Academy of Sciences (IKI, Russia), as well as with C. Murray and N. Cooper from the Queen MaryUniversity (London, UK). Obviously, we will have also collaborations with space agencies (ESA, DLR and CNES) and space mission teams, in particular, for access to specific space data. Annual workshops are foreseen in order to have exchanges between the consortium partners and with invited researchers and external experts.

3. Expected scientific and technological results

The main deliverables consist of several data sets and reports on the following topics: performances of the Laser Tracking and VLBI technology for the project tasks, digital reborn images of USNO planetary photographic plates and astrometric analysis for Mars, Jupiter, Saturn, and Uranus satellites, accurate ephemerides of these satellites and orbits of the space probes which gave space images of these satellites, rotation data of Phobos, report on icy satellites control point networks, shapes and coordinate systems. The main expected scientific results of the ESPaCE project will be new dynamical models (improved orbital parameters and derived characteristics) of several natural satellites and improved orbits of planetary science spacecraft. By combining space and ground-based observations, we will be able to compute accurate ephemerides of these bodies. We also expect that this work will allow us to study interiors of such celestial bodies as Mars, Jupiter, Saturn, and Uranus, and of their natural satellites. In general sense, the ESPaCE network will allow the European scientific community to analyze and use spacecraft and natural satellite data in an integrated process. Such expertise is highly valuable in view of the future European planetary mission (Laplace/JUICE from ESA (European Space Agency) and others).

4. Conclusions

The goal of the ESPaCE project is to strengthen the European collaborative activities in the domain of the development of ephemerides and reference systems for natural satellites and spacecraft. This project is centered on the exploitation of astrometric data for the dynamical modeling, and on the investigation of new technologies for planetary positioning and spacecraft tracking. The ESPaCE consortium is the first one in this domain in Europe and the work plan will allow it to deliver original scientific tools, data sets, and reports. By establishing this project, all the partners of this consortium have decided to join their efforts to initiate sustainable activities in this domain. This project aims at initiating a European network of experts and at providing useful tools, data, services for the European space organizations.

References

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