

SPICE IN ESA DATALABS. A. Escalante¹, R. Vallés¹, and C. Arviset², ¹RHEA Systems for the European Space Agency, ESA/ESAC Camino Bajo del Castillo s/n, Ur. Villafranca del Castillo, 28692 Villanueva de la Canada, Madrid, Spain, alfredo.escalante.lopez@esa.int, ²ESA/ESAC.

Introduction: SPICE is an information system the purpose of which is to provide scientists the observation geometry needed to plan scientific observations and to analyze the data returned from those observations. SPICE is comprised of a suite of data files, usually called kernels, and software -mostly subroutines [1]. The user incorporates a few of the subroutines into his/her own program that is built to read SPICE data and compute needed geometry parameters for whatever task is at hand. Some examples of geometry parameters typically computed are range or altitude, latitude and longitude, illuminations angles (phase, incidence and emission), instrument pointing and field-of-view calculations, reference frame transformations, and coordinate system conversions. SPICE is also very adept at time conversions.

The ESA SPICE Service: The ESA SPICE Service (ESS) leads the SPICE operations for ESA missions. The group generates the SPICE Kernel Datasets (SKDs) for missions in development (JUICE, ExoMars 2022, Hera, Comet-Interceptor, and EnVision), missions in operations (Mars Express, ExoMars 2016, BepiColombo, and Solar Orbiter) and legacy missions (Venus Express, Rosetta and SMART-1). ESS is also responsible for the generation of SPICE Kernels for INTEGRAL. Moreover, ESS provides SPICE support Kernels for Gaia and James Webb Space Telescope. The generation of SKDs includes the development and operation of software to convert ESA orbit, attitude, payload telemetry and spacecraft clock correlation data into the corresponding SPICE format. ESS also provides consultancy and support to the Science Ground Segments of the planetary missions, the Instrument Teams and the science community. The access point for the ESS activities, data and latest news can be found at the following site <https://www.cosmos.esa.int/web/spice>. ESS works in partnership with NAIF.

SPICE in ESA Datalabs: ESS offers other services beyond the generation and maintenance of SPICE Kernel Datasets, such as instances and configuration for WebGeocalc and Cosmographia for the ESA missions. More recently, the complete SPICE Data Volume is now accessible at ESA Datalabs [2], allowing the implementation of SPICE applications without requiring a local copy of the SPICE Kernel Datasets. SPICE devoted Datalabs developed by the ESS will be presented in this work. More specifically, a JupyterLab based Datalab has been added to the Datalabs catalog

making available: SPICE tutorials for getting hands-on loading SPICE kernels and computing geometry for ESA missions; a tool for analyzing joint observations of Mars Express and Trace Gas Orbiter; and the SPICE-based renderer for space-born instruments using high-resolution tiled Digital Shape Kernels (DSKs) for Mercury and Mars.

SPICE-Enhanced Cosmographia. NAIF offers for public use a SPICE-enhanced version of the open source visualization tool named Cosmographia. This is an interactive tool devoted to 3D visualizations of celestial bodies ephemerides and shape models, spacecraft trajectories and orientations, movable parts position, and instrument field-of-views and footprints. ESS provides the framework and configuration required to load the ESA missions in Cosmographia, this contribution will demonstrate its usage for the ESA Planetary missions [3]. Furthermore, a Datalab implementing an instance of Cosmographia is available in the Datalab catalog, such that users can now run Cosmographia in a web browser.

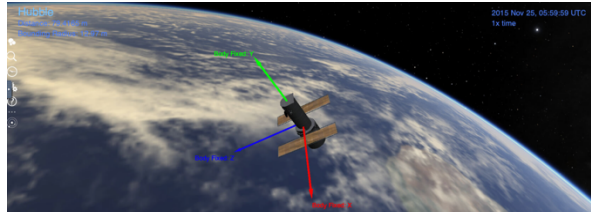


Fig1: Hubble SKD seen in Cosmographia Datalab

References: [1] Acton C. (1996) *Planet. And Space Sci.*, 44, 65-70. [2] Navarro, V. et al., (2019) *ADASS 2019*. [3] Acton, C. et al., (2017) *Planet. And Space Sci.*