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Introduction: NASA's "SPICE"[1] [1] ancillary information system is the world-wide de facto standard used by scientists to compute observation geometry needed to plan observations from instruments aboard robotic spacecraft, and to subsequently help in analyzing the data returned from those observations. In this context "ancillary data" are items such as spacecraft orbit and attitude; target body size, shape and orientation; instrument field-of-view size and orientation; and time system computations. SPICE comprises not only these data, usually called "SPICE kernels," but also a set of APIs (subroutines) known as the SPICE Toolkit, used to read those SPICE data and compute many interesting derived quantities such as spacecraft altitude, sub-spacecraft latitude/longitude, instrument field-of-view projection on a planetary surface, and lighting angles. SPICE users incorporate a few of these modules into their own application program to accomplish whatever is needed.

The SPICE system is implemented and maintained by members of the Navigation and Ancillary Information Facility (NAIF), located at the Jet Propulsion Laboratory.

SPICE Capabilities: Fig. 1 depicts the kinds of jobs for which SPICE is most often used. These span the gamut from early mission planning, where scientists are asked to evaluate a trajectory design relative to science objectives; to science data analysis long after the mission has ended.

Using SPICE: The most usual method for using SPICE is to write one's own application program that includes a few APIs (subroutines) taken from the SPICE Toolkit. Those APIs are used to read data from SPICE kernels and to process those data to yield the observation geometry parameters of interest. Fig. 2 depicts this kind of usage. The SPICE Toolkit software is available in several languages–Fortran 77, C, IDL, MATLAB, Java Native Interface, and Python–and for those computing environments most commonly used by space science researchers–Linux, Windows and Macintosh.

[1] **S**pacecraft, **P**lanet, **I**nstrument, **C**amera-matrix, **E**vents See https://naif.jpl.nasa.gov

Additional Method for Using SPICE: Sometimes a scientist or engineer who needs some mission geometry information hasn't the time or training to write a SPICE-based application. What can be done? The NAIF Team provides a geometry server that can be accessed by any computer having a web browser. This tool, named WebGeocalc, allows a scientist to use simple graphical user interface controls to specify the computation wanted and the SPICE data files to be used. After pressing the CALCULATE button the numeric results are returned to the scientist's browser window. In some cases graphical results are also provided.
See https://naif.jpl.nasa.gov/naif/webgeocalc.html

Visualizing Mission Geometry Using SPICE: Another SPICE-based tool that is becoming very popular is named SPICE-Enhanced Cosmographia. This is a very precise, highly interactive 3D visualization tool that can be installed on a scientist's workstation–Linux, Windows or Macintosh. It is driven by SPICE kernels, and is configured using a small set of "catalog files" implemented using the JavaScript Object Notation (JSON) data interchange methodology. Scientists can use Cosmographia to clearly visualize almost any geometric conditions of a space science mission, and can use future-looking SPICE data or in-the-past SPICE data in doing so.
See https://naif.jpl.nasa.gov/naif/cosmographia.html

SPICE is Free: One of the best attributes of SPICE is that it is absolutely free for anyone to use: no charges, no licensing, no export restrictions. It's also important to note that the software is thoroughly tested before being released, the system is very well documented, and everything is 100 percent backwards compatible by design.

References: [1] Charles Acton, Nathaniel Bachman, Boris Semenov, Edward Wright; A look toward the future in the handling of space science mission geometry; Planetary and Space Science (2017); DOI 10.1016/j.pss.2017.02.013 https://doi.org/10.1016/j.pss.2017.02.013

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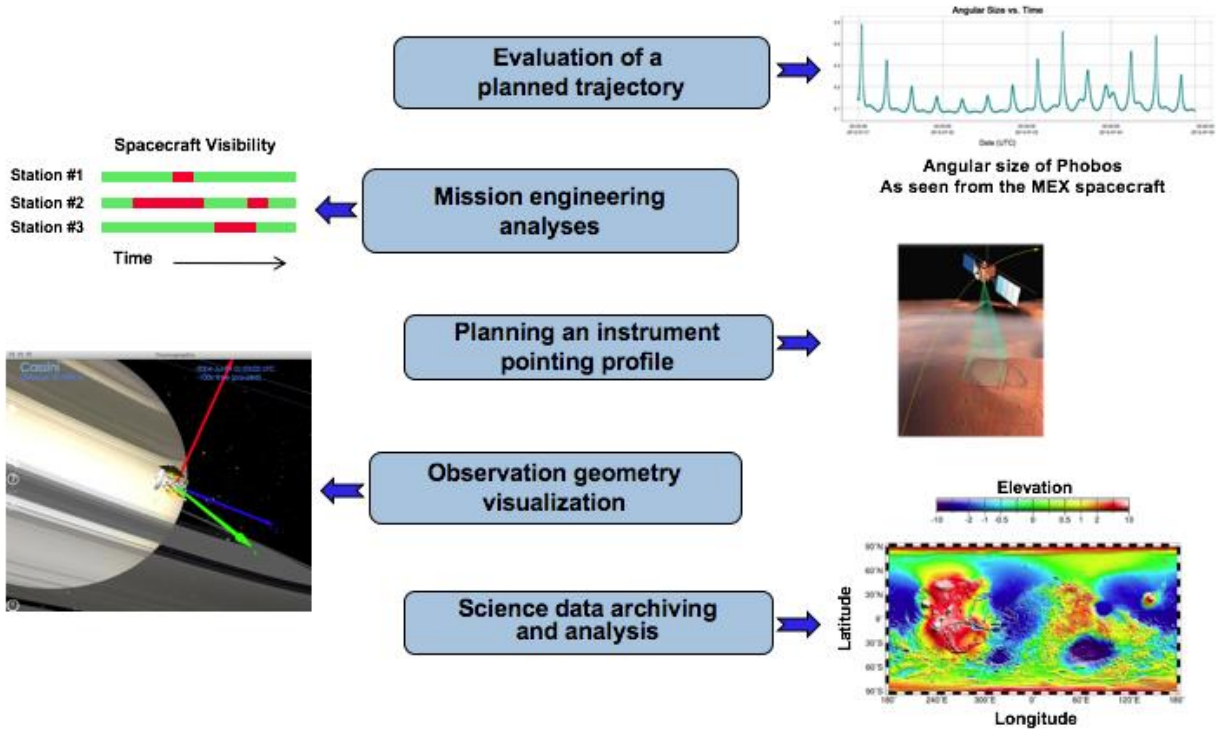

Fig. 1 Common Uses of the SPICE System

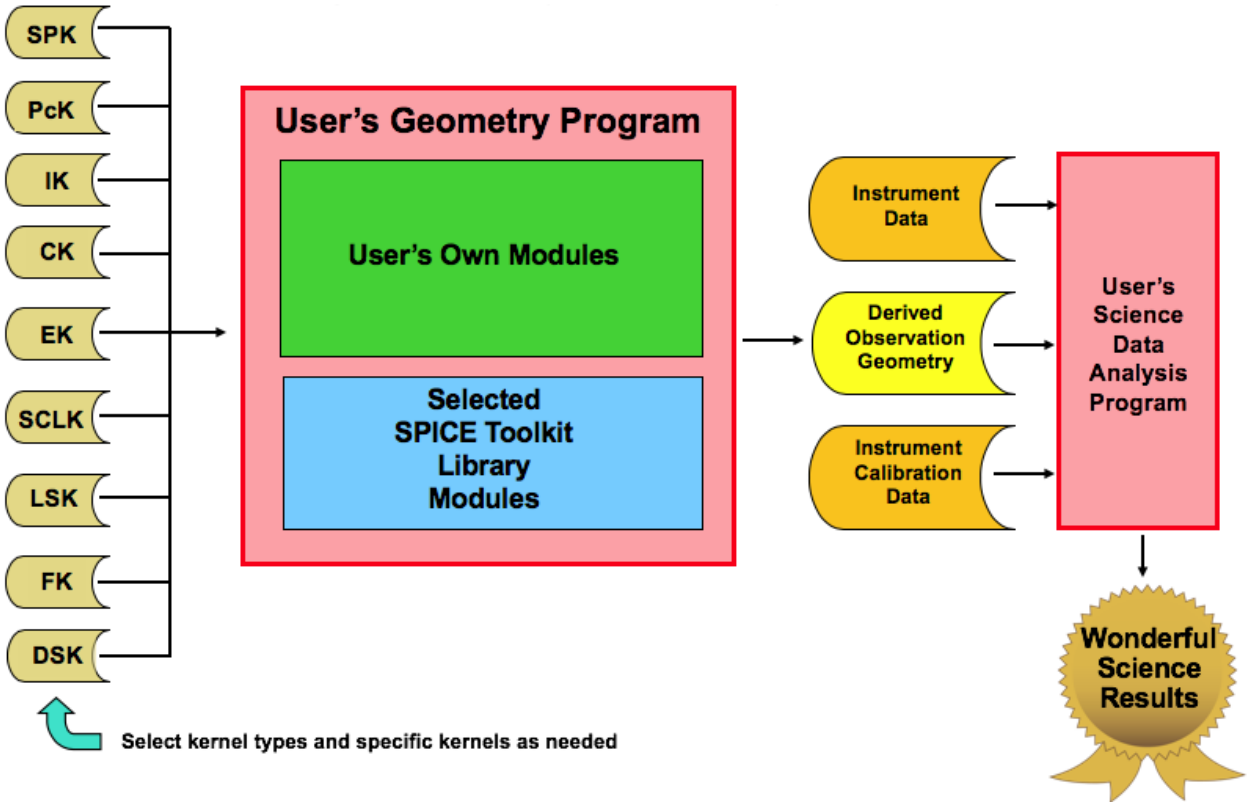

Fig. 2 Typical Application of SPICE Data and Software