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pyRTX: a Python package high precision computation of non gravitational forces on deep space probes

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Summary

With the constant improvement of radiometric tracking systems, inaccuracies in the non-gravitational force modeling have become one of the limiting factors to precise orbit determination, and the scientific products that it enables. The main factor impacting the limited accuracy of non-gravitational force models is the complex 3D shape of the spacecraft. While fast, reliable, analytical models are available for simple shapes (spheres, cubes, etc), no such model is generally available for a complex shape. This software package aims to address this limitation. By leveraging ray-tracing, the interaction of the complex spacecraft shape with the forcing environment (radiation, atmosphere) can be accounted for.

Statement of need

`Gala` is an Astropy-affiliated Python package for galactic dynamics. Python enables wrapping low-level languages (e.g., C) for speed without losing flexibility or ease-of-use in the user-interface. The API for `Gala` was designed to provide a class-based and user-friendly interface to fast (C or Cython-optimized) implementations of common operations such as gravitational potential and force evaluation, orbit integration, dynamical transformations, and chaos indicators for nonlinear dynamics. `Gala` also relies heavily on and interfaces well with the implementations of physical units and astronomical coordinate systems in the `Astropy` package (Astropy Collaboration, 2013) (`astropy.units` and `astropy.coordinates`).

`Gala` was designed to be used by both astronomical researchers and by students in courses on gravitational dynamics or astronomy. It has already been used in a number of scientific publications (Pearson et al., 2017) and has also been used in graduate courses on Galactic dynamics to, e.g., provide interactive visualizations of textbook material (Binney & Tremaine, 2008). The combination of speed, design, and support for Astropy functionality in `Gala` will enable exciting scientific explorations of forthcoming data releases from the *Gaia* mission (Gaia Collaboration, 2016) by students and experts alike.

Mathematics

Single dollars ($) are required for inline mathematics e.g. $f(x) = e^{\pi/x}$

Double dollars make self-standing equations:

$$\Theta(x) = \left\{\begin{array}{l} 0\textrm{ if } x < 0\cr 1\textrm{ else} \end{array}\right.$$

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You can also use plain $\LaTeX$for equations

$$\hat{f}(\omega) = \int_{-\infty}^{\infty} f(x) e^{i\omega x} dx \tag{1}$$

and refer to Equation 1 from text.

Citations

Citations to entries in paper.bib should be in rMarkdown format.

If you want to cite a software repository URL (e.g. something on GitHub without a preferred citation) then you can do it with the example BibTeX entry below for Smith et al. (2020).

For a quick reference, the following citation commands can be used: - `@author:2001` -> "Author et al. (2001)" - `[@author:2001]` -> "(Author et al., 2001)" - `[@author1:2001; @author2:2001]` -> "(Author1 et al., 2001; Author2 et al., 2002)"

Figures

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