

Gala: A Python package for galactic dynamics

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Summary

The forces on stars, galaxies, and dark matter under external gravitational fields lead to the dynamical evolution of structures in the universe. The orbits of these bodies are therefore key to understanding the formation, history, and future state of galaxies. The field of “galactic dynamics,” which aims to model the gravitating components of galaxies to study their structure and evolution, is now well-established, commonly taught, and frequently used in astronomy. Aside from toy problems and demonstrations, the majority of problems require efficient numerical tools, many of which require the same base code (e.g., for performing numerical orbit integration).

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] (`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:2017] and has also been used in graduate courses on Galactic dynamics to, e.g., provide interactive visualizations of textbook material [Binney: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] by students and experts alike. The source code for **Gala** has been archived to Zenodo with the linked DOI: [zenodo]

Mathematics

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

Double dollars make self-standing equations:

$$\Theta(x) = \begin{cases} 0 & \text{if } x < 0 \\ 1 & \text{else} \end{cases}$$

You can also use plain L^AT_EX for equations

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

and refer to Equation 1 from text.

Figures

Figures can be included like this:

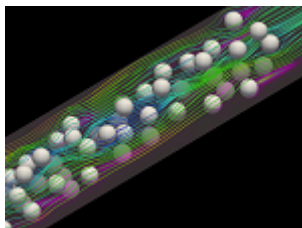


Figure 1: Caption for example figure.

and referenced from text using Figure 1.

Tables

Tables can be included like this:

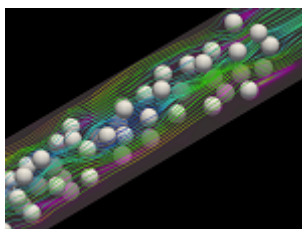


Figure 2: Caption for example table.

and referenced from text using Figure 2.

Acknowledgements

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References