The galpy Package

[1] galpy: Plotting Perfect Plots

Martin Cruzat - May 18, 2025.

[2] The galpy package was coded in python and was designed primarily for galactic dynamics. It supports orbit integration with various potentials, evaluating and sampling many distribution functions, and calculations of action-angle coordinates for all static potentials. This is just a way of saying that it can be used for manipulating gravitational potentials, simulating the orbit of stars, and analyzing different galaxies. It is very useful for plotting as well as it is designed to be able to plot stars in a galaxy or densities of potentials.

[3] The reason I picked this is because I am personally interested in astrophysics and although astropy was an option, I wanted to use the specific plotting mechanisms of galpy to be able to see how everything works.

[4, 14] The first version of galpy was released on Wednesday December 10th, 2014 by Jo Bovy. While it is a Python package primarily, it can be used with C extensions as well for enhanced performance. Galpy is the best package to do these calculations however there are other options such as astropy and it was built with the NEMO package among others. The report uses galpy version 1.10.2, the current latest version.

[5, 21] Galpy is still being updated with the most updated version being 1.10.2 being released on March 3rd, 2025. The original authors are still maintaining the package and due to its popularity, has gained new contributors as well such as Andrew Pontzen, James Grimmett, and more. The best way to acknowledge galpy would be to cite it as:

Galpy: A Python Library for Galactic Dynamics, Jo Bovy (2015), *Astrophys. J. Supp., 216,* 29 (arXiv/1412.3451)

The citation method also includes: https://ui.adsabs.harvard.edu/abs/2015ApJS..216...29B

[6,7] It was surprisingly easy to install and use it. I used: 'pip install galpy' and it worked. Another way to install it could be either through "conda install" or through github which also appears to be very simple.

[8] The source code is available through github. (https://github.com/jobovy/galpy)

[9] Galpy is used by Gala, another astrophysics package.

[10] It is primarily via Python scripts or Jupyter notebooks. I have opted for the JupyterLab Notebook. It is a fully scriptable, Pythonic interface.

[11] The accompanying JupyterLab Notebook shows how to use galpy.

[12] The package uses matplotlib for its graphs however it does come with inbuilt graphing tools such as "plotDensities" or "plotEscapecurve", both used in the attached notebook.

[13] The following is a plot of the rotational curve of the Miyamoto-Nagai disk potential, The Navarro–Frenk–White profile, the Hernquist Potential, and a combination of all three.
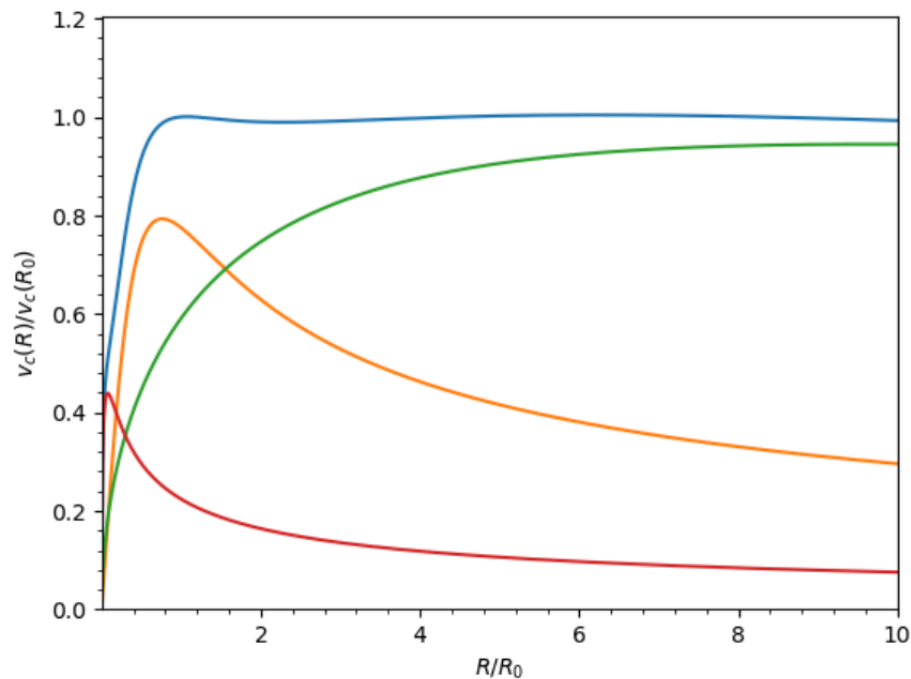
[15] Inputs include parameters like mass, position, velocity, or model potentials. Some data can be generated via galpy tools. In the Notebook some imported potentials are given such as Milky Way data or Miyamoto-Nagai disk potential.

[16] Outputs include orbit paths, time-evolved data, different plots, and more. These can be exported if needed.

[17, 18] Yes, galpy includes unit tests that can be run via pytest or python setup.py test. In order to feel more confident about the code you can use some of the provided tests to ensure your code is running correctly. As for the package, it has been peer reviewed and used in hundreds of scientific papers and its accuracy is confirmed.

[19] There are some dependencies such as packaging, numpy, scipy, and matplotlib packages. This information is found in the galpy installation documentation.

[20] The documentation can be found at docs.galpy.org. It includes tutorials, API references, theory, papers that use galpy, and more. It is an incredible resource and was more than sufficient for me

[22] Galpy Documentation: docs.galpy.org, GitHub Repository: https://github.com/jobovy/galpy, ASCL Entry: https://ascl.net/1411.008

[23] The ADS showed 1279 citations and counting:

https://ui.adsabs.harvard.edu/abs/2015ApJS..216...29B/abstract

[24] I learned new python skills by reading their documentation and trying them out. I mostly learned how to animate plots in the JupyterLab notebook.

[25] I do not have any prior experience with galpy or any of the related data and therefore this package is new to me. This work was done independently.