

sbpy: A Python module for small-body planetary astronomy

Michael Mommert¹, Michael S. P. Kelley², Miguel de Val-Borro³, Jian-Yang Li³, Giannina Guzman⁴, Brigitta Sipőcz⁵, Josef Ďurech⁶, Mikael Granvik⁷, Will Grundy¹, Nick Moskovitz¹, Antti Penttilä⁷, and Nalin Samarasinha³

¹ Lowell Observatory, US ² University of Maryland, US ³ Planetary Science Institute, US ⁴ Villanova University, US ⁵ DIRAC Institute, Department of Astronomy, University of Washington ⁶ Charles University, Prague, Czech Republic ⁷ University of Helsinki, Finland

DOI: [10.21105/joss.01426](https://doi.org/10.21105/joss.01426)

Software

- [Review](#) ↗
- [Repository](#) ↗
- [Archive](#) ↗

Submitted: 01 May 2019

Published: 22 June 2019

License

Authors of papers retain copyright and release the work under a Creative Commons Attribution 4.0 International License ([CC-BY](#)).

Summary

Planetary astronomy - the study of Solar System objects with telescopic observations from the ground or from space - utilizes a wide range of methods that are common in observational astronomy. However, some aspects, including the planning of observations, as well as the analysis and interpretation of the results, require tailored techniques and models that are unique and disparate from those used in most other fields of astronomy. Currently, there is no single open source software package available to support small-body planetary astronomers in their study of asteroids and comets in the same way in which Astropy (Astropy Collaboration et al., 2018, 2013) supports the general astronomy community.

sbpy is a community effort to build a Python package for small-body planetary astronomy in the form of an Astropy affiliated package. The goal is to collect and implement well-tested and well-documented code for the scientific study of asteroids and comets, including (but not limited to):

- observation planning tools tailored to moving objects;
- photometric models for resolved and unresolved observations;
- wrappers and tools for astrometry and orbit fitting;
- spectroscopy analysis tools and models for reflected solar light and emission from gas;
- cometary gas and dust coma simulation and analysis tools;
- asteroid thermal models for flux estimation and size/albedo estimation;
- image enhancement tools for comet comae and PSF subtraction tools;
- lightcurve and shape analysis tools;
- access tools for various databases containing orbital and physical data, as well as ephemerides services.

sbpy is available and being maintained as a github repository at github.com/NASA-Planetary-Science/sbpy; documentation is available on sbpy.readthedocs.io

All functionality provided as part of sbpy has been tested against published results in order to ensure its correctness. An internal reference tracking system enables users to query a list of appropriate references depending on the functionality that has been utilized. In order to improve the performance of computationally intensive functions, like thermal modeling of atmosphereless bodies, C-extensions are utilized.

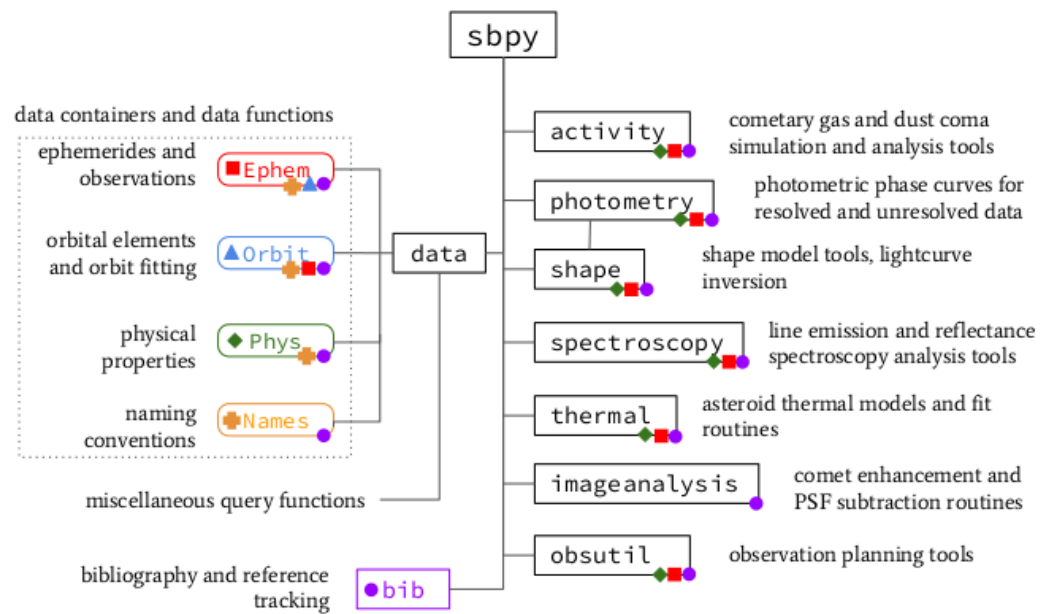


Figure 1: sbpy module structure.

Designed as an Astropy affiliated package, sbpy utilizes a wide range of functionality of Astropy, including its table, constants, units, and modeling submodules, and other affiliated packages like astroquery (Ginsburg et al., 2019). sbpy's API is deliberately emulating that of Astropy wherever possible in order to enable user-friendly and consistent access to its functionality.

sbpy is set up in a highly modular class-based fashion, roughly separated by the individual tasks listed above. Figure 1 provides an overview of these modules and their interrelations as indicated through colored symbols. The main modules, shown as black boxes, interact through data containers for ephemerides and observations (red box symbol), orbits (blue triangle), physical properties (green diamond), and target names (orange cross). All modules make use of the reference tracking system (purple circle).

sbpy is designed to support both professional researchers and interested citizen scientists in their activities.

Acknowledgments

The development of sbpy is supported by NASA PDART Grant No. 80NSSC18K0987.

References

- Astropy Collaboration, Price-Whelan, A. M., Sipőcz, B. M., Günther, H. M., Lim, P. L., Crawford, S. M., Conseil, S., et al. (2018). The Astropy Project: Building an Open-science Project and Status of the v2.0 Core Package, *156*, 123. doi:[10.3847/1538-3881/aabc4f](https://doi.org/10.3847/1538-3881/aabc4f)
- Astropy Collaboration, Robitaille, T. P., Tollerud, E. J., Greenfield, P., Droettboom, M., Bray, E., Aldcroft, T., et al. (2013). Astropy: A community Python package for astronomy, *558*, A33. doi:[10.1051/0004-6361/201322068](https://doi.org/10.1051/0004-6361/201322068)

Ginsburg, A., Sipőcz, B. M., Brasseur, C. E., Cowperthwaite, P. S., Craig, M. W., Deil, C., Guillochon, J., et al. (2019). astroquery: An Astronomical Web-querying Package in Python, 157, 98. doi:[10.3847/1538-3881/aafc33](https://doi.org/10.3847/1538-3881/aafc33)