

AstronomyCalc: A python toolkit for teaching Astronomical Calculations and Data Analysis methods

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Summary

Understanding astrophysical and cosmological processes can be challenging due to their complexity and the lack of simple, everyday analogies. To address this, we present **AstronomyCalc**, a user-friendly Python package designed to facilitate the learning of these processes aiming to help develop insights based on the variation theory of learning [lo2011towards; ling2012variation].

AstronomyCalc enables students and educators to engage with key astrophysical and cosmological calculations, such as solving the Friedmann equations, which are fundamental to modeling the dynamics of the universe. Users can construct and explore various cosmological models, including the Milne and Einstein-de Sitter universes [see ryden2017introduction for more examples], by adjusting parameters such as matter density and Hubble constant. This interactive approach allows users to intuitively understand how varying these parameters influences properties such as expansion rates and cosmic time evolution.

Additionally, **AstronomyCalc** includes modules for generating synthetic astronomical data or accessing publicly available datasets. In the current version, we can generate synthetic Type Ia supernova measurements of cosmological distances [vanderplas2012introduction] or use publicly available Pantheon+ dataset [brout2022pantheon+]. We can also download and study the SPARC dataset of galaxy rotation curves of 175 disk galaxies [lelli2016sparc]. These data sets can be analyzed within the package to test cosmological and astrophysical models, providing a hands-on experience that mirrors the process of scientific research in astronomy. By integrating theory with observational data analysis, AstronomyCalc not only aids in conceptual learning but also offers insights into the empirical methods used in the field.

Statement of Need

AstronomyCalc is a valuable tool for students and educators, bridging the gap between theoretical concepts and practical application, thereby enhancing the overall learning experience in astronomy and cosmology.

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References