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pySYD

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Automated Measurements of Global Asteroseismic Parameters

pypi package 1.6.6 | docs passing | License MIT | JOSS Under Review

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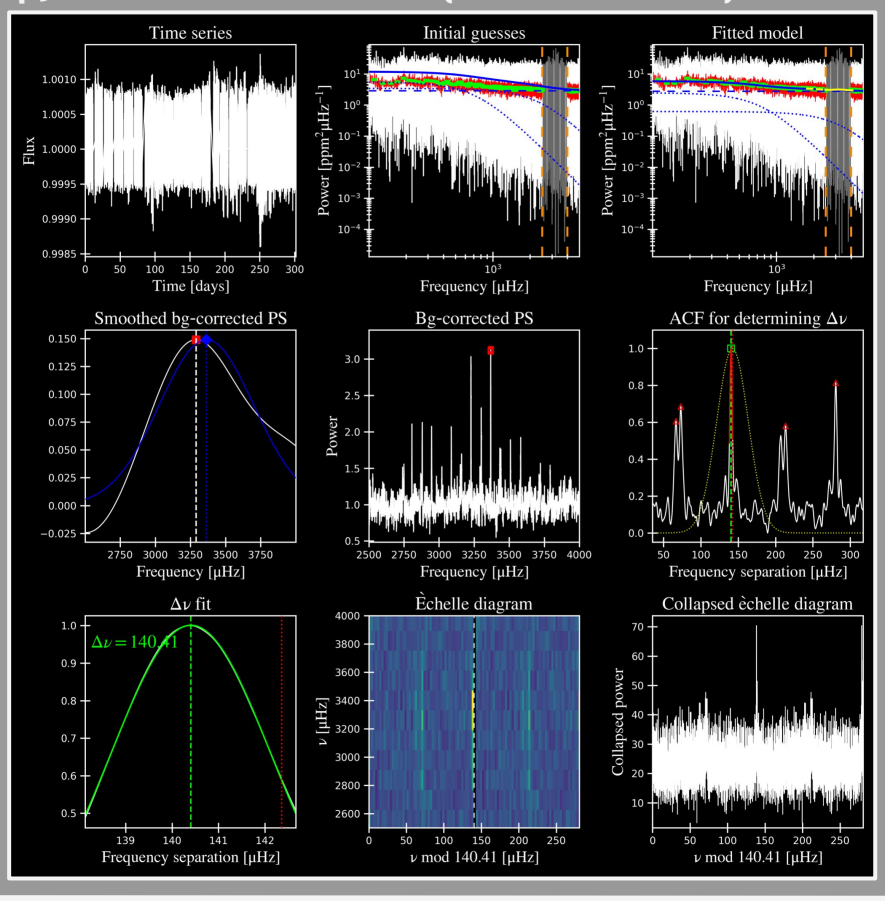
Statement of Need

The NASA space telescopes Kepler, K2 and TESS have recently provided very large databases of high-precision light curves of stars. By detecting brightness variations due to stellar oscillations, these light curves allow the application of asteroseimology to large numbers of stars, which requires automated software tools to efficiently extract observables. Several tools have been developed for asteroseismic analyses (e.g., A2Z[1], COR[2], OCT[3], SYD[4]), but many of them are closed-source and therefore inaccessible to the general astronomy community. Some open-source tools exist (e.g., FAMED[5], PBjam[6], lightkurve[7]), but they are either optimized for smaller samples of stars or have not been extensively tested against closed-source tools. ***Here we present pySYD, a well-documented, open-source asteroseismology package that has been benchmarked against closed-source tools and ensures the reproducibility of legacy results from the Kepler mission.***

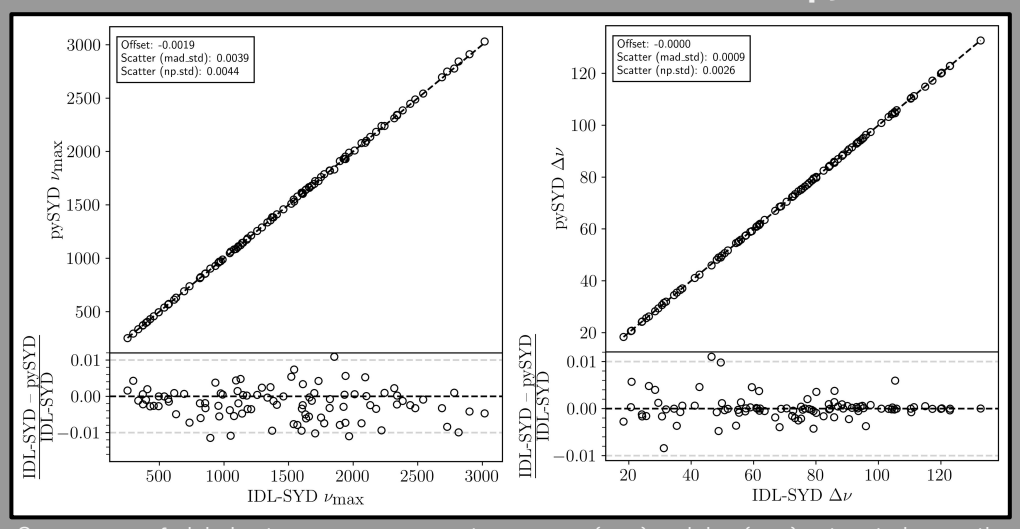
The pySYD Library

pySYD is adapted from the framework of the IDL-based SYD pipeline, which has been used frequently to measure asteroseismic parameters for Kepler stars[8,9,10,11,12] and has been extensively tested against other closed-sourced tools[13,14]. pySYD was developed using the same well-tested methodology, but comes with various new improvements to provide accessible and reproducible results quickly! Therefore, pySYD will be a promising tool for the broader astronomy community to analyze current and forthcoming data from the NASA TESS mission[15].

pySYDxTESS: α Men A[16] (TIC 141810080)



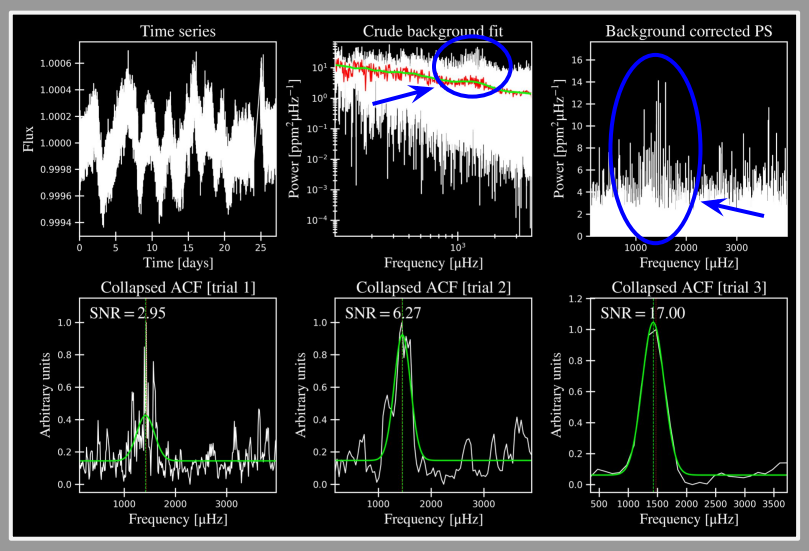
pySYDxSYD

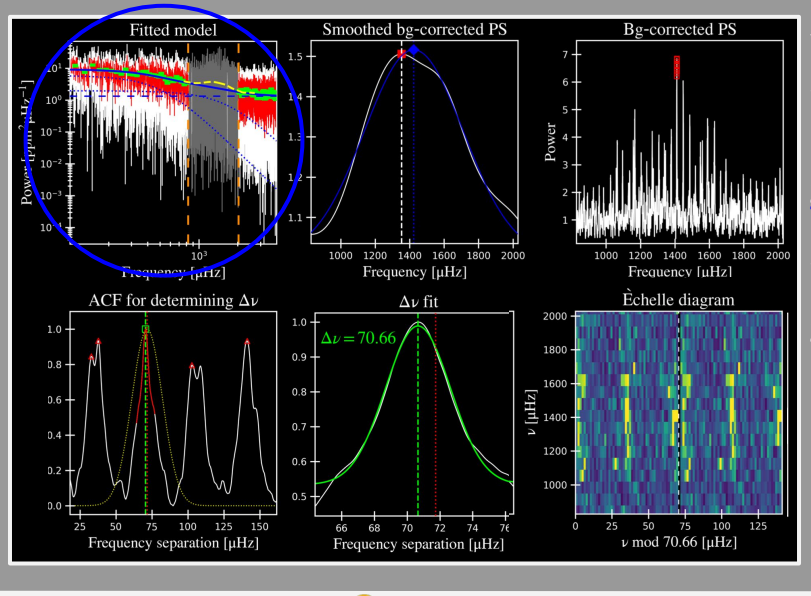


Comparison of global asteroseismic parameters numax (ν_{max}) and dnu ($\Delta\nu$) estimated using the pySYD and SYD pipelines. The scatter between the two pipelines is much less than the typical uncertainties when comparing results from different pipelines.

How it works

Given an input power spectrum, the first module estimates an initial value for ν_{max}, or the center of the frequency region containing **power excess due to solar-like oscillations**. Before this can be done, we need to perform a rough correction for the stellar contribution due to granulation processes.





This region in the power spectrum is then masked out in order to properly characterize the granulation background. **The best-fit model** is subtracted from the power spectrum, where global asteroseismic parameters ν_{max} and $\Delta\nu$ can now be reliably measured.

Note: The plots shown here are a hand-selected subset from the original output figure.

[1] Mathur+2010 [2] Mosser & Appourchaux 2009 [3] Hekker+2010 [4] Huber+2009 [5] Corsaro & De Ridder 2014
[6] Nielsen+2021 [7] Lightkurve Collaboration+2018 [8] Huber+2011 [9] Bastien+2013 [10] Chaplin+2014
[11] Serenelli+2017 [12] Yu+2018 [13] Hekker+2011 [14] Verner+2011 [15] Ricker+2010 [16] Chontos+2021a

Please visit https://pysyd.readthedocs.io for more information, including installation/setup instructions, more examples and additional resources!