

Future Plans - Indexing of Research Artifacts

Edwin Henneken and the ADS Team

ADS Users Group Meeting, 19-20 Nov. 2020



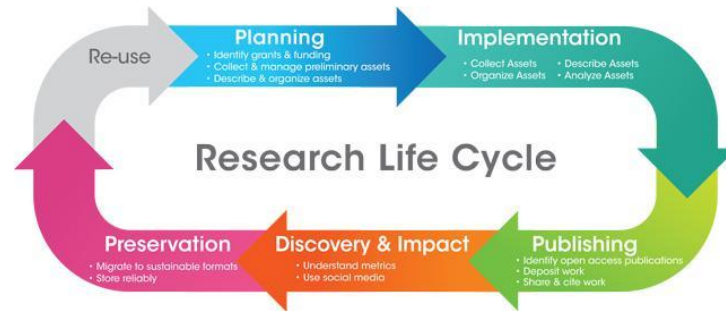
Research Objects Stage

Research in data-intensive disciplines is increasingly consuming and generating a variety of digital resources during the course of scientific investigations. This has steadily increased the need for means to systematically capture the lifecycle of scientific investigations, which at the same time provide a single-entry point to all the related resources, including data, publications, presentations, computational resources (software, Jupyter Notebooks, protocols), and the researchers involved in the investigation.

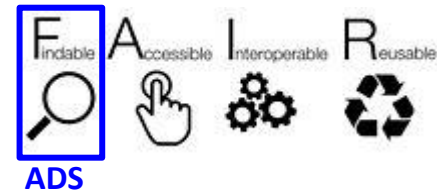
Goal: enhance the sharing, preservation and communication of data-intensive science, facilitating validation, citation and reuse by the community.

NASA: NASA SMD Strategy WP goal: *“Improve discovery and access for all SMD data to immediately benefit science data users and improve the overall user experience”*

ADS: data linking, ROR, ORCID, Asclepias, DOI → Research Artifacts



"Research Life Cycle" image from UC Irvine Library Digital Scholarship Services (<https://www.lib.uci.edu/dss>)



Scolnic et al, ApJ 859, 101 (29 May 2018)

Apj paper has DOI 10.17909/t95q4x linked under
“Article data” tab:

Upon publication, we will release doi:10.17909/T95Q4X, a suite of data files, coding routines, and supplementary tables to replicate this analysis.

DOI 10.17909/t95q4x is mentioned 7 times in HTML
and PDF document:

- Narrative (3 times)
- Table captions (3 times)
- Appendix A (data & code availability, 1 time)

How does this DOI show up in the ADS?

THE ASTROPHYSICAL JOURNAL

The Complete Light-curve Sample of Spectroscopically Confirmed SNe Ia from Pan-STARRS1 and Cosmological Constraints from the Combined Pantheon Sample

D. M. Scolnic^{1,21}, D. O. Jones², A. Rest^{2,3}, Y. C. Pan⁴, R. Chornock⁵, R. J. Foley⁴, M. E. Huber⁶, R. Kessler¹, G. Narayan³, A. G. Riess^{3,2} + Show full author list

Published 2018 May 29 • © 2018. The American Astronomical Society. All rights reserved.
[The Astrophysical Journal, Volume 859, Number 2](#)

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Figures Tables References Article data

External repository

MAST dataset

What is article data?

Appendix A: Data Tables and Code Repository

Upon publication, we will release [doi:10.17909/t95q4x](https://doi.org/10.17909/t95q4x), a suite of data files, coding routines, and supplementary tables to replicate this analysis. This includes the following:

1. A table of the spectroscopic observations of each SN in the PS1 sample that includes their ID, date of observation, telescope observed and measured redshift. A shortened version is included below in Table 15.
2. A table of key recovered parameters from the light-curve fits for the full Pantheon sample. A shortened version of this is shown below in Table 16. We also include a full output table from the SNANA fitter of a thorough listing of fitted parameters and other properties of the light curves. Final redshifts and distances are also given—a shortened version is shown in Table 17.
3. A table of binned distance estimates over redshift for a compressed version of the data set.
4. A full systematic covariance matrix for the binned and unbinned versions.
5. Stellar catalogs of the MD fields.
6. Necessary files to use with the CosmoMC or CosmoSIS software with instructions.
7. A folder of all the SNANA set-up scripts to fit each sample. A folder of all the SNANA set-up scripts to simulate each sample.
8. Output tables for 30 simulated samples used to test external methods and perform null tests on this data set.
9. Code for remaking all figures in this paper.

Abstract

1. Introduction
2. The PS1 Search, Photometry, and Calibration Pipeline
3. PS1 Light-curve Fitting and Simulation
4. Combining Multiple SN Samples
5. Analysis Framework
6. Results
7. Discussion
8. Conclusion

Appendix A: Data Tables and Code Repository

Appendix B: Template Construction

Appendix C: Low-z Simulations

Footnotes

References

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The screenshot shows the ADS search interface. The search bar contains the query "doi:10.17909/t95q4x". Below the search bar, it states "Your search returned 0 results". On the left sidebar, there are navigation options for Authors, Collections, Refereed, Affiliations, Keywords, Publications, Bib Groups, Simbad Objects, Ned Objects, Data, Vizier Tables, and Publication Type. The main content area displays a message: "Sorry no results were found for doi:10.17909/t95q4x". Below this message are several suggestions: "Try broadening your search", "Disable any filters that may be applied", "Check out some examples", and "Read our help pages". There is also a "Leave Feedback" button.

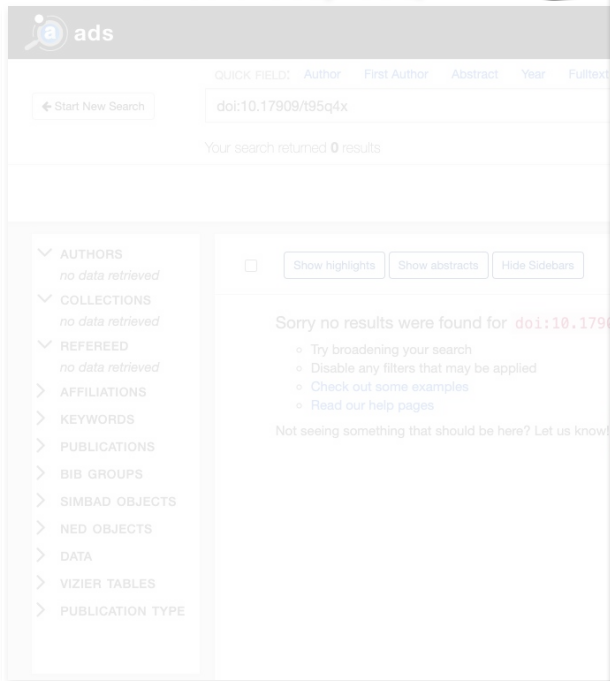
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The screenshot shows the ADS abstract page for the paper "The Complete Light-curve Sample of Spectroscopically Confirmed SNe Ia from Pan-STARRS1 and Cosmological Constraints from the Combined Pantheon Sample". The abstract text is visible, starting with "We present optical light curves, redshifts, and classifications for 365 spectroscopically confirmed Type Ia supernovae (SNe Ia) discovered by the Pan-STARRS1 (PS1) Medium Deep Survey...". On the right sidebar, there is a section for "FULL TEXT SOURCES" with links to "My Institution", "Publisher", and "arXiv". Below this, there is a section for "DATA PRODUCTS" with links to "MAST (2)" and "IRSA (1)". The "MAST (2)" link is circled in red. There is also an "Add paper to library" button and a "GRAPHICS" section with a table of links and a "Click to view more" button.

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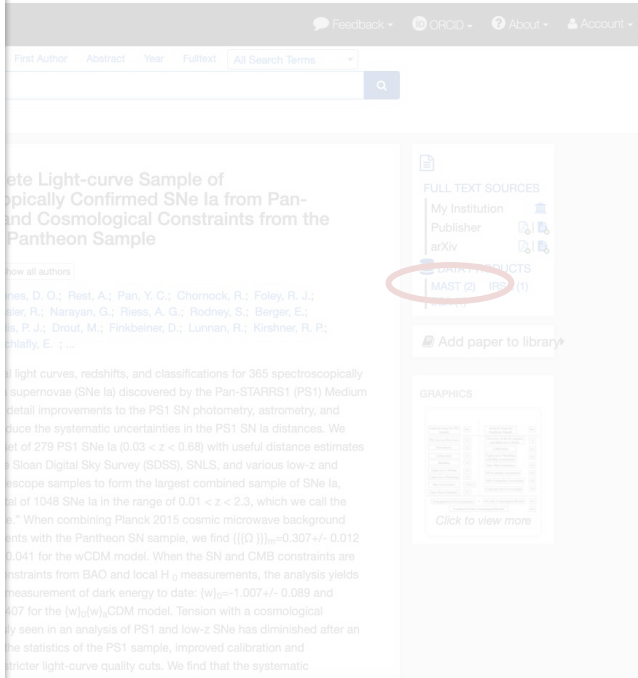
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The Foundation Supernova Survey: Measuring Cosmological Parameters with Supernovae from a Single Telescope Jones, D. O.; Scolnic, D. M.; Foley, R. J. and 27 more				
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The Complete Light-curve Sample of Spectroscopically Confirmed SNe Ia from Pan-STARRS1 and Cosmological Constraints from the Combined Pantheon Sample Scolnic, D. M.; Jones, D. O.; Rest, A. and 37 more				
16	2018ApJ...857...51J	2018/04	cited: 76	  
Measuring Dark Energy Properties with Photometrically Classified Pan-STARRS Supernovae. II. Cosmological Parameters Jones, D. O.; Scolnic, D. M.; Riess, A. G. and 25 more				

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GRAPHICS

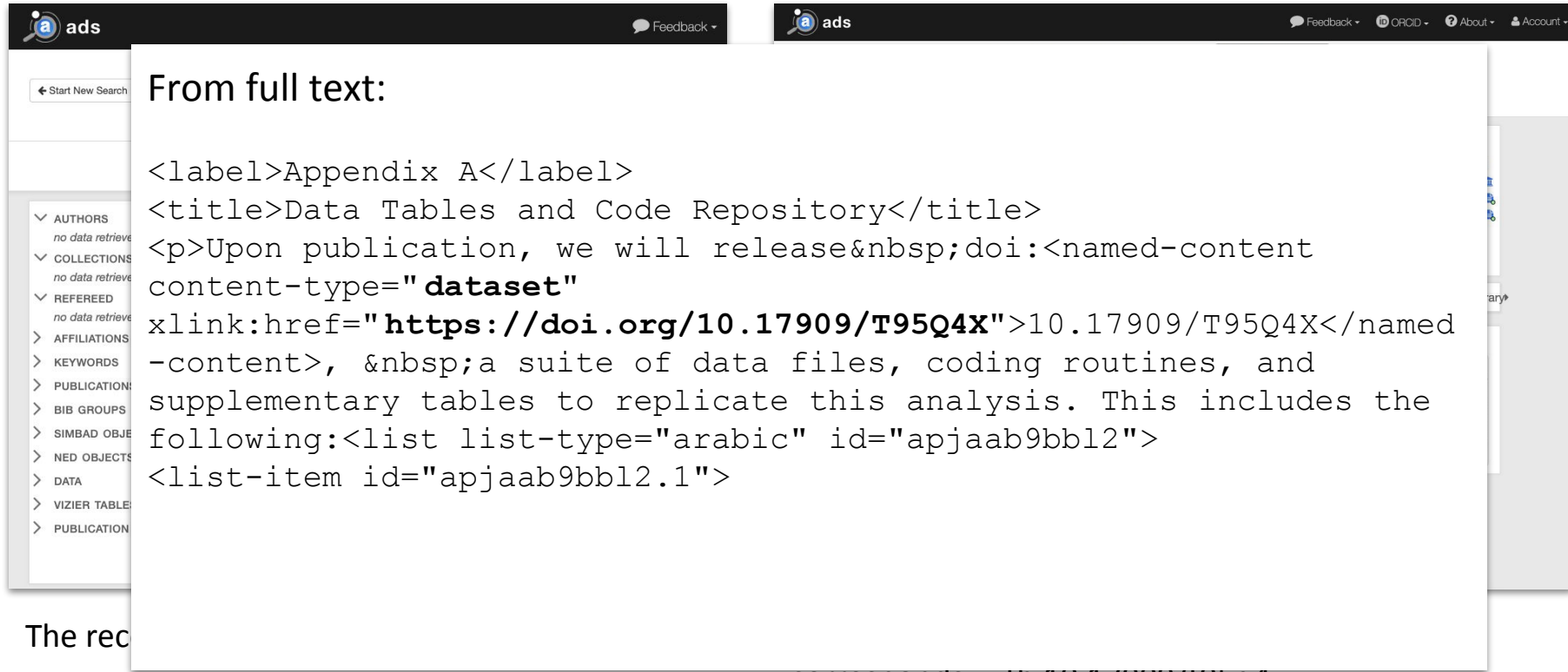
light curves, redshifts, and classifications for 265 spectroscopically confirmed supernovae (SNe Ia) discovered by the Pan-STARRS1 (PS1) Medium Detail improvements to the PS1 SN photometry, astrometry, and reduce the systematic uncertainties in the PS1 SN Ia distances. We present a sample of 279 PS1 SNe Ia ($0.03 < z < 0.68$) with useful distance estimates from the Sloan Digital Sky Survey (SDSS), SNLS, and various low- z and wide-field samples to form the largest combined sample of SNe Ia, totaling 1048 SNe Ia in the range of $0.01 < z < 2.3$, which we call the "Pantheon". When combining Planck 2015 cosmic microwave background measurements with the Pantheon SN sample, we find $H_0 = 0.307 \pm 0.012 \pm 0.041$ for the w_{CDM} model. When the SN and CMB constraints are combined with BAO and local H_0 measurements, the analysis yields constraints on dark energy to date: $w_0 = -1.007 \pm 0.089$ and $w_0 = -1.007 \pm 0.089$ for the w_0/w_0 CDM model. Tension with a cosmological constant is seen in an analysis of PS1 and low- z SNe has diminished after an analysis of the statistics of the PS1 sample, improved calibration and stricter light-curve quality cuts. We find that the systematic

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The screenshot shows the ADS (Astrophysics Data System) interface. The top navigation bar includes the ADS logo, a search bar, and links for Feedback, ORCID, About, and Account. The main content area displays a search result for '10.17909/t95q4x'. A text overlay is positioned over the search result, containing XML metadata extracted from the full text of the document. The metadata includes the title 'Data Tables and Code Repository' and a paragraph describing the release of a dataset. The dataset is identified by the DOI '10.17909/T95Q4X' and is described as a suite of data files, coding routines, and supplementary tables. The XML also includes a list of items, with the first item identified by the ID 'apjaab9bb12.1'.

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xlink:href="https://doi.org/10.17909/T95Q4X">10.17909/T95Q4X</named
-content>, &nbsp;a suite of data files, coding routines, and
supplementary tables to replicate this analysis. This includes the
following:<list list-type="arabic" id="apjaab9bb12">
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2 2020CSRL.20604194W 2020/12
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2020JGRE..12506130F

Acknowledgments

This work was supported by the LRO project and the Diviner science investigation. The Diviner Global Cumulative Products (GCP) used in this study are publicly available via the Geosciences Node of the Planetary Data System (http://pds-geosciences.wustl.edu/lro/lro-l-dlre-4-rdr-v1/lroldr_1001/data/gcp/). The CE-2 MRM data are downloaded from http://moon.bao.ac.cn/index_en.jsp. The improved one-dimensional thermal model used in this study can be downloaded from <https://doi.org/10.5281/zenodo.3579654>. The original version of the model is obtained from <https://github.com/phayne/heat1d>. The produced data including the bolometric Bond albedo map and loss tangent maps are available from <https://doi.org/10.5281/zenodo.3575481>.

2019GeoRL..46.1879Z

Acknowledgments

This work was supported by the Environmental Defense Fund. Y. Zhang was partially funded by the Kravis Scientific Research Fund at Environmental Defense Fund (EDF). We acknowledge the data sources and science teams for the provision of publicly available data sets used in this study, namely, DOMINO v2 OMI data from KNMI (<http://www.temis.nl/airpollution/no2.html>), VIIRS and DMSP radiant heat and gas flaring data from NOAA (https://www.ngdc.noaa.gov/eog/viirs/download_global_flare.html), OMSO2 OMI data (DOI: 10.5067/Aura/OMI/DATA 2022), MERRA-2 reanalysis (<https://gmao.gsfc.nasa.gov/reanalysis/MERRA-2/>), and SEAC⁴RS aircraft measurements data (DOI: 10.5067/Aircraft/SEAC4RS/Aerosol-TraceGas-Cloud) from NASA. We thank Ramon Alvarez from EDF for stimulating discussions during this work. We also thank two anonymous reviewers for their comments in helping improve an earlier version of this paper.

Acknowledgements can contain a wealth of information, potentially linkable.

How about Jupyter Notebooks?

THE ASTRONOMICAL JOURNAL, 157:64 (29pp), 2019 February
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<https://doi.org/10.3847/1538-3881/aa85c5>



starry: Analytic Occultation Light Curves

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Abstract

We derive analytic, closed form, numerically stable solutions for the total flux received from a spherical planet, moon, or star during an occultation if the specific intensity map of the body is expressed as a sum of spherical harmonics. Our expressions are valid to arbitrary degree and may be computed recursively for speed. The formalism we develop here applies to the computation of stellar transit light curves, planetary secondary eclipse light curves, and planet-planet/planet-moon occultation light curves, as well as thermal (rotational) phase curves. In this paper, we also introduce *starry*, an open-source package written in C++ and wrapped in Python that computes these light curves. The algorithm in *starry* is six orders of magnitude faster than direct numerical integration and several orders of magnitude more precise. *starry* also computes analytic derivatives of the light curves with respect to all input parameters for use in gradient-based optimization and inference, such as Hamiltonian Monte Carlo (HMC), allowing users to quickly and efficiently fit observed light curves to infer properties of a celestial body's surface map. (Please see <https://github.com/rodriger/starry>, <https://rodriger.github.io/starry/>, and <https://doi.org/10.5281/zenodo.1312286>).

Key words: eclipses – methods: analytical – occultations – techniques: photometric

1. Introduction

expected to dramatically push the boundaries of what can be inferred from these observations, potentially leading to the

This paper is organized as follows. In Section 2, we discuss the real spherical harmonics and introduce our mathematical formalism for dealing with spherical harmonic surface maps. In Section 3, we discuss how to compute analytic thermal phase curves and occultation light curves for these surface maps. In Section 4, we introduce our light curve code, *starry*, and discuss how to use it to compute full light curves for systems of exoplanets and other celestial bodies. We present important caveats in Section 5 and conclude in Section 6. Most of the math, including the derivations of the analytic expressions for the light curves, is folded into the appendices. For convenience, throughout the paper, we provide links to the Python⁷ code to reproduce all of the figures, as well as links to Jupyter⁸ notebooks containing proofs and derivations of the principal equations. Finally, Table 1 lists all of the symbols used in the paper, with references to the equations defining them.

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Jupyter Notebooks: A Primer for Data Curators

Bouquin, Daina; Hou, Sophie; Benzing, Matthew; Wilson, Lee (Data Curation Network, 2019)



Title
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Authors
Bouquin, Daina
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Issue Date
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Abstract

Jupyter Notebooks are composite digital objects used to develop, share, view, and execute interspersed, interlinked, and interactive documentation, equations, visualizations, and code. Researchers seeking to deposit software, in this case Jupyter Notebooks, in repositories do so with the expectation that repositories will provide documentation explaining “what you can deposit, the supported file formats for deposits, what metadata you may need to provide, how to provide this metadata and what happens after you make your deposit” (Jackson, 2018a). This expectation is not necessarily met by repositories that currently accept software deposits and complex objects like Jupyter Notebooks. This guide is meant to both inform curatorial practices around Jupyter Notebooks, and support the development of resources that meet researchers’ expectations to ensure long-term availability of software in curated archival repositories. Guidance provided by Jisc and the Software Sustainability Institute outlines three different kinds of software deposits: a minimal deposit, a runnable deposit, and a comprehensive deposit (Jackson, 2018b). This primer follows this same conceptual framework in dealing with Jupyter Notebooks, which even in their static, non-executable form, can be used to document how scientific research was carried out or be used as teaching models among many other use cases.

Appears in collections
Data Curation Network Primers [23]

Description

This work was created as part of the Data Curation Network “Specialized Data Curation” Workshop #1 co-located with the Digital Library Federation (DLF) Forum 2018 in Las Vegas, Nevada on October 17-18, 2018.

may be written as

$$I(x, y) = \mathbf{g}^T(x, y) \mathbf{y}, \quad (3)$$

where \mathbf{y} is the spherical harmonic basis, arranged in increasing degree and order:

$$\mathbf{y} = (Y_{0,0} \ Y_{1,-1} \ Y_{1,0} \ Y_{1,1} \ Y_{2,-2} \ Y_{2,-1} \ Y_{2,0} \ Y_{2,1} \ Y_{2,2} \ \dots)^T, \quad (4)$$

$$\tilde{\mathbf{g}}_n = \begin{cases} \begin{cases} \frac{\mu-\nu}{2} x^2 y^2 & \nu \text{ even} \\ z & l=1, m=0 \\ 3x^{l-2}yz & \nu \text{ odd}, \mu=1, l \text{ even} \\ z(-x^{l-3} + x^{l-1} + 4x^{l-3}y^2) & \nu \text{ odd}, \mu=1, l \text{ odd} \\ z\left(\frac{\mu-3}{2}x^{l-2}y^{l-1} - \frac{\mu-3}{2}x^{l-2}y^{l-1} - \frac{\mu-3}{2}x^{l-2}y^{l-1}\right) & \text{otherwise} \end{cases} & \nu \text{ even} \\ l=1, m=0 \\ \nu \text{ odd}, \mu=1, l \text{ even} \\ \nu \text{ odd}, \mu=1, l \text{ odd} \\ \text{otherwise} \end{cases} \quad (11)$$

where $Y_{lm} = Y_{lm}(x, y)$ are given by Equation (50). For reference, in this basis the coefficient of the spherical harmonic Y_{lm} is located at the index

$$n = l^2 + l + m \quad (5)$$

of the vector \mathbf{y} . Conversely, the coefficient at index n of \mathbf{y} corresponds to the spherical harmonic of degree and order given by

$$l = \lceil \sqrt{n} \rceil \\ m = n - \lfloor \sqrt{n} \rfloor^2 - \lfloor \sqrt{n} \rfloor, \quad (6)$$

where $\lfloor \cdot \rfloor$ is the floor function.

2.3. Change of Basis

In order to compute the occultation light curve for a body with a given surface map \mathbf{y} , it is convenient to first find its polynomial representation \mathbf{p} , which we express as a vector of coefficients in the polynomial basis $\tilde{\mathbf{p}}$:

$$\tilde{\mathbf{p}}_n = \begin{cases} x^2 y^2 & \nu \text{ even} \\ x^{l-2} y^{l-2} z & \nu \text{ odd} \end{cases} \\ \tilde{\mathbf{p}} = (1 \ x \ z \ y \ x^2 \ xz \ xy \ yz \ y^2 \ \dots)^T \quad (7)$$

(Jupyter), where

$$\mu = l - m \\ \nu = l + m, \quad (8)$$

with l and m given by Equation (6). To find \mathbf{p} given \mathbf{y} , we introduce the change-of-basis matrix A , which transforms a vector in the spherical harmonic basis \mathbf{y} to the polynomial basis $\tilde{\mathbf{p}}$:

$$\tilde{\mathbf{p}} = A \mathbf{y}. \quad (9)$$

The columns of A are simply the polynomial vectors corresponding to each of the spherical harmonics in Equation (4); see Appendix B for details. As before, the

specific intensity at the point (x, y) may be computed as

$$I(x, y) = \tilde{\mathbf{p}}^T \mathbf{p} \\ = \tilde{\mathbf{p}}^T A \mathbf{y}. \quad (10)$$

As we will see in the next section, integrating the surface map over the disk of the body is easier if we apply one final transformation to our input vector, rotating it into what we will refer to as Green's basis, \mathbf{g} :

(Jupyter), where the values of $l, m, \mu,$ and ν are given by Equations (6) and (8). Given a polynomial vector \mathbf{p} , the corresponding vector in Green's basis, \mathbf{g} , can be found by performing another change-of-basis operation:

$$\mathbf{g} = A_2 \mathbf{p}, \quad (12)$$

where the columns of the matrix A_2 are the Green's vectors corresponding to each of the polynomial terms in Equation (7); see Appendix B for details.

Note that we can also transform directly from the spherical harmonic basis to Green's basis:

$$\mathbf{g} = A_2 A \mathbf{y} \\ = A \mathbf{y}, \quad (13)$$

where

$$A \equiv A_2 A_1 \quad (14)$$

is the full change-of-basis matrix. For completeness, we again note that the specific intensity at a point on a map described by the spherical harmonic vector \mathbf{y} can be written

$$I(x, y) = \tilde{\mathbf{g}}^T(x, y) \mathbf{g} \\ = \tilde{\mathbf{g}}^T(x, y) A \mathbf{y}. \quad (15)$$

2.4. Rotation of Surface Maps

Defining a map as a vector of spherical harmonic coefficients makes it straightforward to compute the projection of the map under arbitrary rotations of the body via a rotation matrix \mathbf{R} :

$$\mathbf{y}' = \mathbf{R} \mathbf{y}, \quad (16)$$

where \mathbf{y}' are the spherical harmonic coefficients of the rotated map. In Appendix C, we derive expressions for \mathbf{R} in terms of the Euler angles $\alpha, \beta,$ and γ , as well as in terms of an angle θ and an arbitrary axis of rotation \mathbf{u} . Follow the link next to Figure 1 to view an animation of the spherical harmonics rotating about the y -axis, computed from Equation (16).

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Non-actionable software citations

Actionable software citation

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<graphic xmlns:xlink="http://www.w3.org/1999/xlink" xlink:href="ajaae8e5eqn7.gif"/>
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