



*An overview of*

The

Astro

Project

py

Adrian Price-Whelan

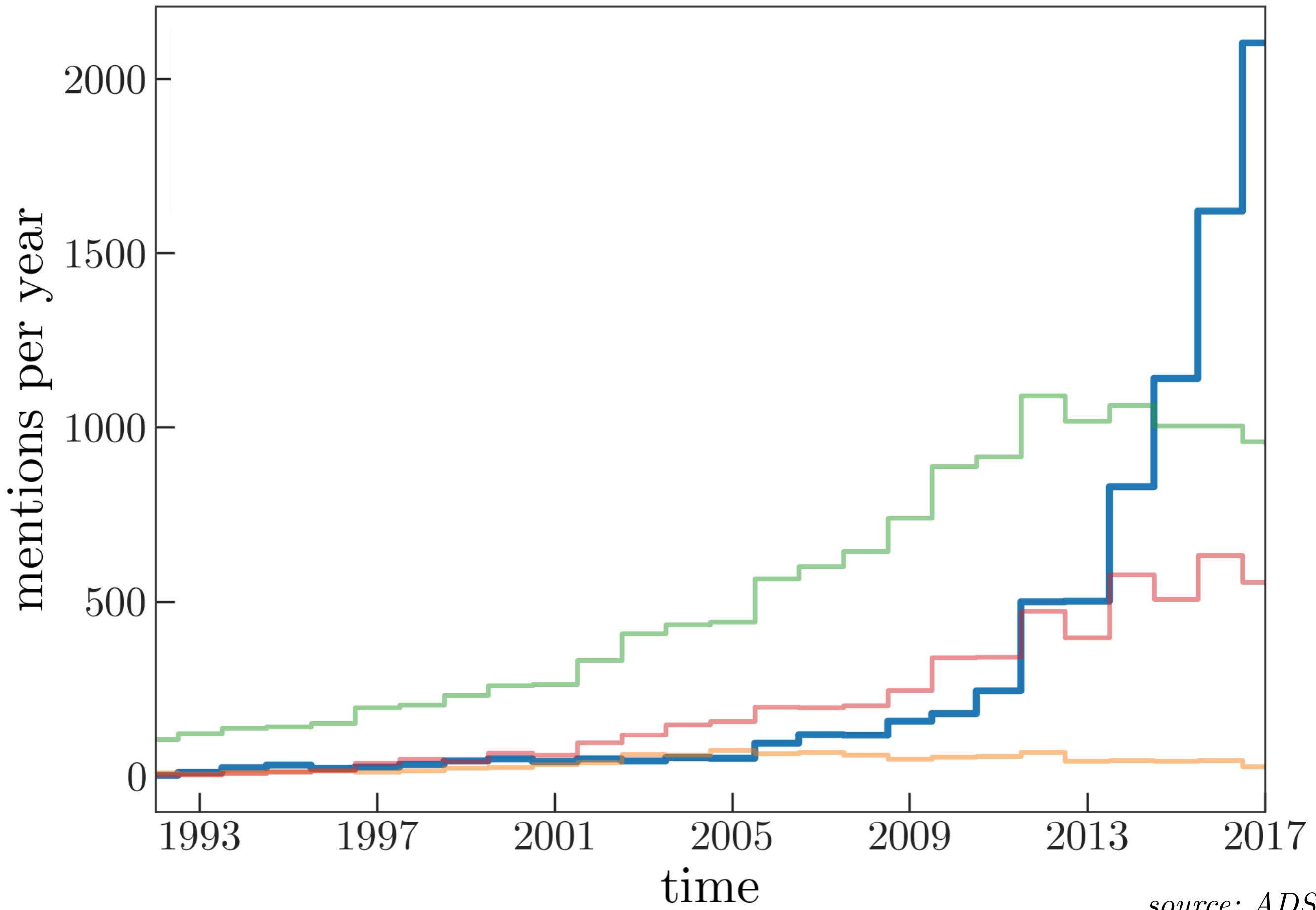


adrn



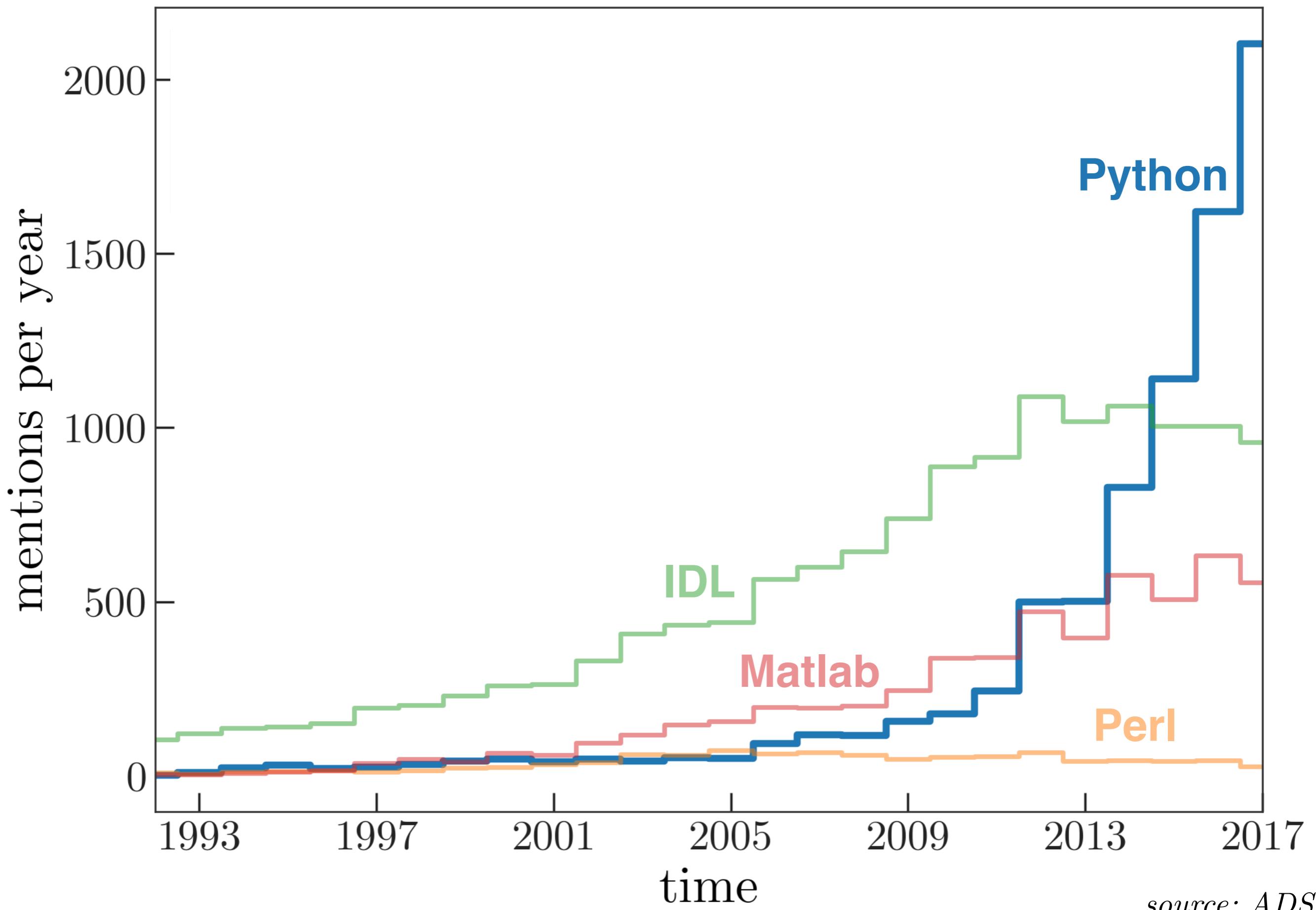
adrianprw

# mentions in the astronomical literature

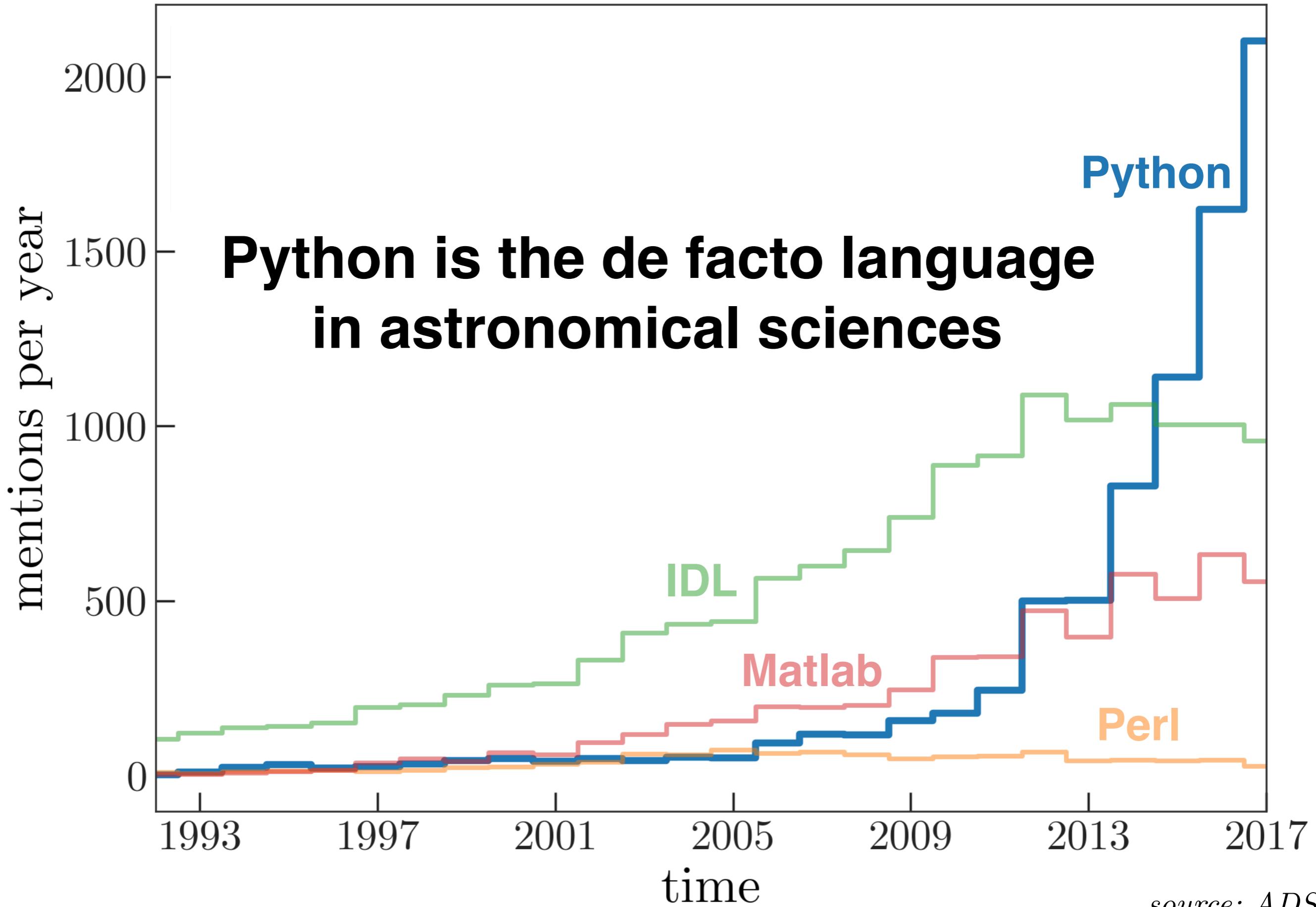


source: ADS

# mentions in the astronomical literature



# mentions in the astronomical literature





*What is*

The

**Astropy**

Project



*What is*

The

# Astropy

Project

**Core package**



*What is*  
The  
**Astropy**  
Project

**Core package      Community**



*What is*

The

# Astropy

Project

**Core package**

**Community**

**Ecosystem**



# Adrian Price-Whelan

*Astropy user & maintainer*

Lyman J. Spitzer, Jr. Fellow  
Princeton University

 adrn  adrianprw

**I work on stellar dynamics  
in the Milky Way**

# I work on stellar dynamics in the Milky Way

 *Observations*

## The Milky Way, Revealed as Never Before

As a major new catalogue of our galaxy's stars from the Gaia space mission reverberates through the scientific community, astronomers are rushing to make revolutionary discoveries

---

By Lee Billings on April 25, 2018



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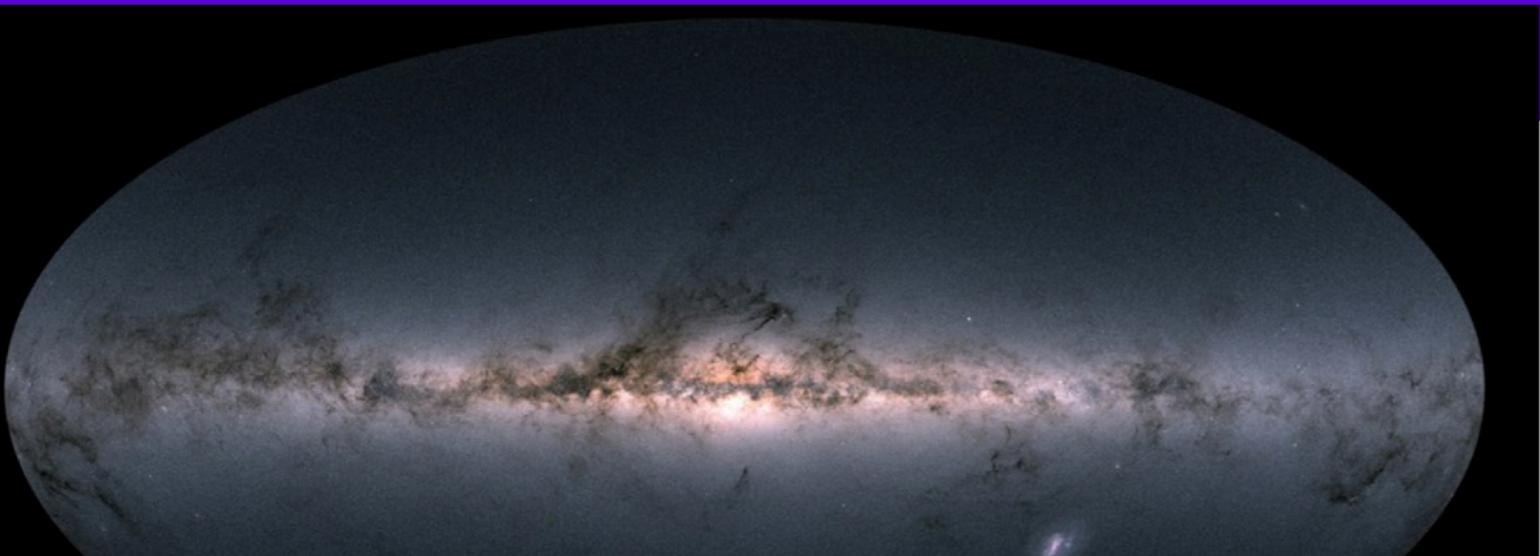
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By Lee Billings on April 25, 2018

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pectacular 3-D atlas shows 1.7 billion stars in unprecedented detail.

by Denise Chow / Apr.27.2018 / 1:32 PM ET / Updated Apr.27.2018 / 3:12 PM ET



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## Gaia second data release

By –  
Lee Billings,  
Scientific  
American

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## This stunning map of the Milky Way pinpoints more than 1 billion stars

Science Apr 26, 2018 12:30 PM EDT

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*Observations*

## The Milky Way, Revealed as Before

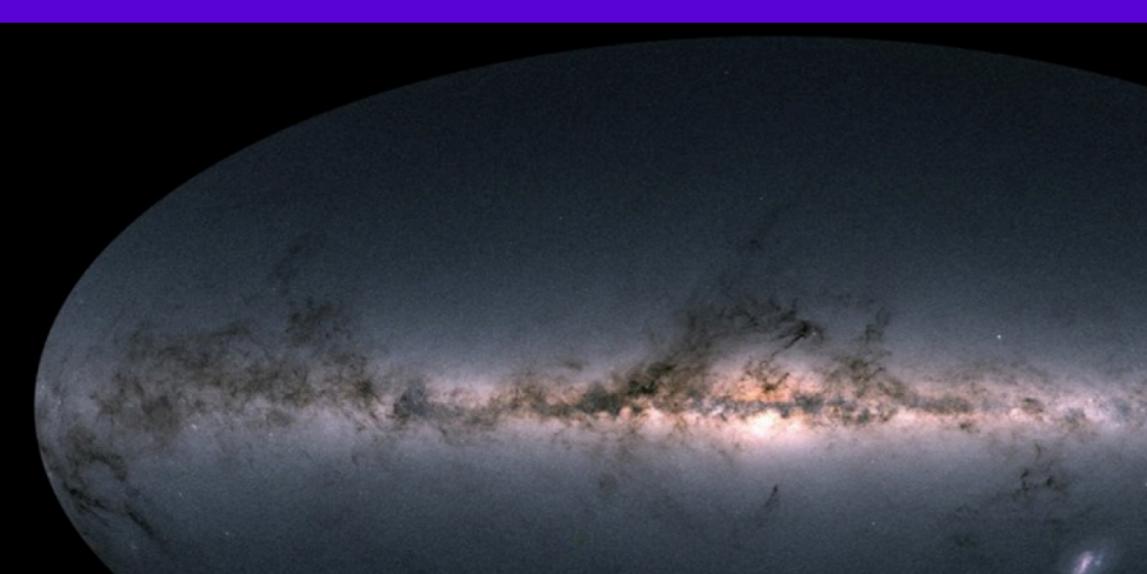
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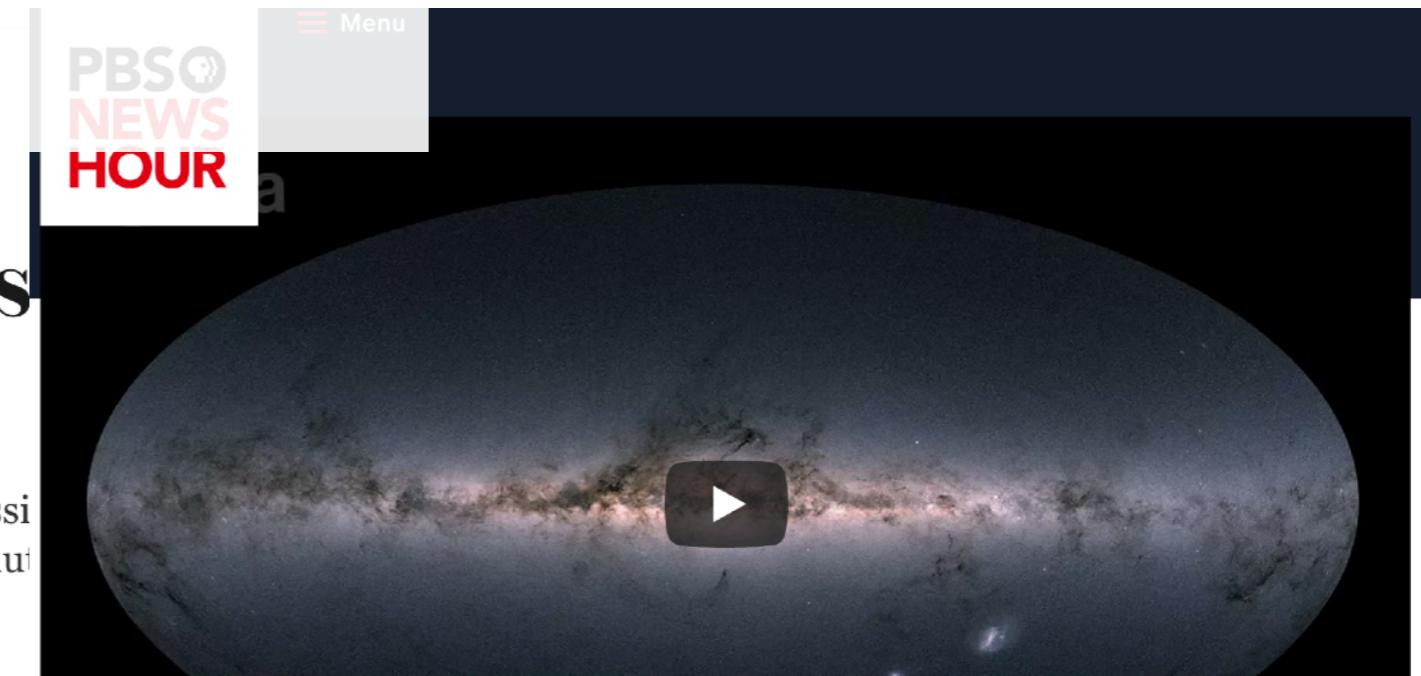
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## Gaia second data release

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### The Gaia satellite gave us a new star map that is out of this world

By Don Lincoln  
Updated 11:52 AM ET, Sat April 28, 2018



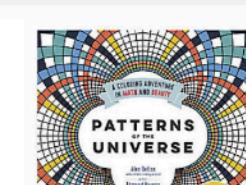
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Observations

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## The Milky Way, Revealed as

SHANNON STIRONE PHOTO 04.29.18 10:00 AM

### STAR SEARCH: GAIA TALLIES UP OUR MILKY WAY

As a major new catalog of stars is released through the scientific community, we look at what it means for our understanding of the galaxy.

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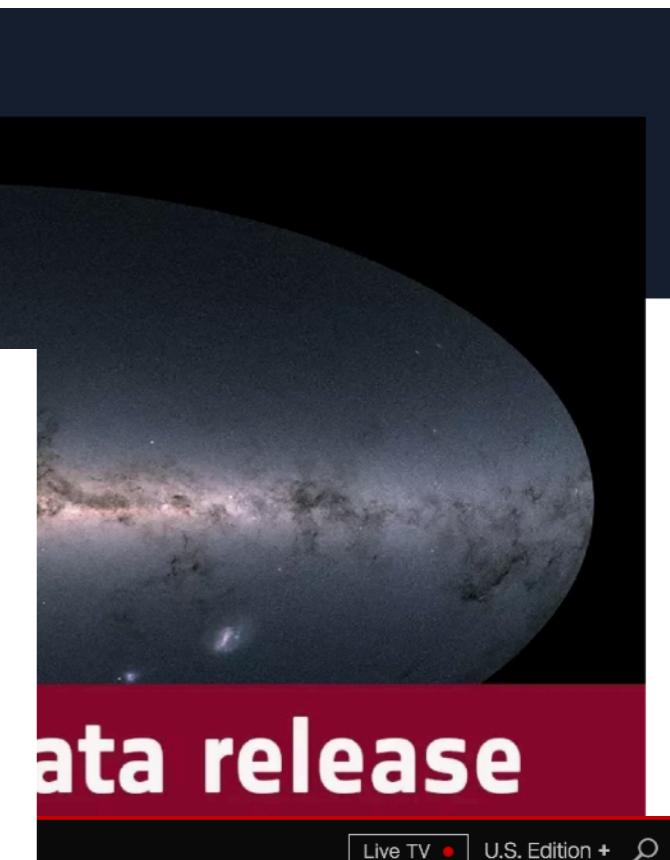
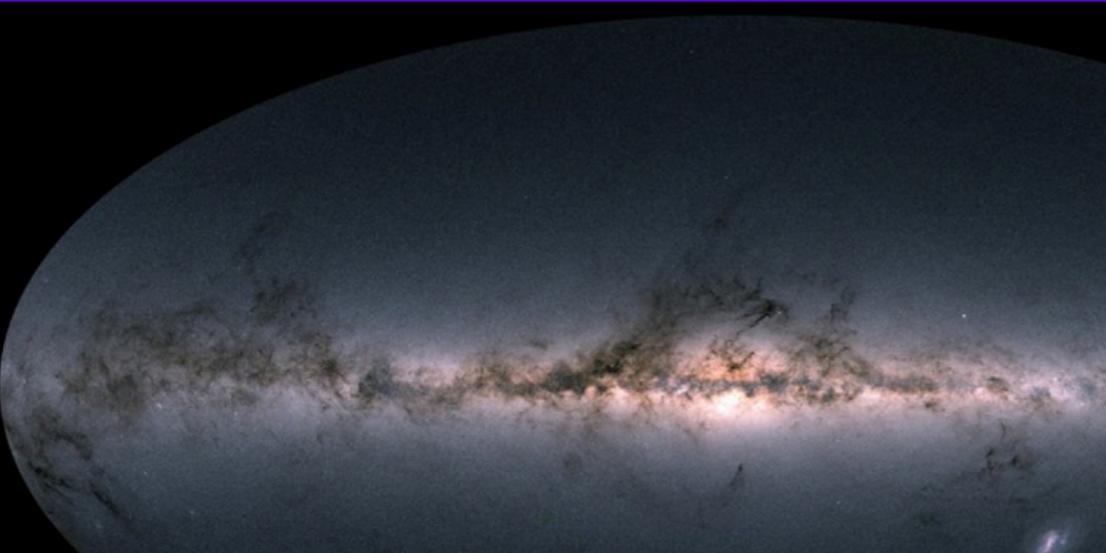
THIS WEEK WE'LL be staying local—but not here on Earth, or even in our solar system. We are zooming through our own galaxy, the Milky Way, because the European Space Agency just has released the long-awaited data set from its Gaia spacecraft. Gaia's mission is to survey the galaxy and go about counting stars, measuring their distances, and generally studying the larger environment that houses our solar system and so many others. The Gaia team already has cataloged more than 1 billion stars in its enormous data trove. What's more, the ESA now exactly how far 100 million of them are from Earth. It's an out-of-this-world accomplishment for the space agency and the mission team.

Astronomers tap Gaia's data to better understand the workings of the galaxy, including the motion of stars, their speed, and also how interstellar dust interacts with galactic objects. It's fun to learn about other places in the universe,

Vast new star catalog about the Milky Way

spectacular 3-D atlas shows

Denise Chow / Apr. 27.2018 / 1:32 PM

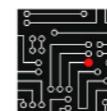


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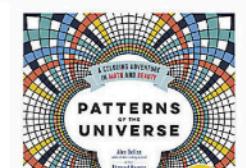


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# I work on stellar dynamics in the Milky Way

Observations

by [David Weintraub](#)

## The Milky

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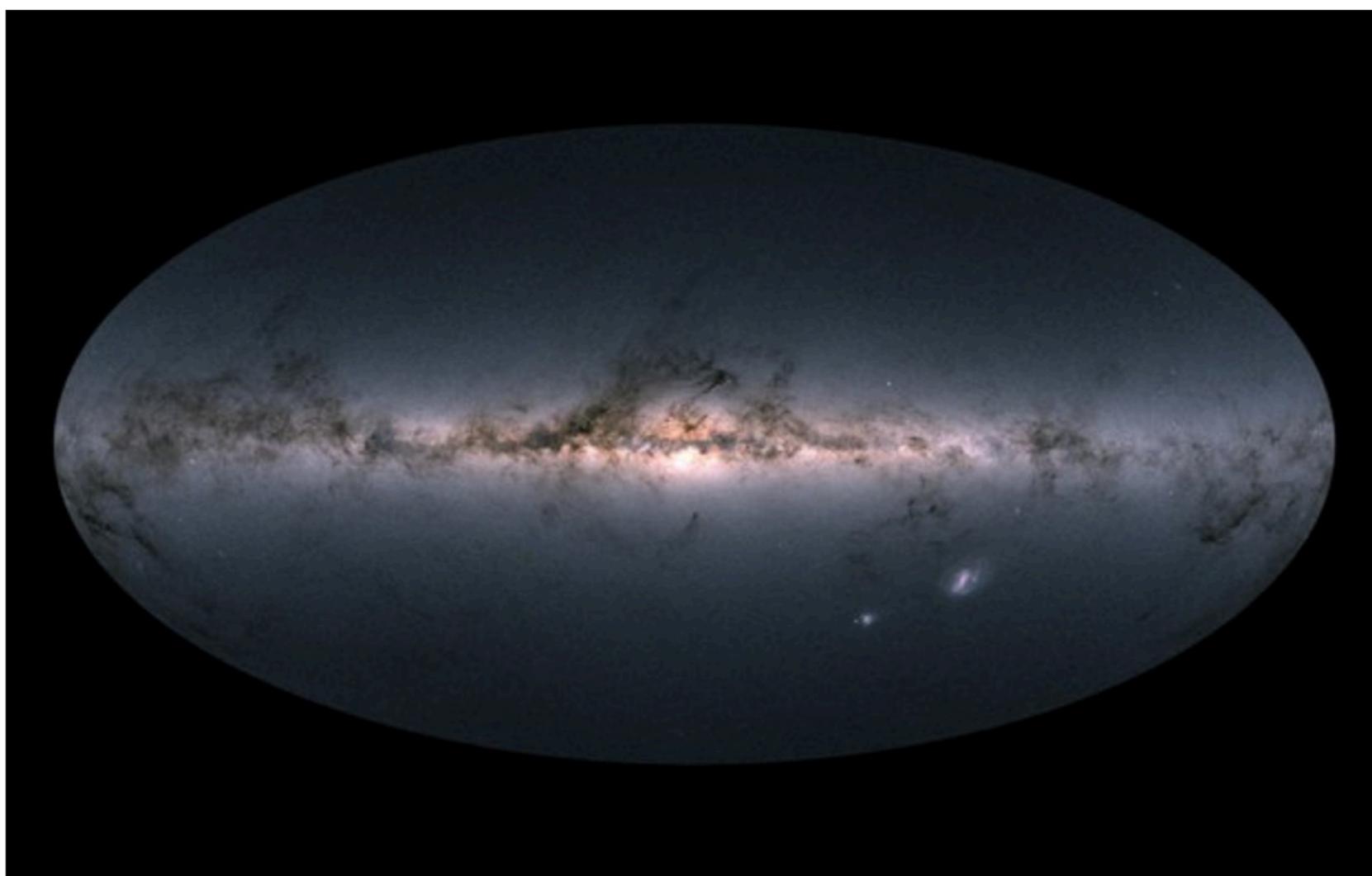
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## Vast new star map about the Milky Way

A spectacular 3-D atlas shows

Denise Chow / Apr. 27. 2018 / 1:32 p.m. ET



Gaia's sky in colour

### GAIA CREATES RICHEST STAR MAP OF OUR GALAXY – AND BEYOND

25 April 2018 ESA's Gaia mission has produced the richest star catalogue to date, including high-precision measurements of nearly 1.7 billion stars and revealing previously unseen details of our home Galaxy.

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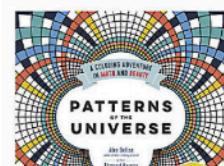
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Observations

—

## The Milky

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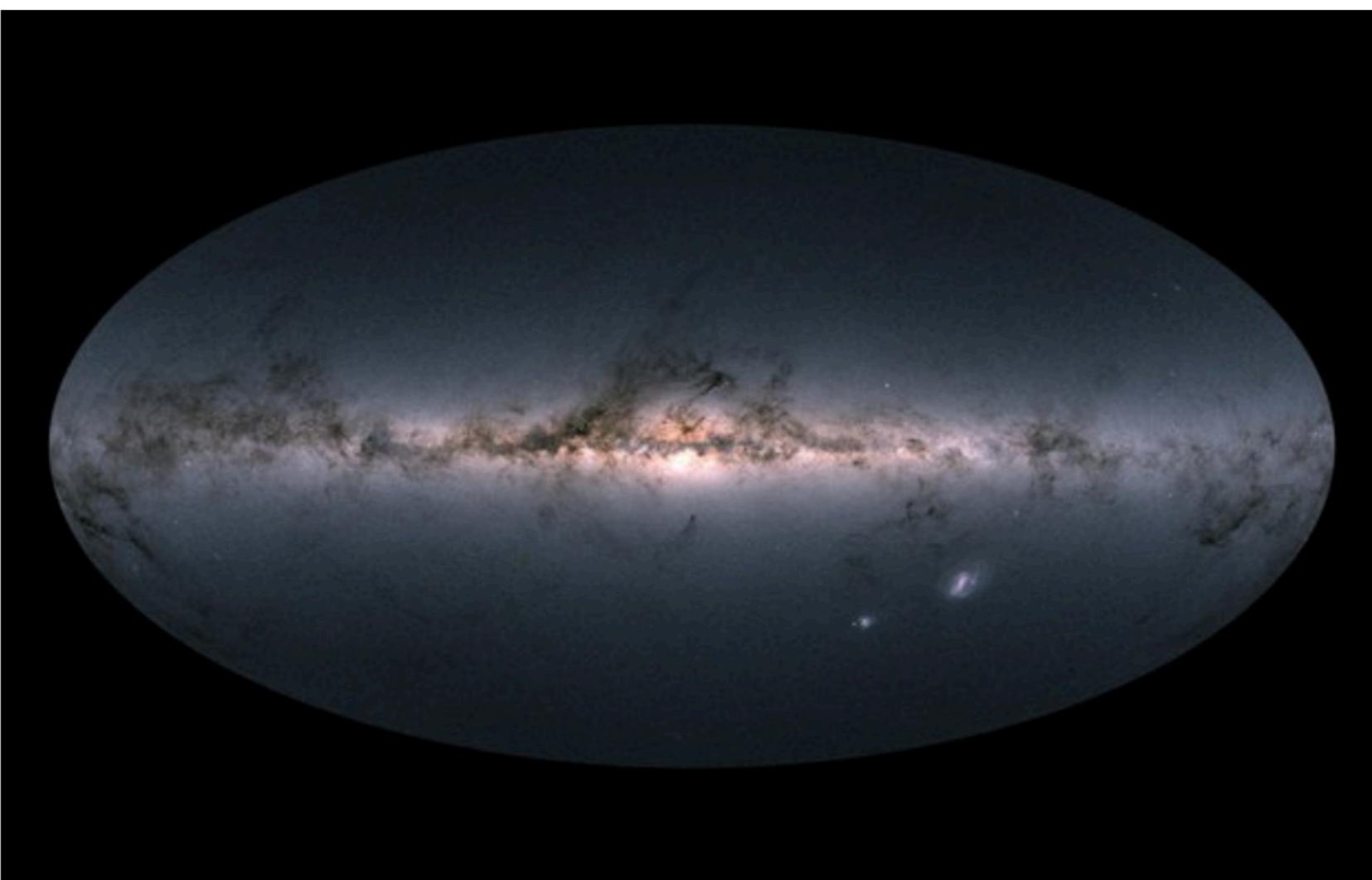
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Denise Chow / Apr. 27. 2018 / 1:32 p.m. ET



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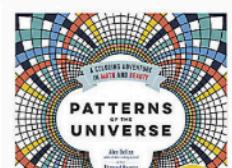
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**I like to write code**



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## Adrian Price-Whelan

adrn

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Princeton University

Princeton, NJ

<http://adrian.pw>

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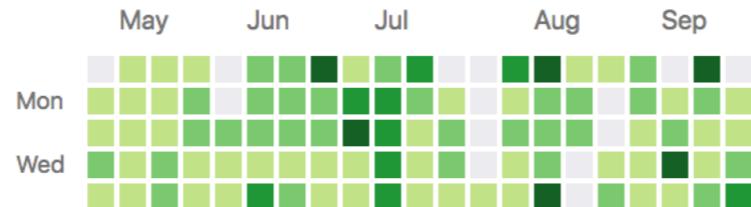
a Python package for working with data from the Gaia mission

Python

3

4

3,270 contributions in the last year

[Contribution settings ▾](#)

I like to write code

# **What I use Python for:**

Data analysis / statistical modeling

Dynamical models and simulations

Analyze survey data

Visualization

# **My roles in the Astropy project:**

Deputy maintainer of astropy.coordinates

Deputy maintainer of astropy.units

Infrastructure lead for Astropy tutorials

Maintainer of affiliated package: Gala

**How did I get involved?**

# My first contribution to Astropy:

(core package)

## Separate color printing from coloring text #417



eteq merged 4 commits into astropy:master from adrн:color\_print on Oct 15, 2012

Conversation 6

Commits 4

Files changed 2



adrн commented on Oct 10, 2012

Member



This is the implementation of [#413](#) -- I've just separated the code that wraps strings with the ANSI color codes from the code that actually prints to the terminal. @mdboom mentioned that this was an implementation choice (see [#101](#)) but I think it's fine to have a separate "private" method to do this.

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**0 new lines of code,  
~4 lines of code rearranged**

# My first major contribution to Astropy:

Following in-person meeting and discussion  
with core devs Erik T., Tom R., ...

## Implementation of Quantity object #445

 Merged eteq merged 40 commits into astropy:master from adrн:quantity on Nov 19, 2012

 Conversation 192

 Commits 40

 Files changed 11



adrн commented on Oct 21, 2012

Member



I think I covered everything we talked about in the API discussion. Please let me know if you see any problems, or unclear docstrings. I still have a few TODO items, but I wanted to get this up for discussion ASAP.

- Who will modify the Unit code so that operations with Unit objects instead return Quantity objects? @mdboom or me?
- I need to start writing the documentation for Quantity, should that all go into this same pull request? e.g. should I start doing that and just add those commits here?

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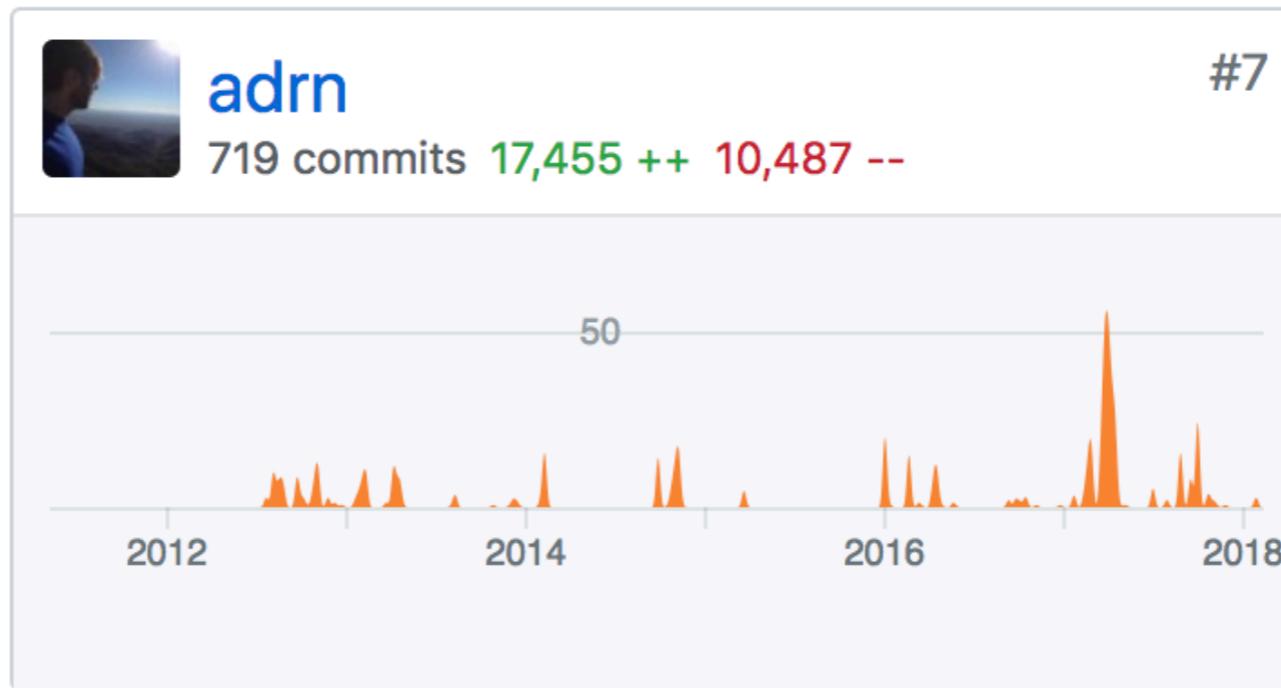
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# Now:



## Top contributors start small!

# The Astropy Core Package

*Key functionality and common tools needed for  
doing astronomy and astrophysics with Python*

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*Key functionality and common tools needed for doing astronomy and astrophysics with Python*

**For example:**

Unit conversion and representation in code

Time manipulations and representations

File I/O for astronomical data formats

Coordinate transformations

# For example:

Units and coordinates

```
In [2]: c1 = coord.SkyCoord(ra=86.7 * u.degree,  
                           dec=-16.33 * u.degree)  
c1.to_string(style='hmsdms')
```

```
Out[2]: '05h46m48s -16d19m48s'
```

```
In [3]: c2 = coord.SkyCoord.from_name('NGC 5897')  
c2.to_string(style='hmsdms', sep=' ', precision=1)
```

```
Out[3]: '15 17 24.4 -21 00 36.4'
```

# For example:

## Reading and writing tables

```
In [2]: tbl_str = """APOGEE_ID P e K
2M00111178+6819091 176.226913452 0.0057013500481 6.405345266
2M00111178+6819091 570.379882812 0.0180691946298 6.89323893003
2M00241366+5907430 392.047149658 0.314418673515 4.94559523893
2M00241366+5907430 196.748336792 0.0337918661535 3.99015023048"""
tbl = ascii.read(tbl_str)
```

```
In [3]: tbl.write(sys.stdout, format='aastex')
```

```
\begin{deluxetable}{cccc}
\tablehead{\colhead{APOGEE\_ID} & \colhead{P} & \colhead{e} & \colhead{K}}
\startdata
2M00111178+6819091 & 176.226913452 & 0.0057013500481 & 6.405345266 \\
2M00111178+6819091 & 570.379882812 & 0.0180691946298 & 6.89323893003 \\
2M00241366+5907430 & 392.047149658 & 0.314418673515 & 4.94559523893 \\
2M00241366+5907430 & 196.748336792 & 0.0337918661535 & 3.99015023048
\enddata
\end{deluxetable}
```

## **& so much more!**

physical constants (`astropy.constants`)

units and quantities (`astropy.units`)

Data Tables (`astropy.table`)

Time and Dates (`astropy.time`)

Coordinate Systems (`astropy.coordinates`)

World Coordinate System (`astropy.wcs`)

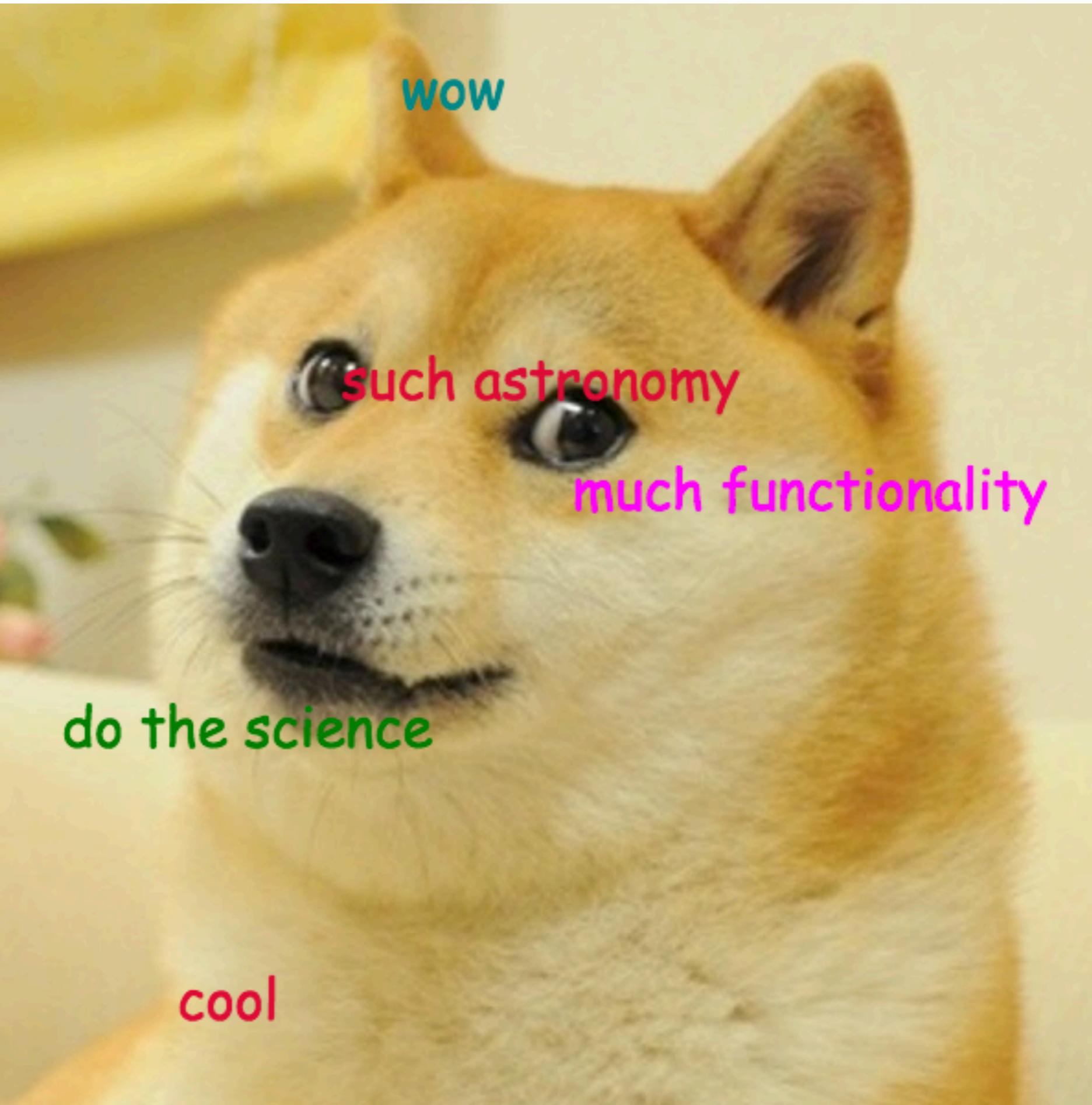
Models and Fitting (`astropy.modeling`)

FITS File handling (`astropy.io.fits`)

Cosmology (`astropy.cosmology`)

Data Visualization (`astropy.visualization`)

Astrostatistics Tools (`astropy.stats`)



wow

such astronomy

much functionality

do the science

cool

# Who develops the Astropy Core Package?

A collaborative effort

~240 contributors

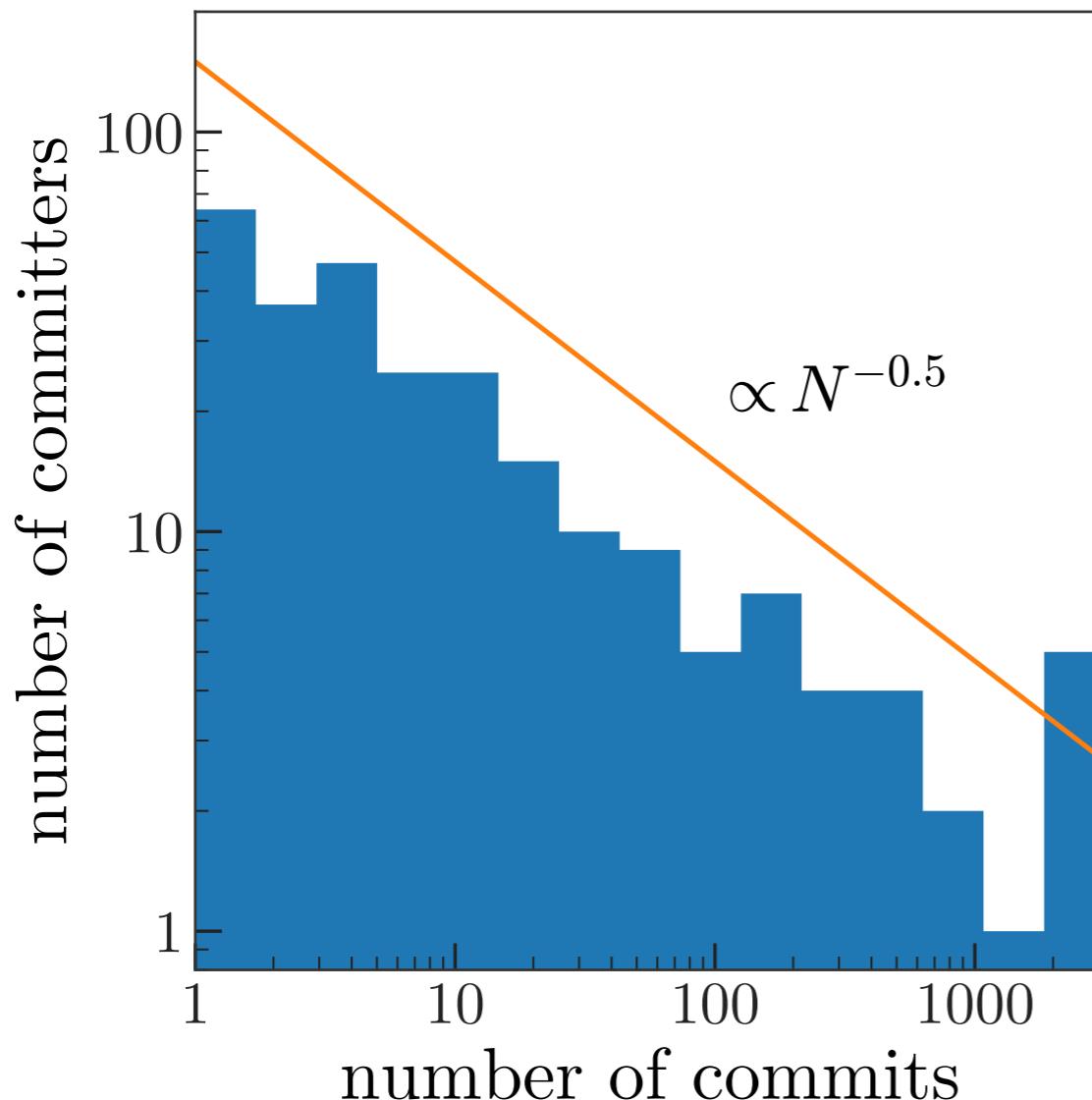
~20 package leads & maintainers

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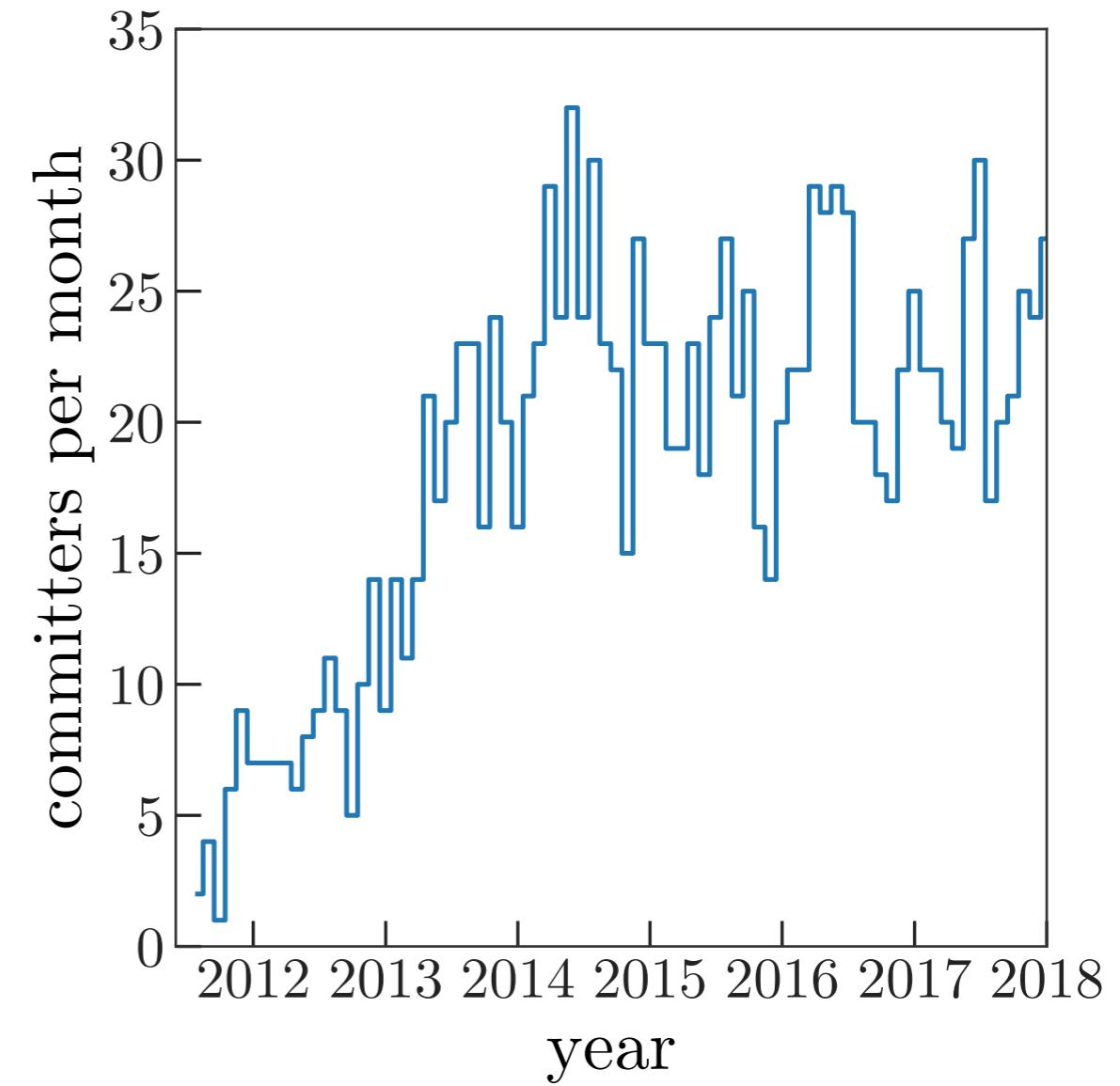
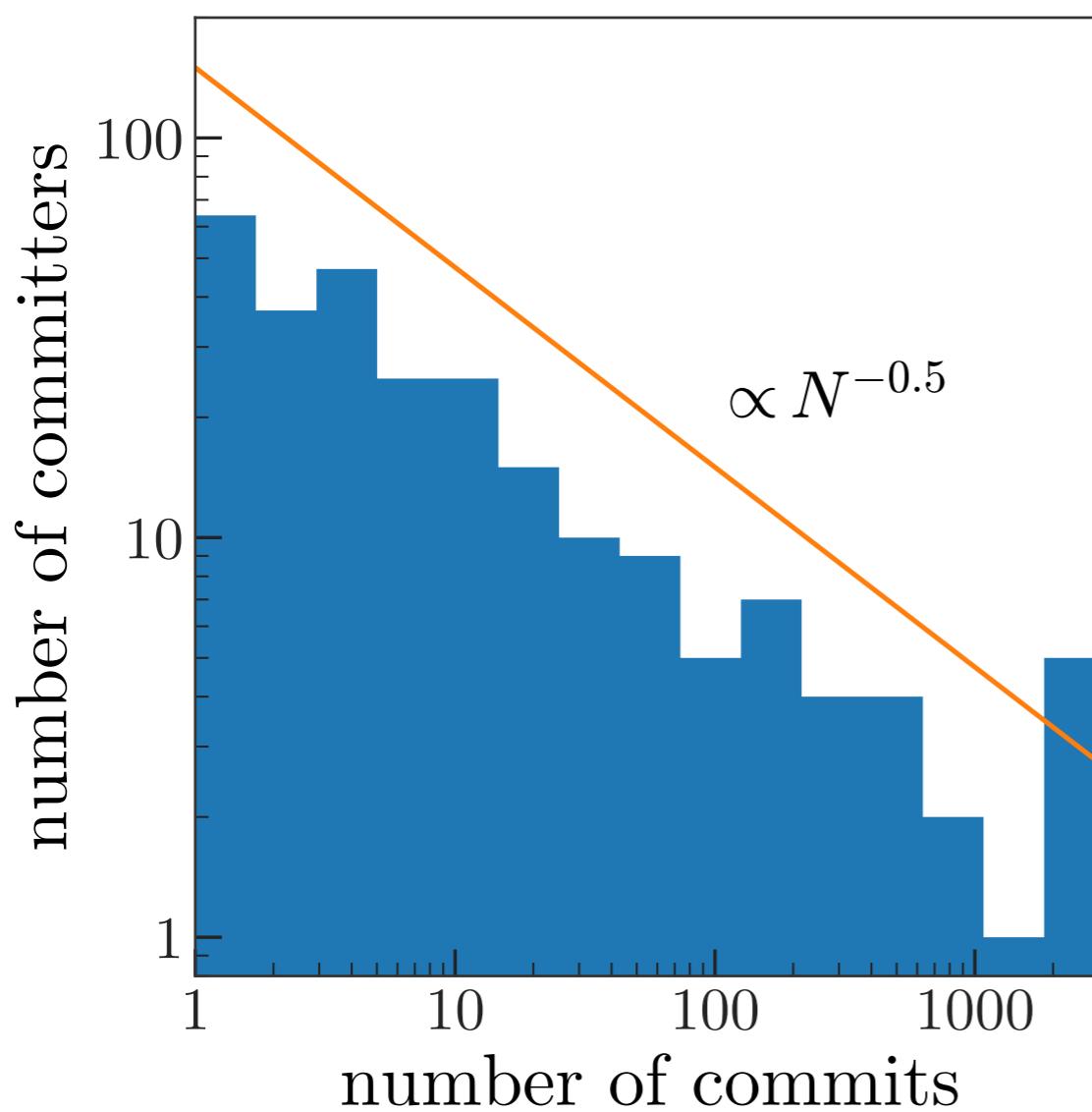


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# Maintainers Deputies

Core package release coordinator		Brigitta Sipocz	Tom Robitaille, Erik Tollerud
Sub-package maintainer			
	astropy.constants	David Shupe	Marten van Kerkwijk
	astropy.convolution	Adam Ginsburg	Axel Donath, Larry Bradley
	astropy.coordinates	Erik Tollerud	Stuart Littlefair, Adrian Price-Whelan
	astropy.cosmology	Alex Conley	<i>Unfilled</i>
	astropy.io.ascii	Tom Aldcroft	Hans Moritz Günther
	astropy.io.fits	<i>Unfilled</i>	Simon Conseil, Michael Seifert, Dan D'Avella
	astropy.io.misc	Tom Robitaille <sup>1</sup>	Matteo Bachetti
	astropy.io.votable	<i>Unfilled</i>	Pey Lian Lim
	astropy.modeling	Nadia Dencheva	Pey Lian Lim
	astropy.nddata	Matt Craig	Steve Crawford, Michael Seifert
	astropy.samp	Tom Robitaille <sup>1</sup>	<i>Unfilled</i>
	astropy.stats	Steve Crawford	Larry Bradley
	astropy.table	Tom Aldcroft	Marten van Kerkwijk
	astropy.time	Tom Aldcroft	Marten van Kerkwijk
	astropy.units	Marten van Kerkwijk	Adrian Price-Whelan
	astropy.utils	Pey Lian Lim	Brigitta Sipocz, Erik Tollerud
	astropy.visualization	Larry Bradley	Tom Robitaille
	astropy.wcs	<i>Unfilled</i>	Nadia Dencheva

<sup>1</sup>Would prefer deputy role

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	astropy.visualization	Larry Bradley	Tom Robitaille
	astropy.wcs	<i>Unfilled</i>	Nadia Dencheva

- Evaluating & merging new pull requests by sub-package
- Feature development & issue tracking

<sup>1</sup>Would prefer deputy role

# The Astropy Coordination Committee



**Erik Tollerud**

**Kelle Cruz**

**Tom Aldcroft**

**Tom Robitaille**

- Overall coordination and management of the Astropy project
- Evaluating new affiliated packages
- Arbitrating disagreements in the core package
- Managing finances for the project

# The Astropy Core Package

Open source

 [astropy / astropy](#)

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# The Astropy Core Package

## Open development

### ENH: Adding Transit Periodogram to astropy.stats #7391

[Edit](#)[Open](#)dfm wants to merge 55 commits into `astropy:master` from `dfm:transit-periodogram`

Conversation 21

Commits 55

Files changed 12

+1,844 -0



dfm commented 12 days ago

First-time contributor



Hi all,

This pull request adds a new feature that I've been working on for a while now with contributions from [@mirca](#) and [@joeldhartman](#). This feature is another popular astronomy-specific periodogram like Lomb-Scargle, but this one is used to find transiting exoplanets and eclipsing binary systems by using a top-hat basis instead of sines. For historical reasons, this algorithm is often referred to as "box least squares", but I think that the more descriptive "transit periodogram" name is better.

This algorithm was proposed by [Kovács et al. \(2002\)](#) and the method has since become the standard method of detecting transiting planets. In many cases, this is achieved by wrapping the Fortran code released by those authors (many people use [f2py bindings that I wrote](#) almost 5 years ago). With K2 data continuing to roll in and the launch of TESS (hopefully today! 🤞) it seems like it would be timely to have an implementation of this algorithm within AstroPy.

With this in mind, my collaborators and I have written an efficient implementation of this algorithm in C with Cython bindings that expose an interface that will be familiar for anyone who uses the `LombScargle` class in `astropy.stats`.

## Reviewers

crawfordsm

larrybradley

At least 1 approving review is required to merge this pull request.

## Assignees

No one—assign yourself

## Labels

stats

whatsnew-needed

## Projects

None yet

# The Astropy Core Package

## Open development



pllim commented 12 days ago

Member + 😊 ...

@dfm did you do a `git submodule update`?



pllim commented 12 days ago

Member + 😊 ...

Also saw this error in 32-bit build:

```
astropy/stats/transit_periodogram/transit_periodogram.c: In function 'run_transit_periodogr
astropy/stats/transit_periodogram/transit_periodogram.c:169:30: error: 'INFINITY' undeclare
    best_objective[p] = -INFINITY;
                           ^
astropy/stats/transit_periodogram/transit_periodogram.c:169:30: note: each undeclared ident
error: command 'gcc' failed with exit status 1
```



dfm commented 12 days ago

+ 😊 ...

I hadn't done that, but I did previously rebase. When I do a `git submodule update` now, it doesn't seem to do anything... submodules have always confused me :-\ sorry!

# The Astropy Core Package

## Open development

### Timeseries object for Astropy (APE9) #12

 **Open** Cadair wants to merge 4 commits into `astropy:master` from `Cadair:master`

 Conversation 19  Commits 4  Files changed 1



Cadair commented on Mar 24, 2016 Member + 

This is still in very early draft.



abigailStev commented on Mar 24, 2016 + 

Pinging myself so I can follow development and discussion.

abigailStev referenced this pull request in [StingraySoftware/stingray](#) on Mar 24, 2016

[Use `pandas` or `astropy.tables` in Lightcurve? #91](#) ! Open



ehsteve commented on Mar 30, 2016 + 

I am very interested in this. Thanks for putting this together @Cadair.

# The Astropy Core Package

Workflow almost entirely on GitHub

This organization Search Pull requests Issues Marketplace Explore

## The Astropy Project

<http://www.astropy.org>

Repositories 63 People 131 Teams 37 Projects 1

### Pinned repositories

<b>astropy</b> Repository for the Astropy core package Python 1.6k 856	<b>astropy.github.com</b> The Astropy web pages HTML 16 47	<b>astropy-helpers</b> Helpers for Astropy and Affiliated packages Python 14 37
<b>astropy-tutorials</b> Tutorials for the Astropy Project Jupyter Notebook 67 77	<b>package-template</b> Template for packages that use Astropy. Maintainer: @astrofrog Python 30 49	<b>astropy-APEs</b> A repository storing the Astropy Proposals for Enhancement. 16 22

# The Astropy Core Package

Software testing & Continuous integration

astropy / astropy  build passing

Current Branches Build History Pull Requests > Build #19488

More options

✓ master Merge pull request #7411 from nden/format-output-in-evaluate

-o #19488 passed

 Restart build

Tabular outputs shape

 Ran for 28 min 44 sec

-o Commit 3198acd ↗

 Total time 1 hr 26 min 28 sec

↳ Compare d3bb55d..3198acd ↗

 2 days ago

↳ Branch master ↗

 P. L. Lim authored

 GitHub committed

# The Astropy Core Package

Software testing & Continuous integration

## Initial tests

the “Build matrix”

⌚ 13 min 17 sec

✓ # 19488.1		</> Compiler: gcc C	PYTHON_VERSION=3.5 SETUP_CMD='egg_info'	⌚ 1 min 51 sec	
✓ # 19488.2		</> Compiler: gcc C	PYTHON_VERSION=3.6 SETUP_CMD='egg_info'	⌚ 1 min 50 sec	
✓ # 19488.3		</> Compiler: clang C	CONDA_DEPENDENCIES=\$CONDA_ALL_DEPE...	⌚ 13 min 17 sec	
✓ # 19488.4		</> Compiler: gcc C	MAIN_CMD="flake8 astropy --count \$FLAKE8..."	⌚ 2 min 42 sec	

## Comprehensive tests

⌚ 15 min 24 sec

✓ # 19488.5		</> Compiler: gcc C	SETUP_CMD='build_docs -w' CONDA_DEPEN...	⌚ 12 min 20 sec	
✓ # 19488.6		</> Compiler: gcc C	PYTHON_VERSION=3.5 NUMPY_VERSION=1.1...	⌚ 8 min 7 sec	
✓ # 19488.7		</> Compiler: gcc C	PYTHON_VERSION=3.5 SETUP_CMD='test --r...	⌚ 10 min 48 sec	
✓ # 19488.8		</> Compiler: gcc C	SETUP_CMD='test --coverage --remote-data=...	⌚ 15 min 24 sec	
✓ # 19488.9		</> Compiler: gcc C	NUMPY_VERSION=prerelease EVENT_TYPE='...	⌚ 2 min 15 sec	
✓ # 19488.10		</> Compiler: gcc C	NUMPY_VERSION=1.12 EVENT_TYPE='push p...	⌚ 6 min 56 sec	
✓ # 19488.11		</> Compiler: gcc C	NUMPY_VERSION=dev SETUP_CMD='test --re...	⌚ 10 min 58 sec	

# The Astropy Papers

## hacking the attribution system

2013

### Astropy: A community Python package for astronomy

The Astropy Collaboration, Thomas P. Robitaille<sup>1</sup>, Erik J. Tollerud<sup>2,3</sup>, Perry Greenfield<sup>4</sup>, Michael Droettboom<sup>4</sup>, Erik Bray<sup>4</sup>, Tom Aldcroft<sup>5</sup>, Matt Davis<sup>4</sup>, Adam Ginsburg<sup>6</sup>, Adrian M. Price-Whelan<sup>7</sup>, Wolfgang E. Kerzendorf<sup>8</sup>, Alexander Conley<sup>6</sup>, Neil Crighton<sup>1</sup>, Kyle Barbary<sup>9</sup>, Demitri Muna<sup>10</sup>, Henry Ferguson<sup>4</sup>, Frédéric Grollier<sup>12</sup>, Madhura M. Parikh<sup>11</sup>, Prasanth H. Nair<sup>12</sup>, Hans M. Günther<sup>5</sup>, Christoph Deil<sup>13</sup>, Julien Woillez<sup>14</sup>, Simon Conseil<sup>15</sup>, Roban Kramer<sup>16</sup>, James E. H. Turner<sup>17</sup>, Leo Singer<sup>18</sup>, Ryan Fox<sup>12</sup>, Benjamin A. Weaver<sup>19</sup>, Victor Zabalza<sup>13</sup>, Zachary I. Edwards<sup>20</sup>, K. Azalee Bostroem<sup>4</sup>, D. J. Burke<sup>5</sup>, Andrew R. Casey<sup>21</sup>, Steven M. Crawford<sup>22</sup>, Nadia Dencheva<sup>4</sup>, Justin Ely<sup>4</sup>, Tim Jenness<sup>23,24</sup>, Kathleen Labrie<sup>25</sup>, Pey Lian Lim<sup>4</sup>, Francesco Pierfederici<sup>4</sup>, Andrew Pontzen<sup>26,27</sup>, Andy Ptak<sup>28</sup>, Brian Refsdal<sup>5</sup>, Mathieu Servillat<sup>29,5</sup>, and Ole Streicher<sup>30</sup>

2018

### THE ASTROPY PROJECT: BUILDING AN INCLUSIVE, OPEN-SCIENCE PROJECT AND STATUS OF THE V2.0 CORE PACKAGE

THE ASTROPY COLLABORATION, A. M. PRICE-WHELAN,<sup>1</sup> B. M. SIPÓCZ,  
H. M. GÜNTHER,<sup>2</sup> P. L. LIM,<sup>3</sup> S. M. CRAWFORD,<sup>4</sup> S. CONSEIL,<sup>5</sup> D. L. SHUPE,<sup>6</sup>  
M. W. CRAIG,<sup>7</sup> N. DENCHEVA,<sup>3</sup> A. GINSBURG,<sup>8</sup> J. T. VANDERPLAS,<sup>9</sup>  
L. D. BRADLEY,<sup>3</sup> D. PÉREZ-SUÁREZ,<sup>10</sup> AND M. DE VAL-BORRO<sup>11</sup>  
(PRIMARY PAPER CONTRIBUTORS)

T. L. ALDCROFT,<sup>12</sup> K. L. CRUZ,<sup>13, 14, 15</sup> T. P. ROBITAILLE,<sup>16</sup> AND E. J. TOLLERUD<sup>3</sup>  
(ASTROPY COORDINATION COMMITTEE)

C. ARDELEAN,<sup>17</sup> T. BABEJ,<sup>18</sup> M. BACHETTI,<sup>19</sup> A. V. BAKANOV, S. P. BAMFORD,<sup>20</sup>  
G. BARENTSEN,<sup>21</sup> P. BARMBY,<sup>17</sup> A. BAUMBACH,<sup>22</sup> K. L. BERRY, F. BISCANI,<sup>23</sup>  
M. BOQUIEN,<sup>24</sup> K. A. BOSTROEM,<sup>25</sup> L. G. BOUMA,<sup>1</sup> G. B. BRAMMER,<sup>3</sup>  
E. M. BRAY, H. BREYTENBACH,<sup>4, 26</sup> H. BUDDELMEIJER,<sup>27</sup> D. J. BURKE,<sup>12</sup>

# The Astropy Community

**“Our goal is to keep ours a positive, inclusive, successful, and growing community”**

- the Astropy code of conduct!

# What is The Astropy Community?

## ...us! – Users & developers

Many entry points:

- Mailing lists: [users](#), [developers](#)
- [Slack](#)
- [Regular telecons](#)
- New: Astropy event calendar

Conferences:

- AAS workshops
- Python in Astronomy
- Coordination meetings

In all forums, venues, contexts,  
follow the [Astropy code of conduct!](#)

# The Astropy Ecosystem

Core package + affiliated packages

**Core package:** General tools, long-term stable,  
longer release schedule

**Affiliated packages:** More specialized tools,  
faster development and release cycle

- Can also be Astropy-coordinated, managed  
by the Astropy project

# The Astropy Ecosystem

Example affiliated packages

## Astropy-coordinated:

photutils: detect and perform photometry of sources

astroquery: tools for querying astronomical databases

## Affiliated:

poliastro: astrodynamics and orbital mechanics

astroML: Astronomical machine learning and data mining

<http://affiliated.astropy.org/>

# The Astropy Ecosystem

Making it easier for scientists to package their software

## Astropy package template:

Provides template setup, installation, and documentation infrastructure

e.g., template setup.py and build structure, Sphinx documentation, Py.test testing, Travis CI config.

<https://github.com/astropy/package-template>

# How to Use Astropy

**Need detailed reference and examples?**

Check the documentation!

**Find a bug? Need more examples?**

Make a GitHub issue!

**Know how to fix it? Want to add examples?**

Submit a pull request!

**Want to add cool new things / features?**

Best to chat to developers first via mailing lists, slack

# How to learn Astropy

**New initiative:** "Learn Astropy"

Funding from STScI to develop educational resources, e.g., tutorials

Speak to Lia Corrales (or me, Kelle) if interested in contributing!

# Challenges & The Future

After rapid growth of the project, now in plateau,  
need for stabilization

***How do we get back on the growth curve?***

Many lead / maintainer roles unfilled

***How do we prevent burnout and support devs?***

***User -> Contributor -> Maintainer?***

We have applied for serious funding (>\$10<sup>6</sup>)

***As the project grows (esp. w/ official funding),  
how do we preserve the development culture?***



The  
Astropy  
Project

**Questions?**