Software Development Best Practices: an Astropy perspective

Thomas Robitaille

The Astropy Project / Aperio Software / Freelancing / AAS Publications

🐦 @astrofrog

Version Control

Writing good code

Testing

Documentation

Continuous Integration

Version Control

Keeps history of **all changes**

Keeps track of **contributors**

Astropy uses **git**

(other options include mercurial)

```
$ git log

commit ab1909df7bbfbaaf8d843ac3583ee054928d9636
Author: Thomas Robitaille <thomas.robitaille@gmail.com>
Date:    Mon Jun 26 16:10:29 2017 +0100

    Re-order what's new for 2.0

commit e65364391338d9b2186093f2a87be9e93bae7959
Merge: 819e4d05e a2d75d33e
Author: Nadia Dencheva <nadia.astropy@gmail.com>
Date:    Mon Jun 26 06:40:50 2017 -0400

    Merge pull request #6250 from nden/fix-units-rotations

    improve units in modeling

commit a2d75d33ea7ea5353f87aa3edc715914eabf2b2a
Author: Nadia Dencheva <nadia.dencheva@gmail.com>
Date:    Sun Jun 25 22:13:40 2017 -0400

    fix typo [skip ci]

commit 819e4d05e4efe40caac7aaa87100f7a7594321f0
Merge: dcc8a380d 941c653b0
Author: Tom Aldcroft <taldcroft@gmail.com>
Date:    Sun Jun 25 14:38:37 2017 -0400

    Merge pull request #6181 from taldcroft/time-ecsv

    Allow round trip of Time, TimeDelta and SkyCoord through ECSV file

commit 941c653b0c4eb4feca21ea0455d44d9a7c380187
Author: Marten van Kerkwijk <mhvk@astro.utoronto.ca>
Date:    Sun Jun 25 11:14:39 2017 -0400

    Update documentation to reflect final format of ecsv file.
```

```
$ git diff 24fefe9b 4a7fff25
diff --git a/astropy/tests/pytest_plugins.py b/astropy/tests/pytest_plugins.py
index 507568574..d6fd93e2a 100644
--- a/astropy/tests/pytest_plugins.py
+++ b/astropy/tests/pytest_plugins.py
@@ -147,8 +147,9 @@ def pytest_configure(config):
                           allow_astropy_data=config.getoption('remote_data') == 'astropy')

     doctest_plugin = config.pluginmanager.getplugin('doctest')
-    if (doctest_plugin is None or config.option.doctestmodules or not
-            (config.getini('doctest_plus') or config.option.doctest_plus)):
+    if (doctest_plugin is None or config.option.doctestmodules
+            or not (config.getini('doctest_plus').lower() in ['true', 'enabled']
+                    or config.option.doctest_plus)):
         return

     # These are the default doctest options we use for everything.
```

Version Control - Additional Benefits

See who modified a particular line last (e.g. `git blame`)

Difference between any two commits (e.g. `git diff`)

Bisect to find issues (e.g. `git bisect`)
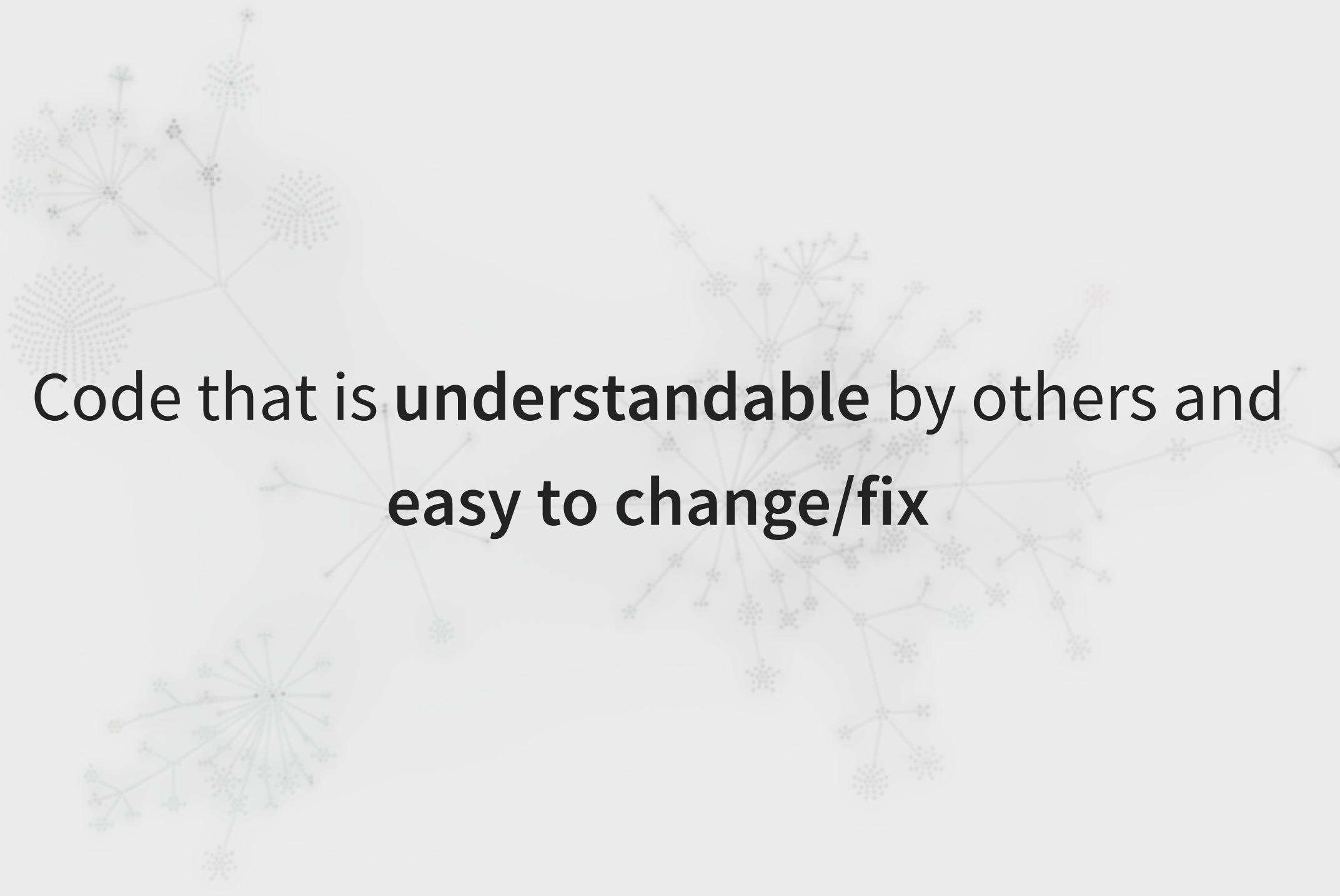
Writing good code

What is 'good' code?

Commented code?
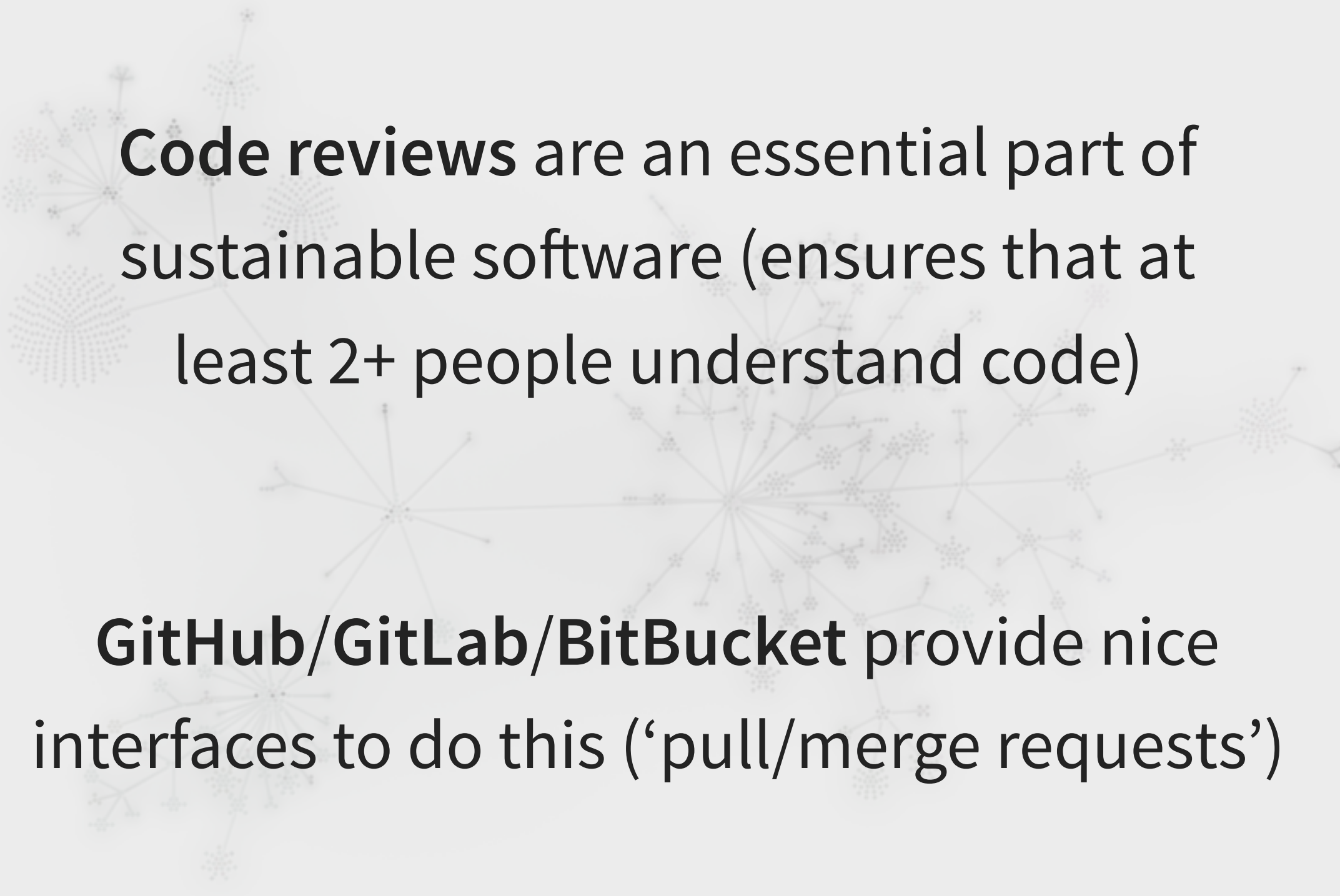
Code that uses functions/classes?

Code that follows style (e.g. PEP8) conventions?

Code that is **understandable** by others and **easy to change/fix**

Code reviews are an essential part of sustainable software (ensures that at least 2+ people understand code)

GitHub/**GitLab**/**BitBucket** provide nice interfaces to do this ('pull/merge requests')

GitHub

GitHub, Inc. [US] https://github.com/astropy/astropy

This repository | Search   Pull requests   Issues   Gist   + ▾

astropy / **astropy**   ⊙ Unwatch ▾ 116   ★ Unstar 688   ⑂ Fork 441

Repository for the Astropy core package http://www.astropy.org — Edit

| ⓡ **13,977** commits | ⑂ **11** branches | 🏷 **34** releases | 👥 **142** contributors |

<> **Code**

Branch: **master** ▾   **astropy** / +   ☰

| ⓘ Issues | 514 |

ⓐ **astrofrog** Merge pull request #4280 from opoplawski/pytest23 ⋯   Latest commit f9148f0 5 hours ago

| ⑂ Pull requests | 103 |

📁 .continuous-integration	For consistency / clarity, rename the PIP variable to PIP_INSTALL [sk…	a month ago
📁 astropy	Use string in skipif() for pytest 2.3 compatiblity	3 days ago
📁 astropy_helpers @ 01a97a2	Updated astropy-helpers again to the latest master, incorporating sev…	a month ago
📁 cextern	Merge pull request #4045 from mdboom/wcs/precision	26 days ago
📁 dev	Add tool to fix up parsing tables	3 months ago
📁 docs	Merge pull request #4238 from bsipocz/docs_fixing_typos_VI_II	10 days ago
📁 licenses	Upgrade PLY to 3.6	3 months ago
📁 static	Fixed support on Python 3, and got rid of .astropy-root per astropy/a…	11 months ago
📄 .astropy-root	Don't rely on .git to enable auto-build when importing from source tr…	4 months ago
📄 .gitattributes	Use union merge for changelog	11 months ago
📄 .gitignore	ignore .swo files generated by vim	6 months ago
📄 .gitmodules	Update the astropy_helpers URL to the real astropy-helpers.	2 years ago
📄 .mailmap	update .mailmap for impending release	9 months ago
📄 .travis.yml	Adding pytz to .travis.yml	a month ago

🔳 **Wiki**

∿ **Pulse**

📊 **Graphs**

⚙ **Settings**

SSH clone URL

git@github.com:ast 📋

You can clone with HTTPS, SSH, or Subversion. ⓘ

⬇ **Clone in Desktop**

⬇ **Download ZIP**

astropy / astropy

<> Code ⓘ Issues 666 ⑀ Pull requests 79 ▥ Projects 2 ▤ Wiki ⚙ Settings Insights ▾

Filters ▾ 🔍 is:pr is:open

Labels Milestones

New pull request

☐ ⑀ 79 Open ✔ 3,849 Closed

Author ▾ Labels ▾ Projects ▾ Milestones ▾ Reviews ▾ Assignee ▾ Sort ▾

☐ ⑀ **Coordinates/velocity bugfix** ✕ `Affects-dev` `Bug` `coordinates`   💬 1
    #6286 opened 44 minutes ago by adrn ⚑ v2.0.0

☐ ⑀ **Add support for GROUP elements in the votable RESOURCE element** ✕ `io.votable` `Work in progress`   💬 3
    #6262 opened 5 days ago by funbaker ⚑ v3.0.0

☐ ⑀ **Add documentation for velocity support in coordinates** ✕ `coordinates` `Docs` `whatsnew-needed`   💬 8
    #6260 opened 5 days ago by adrn ⚑ v2.0.0

☐ ⑀ **Removing numpy 1.9 and python 3.4 from testing** `no-changelog-entry-needed` `testing`   💬 1
    #6246 opened 7 days ago by bsipocz ⚑ v3.0.0

☐ ⑀ **Minor update to releasing docs** `Docs` `Last-before-release` `no-changelog-entry-needed`
    #6244 opened 7 days ago by bsipocz ⚑ v2.0.0

☐ ⑀ **Allow Time to be written as a normal column to FITS files which round-trip on reading** `io.fits`   💬 119
    `table` `Work in progress`
    #6176 opened 17 days ago by AustereCuriosity ⚑ v3.0.0

☐ ⑀ **Added contributions section to repository readme file** ✕ `Docs` `no-changelog-entry-needed`   💬 15
    #6155 opened 22 days ago by sosey • Approved ⚑ v2.0.0

☐ ⑀ **Fix for inserting Quantity slice into Table** ✔ `table` `units`   💬 5
    #6123 opened on May 27 by rirze • Changes requested

☐ ⑀ **Auto-close pull requests after inactivity** ✕ `Enhancement` `Experimental`   💬 16

May 23 by astrofrog

Support Velocities in coordinates by having transforms that use finite differences #6226

Edit

⑃ **Merged**   **eteq** merged 26 commits into `astropy:master` from `eteq:coordinates/finite-diff-vels` 6 hours ago

💬 Conversation **7**   ⊶ Commits **26**   📄 Files changed **9**

+461 −41 ■■■■□

---
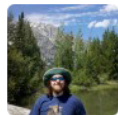
eteq commented 11 days ago • edited

Owner   +😊   ✎

This PR is the fourth (and last) in a series by **@adrn**, **@mhvk**, and myself trying to support velocities in astropy.coordinates. This PR is based on #6219, so will need to be merged **after** that one, and has a lot of commits from the series of PRs. To see a cleaner diff with just these changes, take a look at adrn/astropy#13.

The main purpose of this particular segment of the work is implementing a new transformation that uses finite difference techniques to compute velocities in coordinate frames. It also replaces most of the Astropy transformation machinery to use that new transformation, supporting transforming between the various astropy frames and getting correct velocities out.

It's all working (and there are explicit tests for the main frames of practical use), but there is a flaw: for objects more distant then ~10 kpc, solar system velocity effects (most critically, the heliocentric correction) start getting swamped in machine precision noise because the km-kpc dynamic range is just too much. (This is demonstrated in the `test_numerical_limits` test). For closer objects this isn't really a problem.

This can be fixed in principal by clever finite difference techniques or even just capping the distance as seen in the finite difference transform. However, the details of this probably cannot be worked out in

Reviewers   ⚙

No reviews—request one

Assignees   ⚙

No one—assign yourself

Labels   ⚙

coordinates

merge-when-ci-passes

Projects   ⚙

High priority in
2.0 Feature Planning

Milestone   ⚙

━━━━━━━━━━━

v2.0.0

Support Velocities in coordinates by having transforms that use finite differences #6226

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💬 Conversation 7   ⊶ Commits 26   📄 Files changed 9

+461 −41 ▆▆▆▆▆▆

⊷ Commits on Jun 27, 2017

add FunctionTransformWithFiniteDifference
eteq committed 15 days ago

📋 e567cc5   ‹›

implemented test, but not working due to upstream
eteq committed 15 days ago

📋 356a407   ‹›

Fixes to make finite differences work
eteq committed 14 days ago

📋 a9215ad   ‹›

functioning test (but wrong answer)
eteq committed 12 days ago

📋 bfb5a45   ‹›

finite differences working!
eteq committed 12 days ago

📋 d1f5c2b   ‹›

get intrinsic differntial shift working
eteq committed 12 days ago

📋 8af183f   ‹›

broaden faux lsr tests and associated fixes
eteq committed 12 days ago

📋 ee00a91   ‹›

Support Velocities in coordinates by having transforms that use finite differences #6226

Edit

⑂ **Merged**   **eteq** merged 26 commits into `astropy:master` from `eteq:coordinates/finite-diff-vels` 6 hours ago

⊡ Conversation 7   ⊙ Commits 26   ⊞ Files changed 9

Changes from **all commits** ▾   **9 files** ▾   **+461 −41** ■■■■□ | Unified | **Split** | **Review changes** ▾

---

8 ■■■■□ CHANGES.rst   ‹› ▤ | View | 🖥 ▾

```
@@ −228,8 +228,12 @@ New Features
228  228
229  229       - Frame objects now have experimental support for velocity components. Most
230  230         frames default to accepting proper motion components and radial velocity,
231          −     and the velocitiestransform correctly for any transformation that uses one
232          −     of the ``AffineTransform``-type transformations. [#6219]
     231  +     and the velocities transform correctly for any transformation that uses
     232  +     one of the ``AffineTransform``-type transformations.  For other
     233  +     transformations a finite-difference velocity transformation is available,
     234  +     although it is not as numerically stable as those that use
     235  +     ``AffineTransform``-type transformations. [#6219, #6226]
     236  +
233  237
234  238       - ``astropy.cosmology``
235  239
```

Testing

In many ways, the tests are more important than the actual code

Check that part of functionality works as expected (**unit** test), or check that a bug has been fixed (**regression** test)

Tests should be as simple/short as possible

Testing

```python
def test_constellations():

    sc = SkyCoord(135*u.deg, 65*u.deg)
    assert sc.get_constellation() == 'Ursa Major'
    assert sc.get_constellation(short_name=True) == 'UMa'

    scs = SkyCoord([135]*2*u.deg, [65]*2*u.deg)
    npt.assert_equal(scs.get_constellation(), ['Ursa Major']*2)
    npt.assert_equal(scs.get_constellation(short_name=True), ['UMa']*2)
```

Astropy uses **pytest**

(other options include unittest and nose)

Documentation

Documentation != list of function/classes

Need **installation instructions**, **narrative documentation**, **examples**, and list of functions/classes (**API documentation**)

Astropy uses **Sphinx**

Documentation

```
********************************
Constants (`astropy.constants`)
********************************

.. currentmodule:: astropy.constants

Introduction
============

`astropy.constants` contains a number of physical constants useful in
Astronomy. Constants are `~astropy.units.Quantity` objects with
additional meta-data describing their provenance and uncertainties.

Getting Started
===============

To use the constants in S.I. units, you can import the constants directly from
the `astropy.constants` sub-package::

    >>> from astropy.constants import G

or, if you want to avoid having to explicitly import all the constants you
need, you can simply do:

    >>> from astropy import constants as const
```

Constants (`astropy.constants`)

Introduction

`astropy.constants` contains a number of physical constants useful in Astronomy. Constants are `Quantity` objects with additional meta-data describing their provenance and uncertainties.

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```
>>> from astropy.constants import G
```

or, if you want to avoid having to explicitly import all the constants you need, you can simply do:

```
>>> from astropy import constants as const
```

and then subsequently use for example `const.G` . Cons[t]...
fledged `Quantity` objects, so you can easily convert them to different

v: stable ▼

Building/Hosting: readthedocs.org

Read the Docs

astrofrog ▼

Projects ›
Astropy

View Docs

Overview | Downloads | Search | **Builds** | Versions | ⚙ Admin

Recent Builds

Build Version: | latest ▼

Failed version latest (html)   1 hour, 51 minutes ago

Failed version latest (html)   2 hours, 25 minutes ago

Failed version latest (html)   6 hours, 28 minutes ago

Failed version latest (html)   8 hours, 41 minutes ago

Failed version latest (html)   10 hours, 54 minutes ago

Continuous Integration

Run … for every commit or proposed change where … can be:

Tests

Documentation build

Style checks

etc.

Can check with different versions (e.g. Python 2 and 3)

travis-ci.org (Linux and OSX testing)

✓	# 10757.1	🐧 </> no language set	📦 PYTHON_VERSION=2.6 SETUP_CMD='egg_info'	🕐 1 min 4 sec
✓	# 10757.2	🐧 </> no language set	📦 PYTHON_VERSION=2.7 SETUP_CMD='egg_info'	🕐 1 min 9 sec
✓	# 10757.3	🐧 </> no language set	📦 PYTHON_VERSION=3.3 SETUP_CMD='egg_info'	🕐 1 min 6 sec
✓	# 10757.4	🐧 </> no language set	📦 PYTHON_VERSION=3.4 SETUP_CMD='egg_info'	🕐 1 min 12 sec
✓	# 10757.5	🐧 </> no language set	📦 PYTHON_VERSION=3.5 SETUP_CMD='egg_info'	🕐 1 min 5 sec
✗	# 10757.6	🍎 </> no language set	📦 PYTHON_VERSION=2.7 SETUP_CMD='test' OPTIONAL	🕐 14 min 56 sec
✓	# 10757.7	🐧 </> no language set	📦 PYTHON_VERSION=2.7 SETUP_CMD='build_sphinx -w	🕐 9 min 26 sec
✗	# 10757.8	🐧 </> no language set	📦 PYTHON_VERSION=2.6 SETUP_CMD='test --open-files	🕐 11 min 49 sec
✗	# 10757.9	🐧 </> no language set	📦 PYTHON_VERSION=2.7 SETUP_CMD='test --open-files	🕐 12 min 51 sec
✗	# 10757.10	🐧 </> no language set	📦 PYTHON_VERSION=3.3 SETUP_CMD='test --open-files	🕐 11 min 37 sec
✗	# 10757.11	🐧 </> no language set	📦 PYTHON_VERSION=3.4 SETUP_CMD='test --open-files	🕐 11 min 39 sec
✗	# 10757.12	🐧 </> no language set	📦 PYTHON_VERSION=3.5 SETUP_CMD='test --open-files	🕐 11 min 40 sec
✗	# 10757.13	🐧 </> no language set	📦 PYTHON_VERSION=2.7 SETUP_CMD='test --coverage'	🕐 17 min 49 sec
✗	# 10757.14	🐧 </> no language set	📦 PYTHON_VERSION=3.4 SETUP_CMD='test' OPTIONAL	🕐 1 min 53 sec
✗	# 10757.15	🐧 </> no language set	📦 PYTHON_VERSION=2.7 NUMPY_VERSION=1.8 SETUP_	🕐 11 min 27 sec
✗	# 10757.16	🐧 </> no language set	📦 PYTHON_VERSION=2.7 NUMPY_VERSION=1.7 SETUP_	🕐 11 min 32 sec
✗	# 10757.17	🐧 </> no language set	📦 PYTHON_VERSION=2.7 NUMPY_VERSION=1.6 SETUP_	🕐 10 min 53 sec
✓	# 10757.19	🐧 </> no language set	📦 PYTHON_VERSION=2.7 MAIN_CMD='pep8 astropy --c	🕐 1 min 15 sec

MacOS X →

Documentation ↗

Python 3 —

Style →

appveyor.com (Windows testing)

circleci.com (Linux and OSX testing)

Some checks were not successful
1 failing and 3 successful checks

✕ **ci/circleci** — Your tests failed on CircleCI   Details

✓ **continuous-integration/appveyor/pr** — AppVeyor build succeeded   Details

✓ **continuous-integration/travis-ci/pr** — The Travis CI build passed   Details

✓ **coverage/coveralls** — Coverage remained the same at 84.412%   Details

✓ **This branch has no conflicts with the base branch**
Merging can be performed automatically.

Merge pull request ▾   You can also open this in GitHub Desktop or view command line instructions.

All contributions are made in **GitHub** repositor(ies)

All contributions are reviewed via **pull requests**

Test suite run using **pytest**

Docs written in **Sphinx**, hosted on **ReadTheDocs**

Continuous integration on **Travis**, **AppVeyor**, **CircleCI**

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