Open Gravitational Wave Data

Duncan Brown
Syracuse University

- I joined the LIGO Scientific Collaboration in 1999
- First LIGO paper:

  Abbott,…, DAB,…, Zweizig, “Analysis of LIGO data for gravitational waves from binary neutron stars” Phys. Rev. **D69** 122001 (2004)
- Author 38 out of **368** co-authors
- Cited by **145** since 2004

- Last LIGO paper:

  Abbott,…, DAB,…, Zweizig, “GW170817: Observation of Gravitational Waves from a Binary Neutron Star Inspiral” Phys. Rev. Lett. **119**, 161101 (2017)

- Author 137 out of **1125** co-authors

- Cited by **2057** since October 2107

- Left the LIGO Scientific Collaboration in January 2018

the future of science is OPEN

fosteropenscience.eu

- LIGO Data Management Plan: https://dcc.ligo.org/M1000066/public
- *"Release of events and important non-detections will occur with publication of one or more papers discussing these observational results in the scientific peer-reviewed literature."*
- All O1 and O2 events available now

- Calibrated strain data for all published detections are available from https://gw-openscience.org

Gravitational Wave Open Science Center

Data ▾ Software ▾ Online Status ▾ About GWOSC ▾

Catalog GWTC-1-confident

Confident detections from GWTC-1, the Gravitational-Wave Transient Catalog of Compact Binary Mergers Observed by LIGO and Virgo during the First and Second Observing Runs.

Catalog Description

For strain data:

- Click an event name
- Or see the JSON file list.

JSON Parameter Table

Show/hide columns

SORT: EVENT (A-Z) ▾

Event	Primary mass (M_sun)	Secondary mass (M_sun)	Effective inspiral spin	chirp mass (M_sun)	Final spin	Final mass (M_sun)	Luminosity distance (Mpc)	GPS time (s)
GW150914	$\mathbf{35.6}^{+4.8}_{-3.0}$	$\mathbf{30.6}^{+3.0}_{-4.4}$	$\mathbf{-0.01}^{+0.12}_{-0.13}$	$\mathbf{28.6}^{+1.6}_{-1.5}$	$\mathbf{0.69}^{+0.05}_{-0.04}$	$\mathbf{63.1}^{+3.3}_{-3.0}$	$\mathbf{430}^{+150}_{-170}$	**1126259462.4**

- *"The transition to Open Data, with the regular release of data during observation runs and prompt public alerts of transient events [will begin in April 2019]"*

- O3 alerts can be viewed at https://gracedb.ligo.org

UID	Labels	t_start	t_0	t_end	FAR (Hz)	UTC Created
S190602aq	ADVOK SKYMAP_READY EMBRIGHT_READY PASTRO_READY DQOK GCN_PRELIM_SENT	1243533584.081266	1243533585.089355	1243533586.346191	1.901e-09	2019-06-02 17:59:51 UTC
S190524q	ADVNO SKYMAP_READY EMBRIGHT_READY PASTRO_READY DQOK GCN_PRELIM_SENT	1242708743.678669	1242708744.678669	1242708746.133301	6.971e-09	2019-05-24 04:52:30 UTC
S190521r	PE_READY ADVOK SKYMAP_READY EMBRIGHT_READY PASTRO_READY DQOK GCN_PRELIM_SENT	1242459856.453418	1242459857.460739	1242459858.642090	3.168e-10	2019-05-21 07:44:22 UTC
S190521g	PE_READY ADVOK SKYMAP_READY EMBRIGHT_READY PASTRO_READY DQOK GCN_PRELIM_SENT	1242442966.447266	1242442967.606934	1242442968.888184	3.801e-09	2019-05-21 03:02:49 UTC
S190519bj	PE_READY ADVOK SKYMAP_READY EMBRIGHT_READY PASTRO_READY DQOK GCN_PRELIM_SENT	1242315361.378873	1242315362.655762	1242315363.676270	5.702e-09	2019-05-19 15:36:04 UTC
S190518bb	ADVNO SKYMAP_READY EMBRIGHT_READY PASTRO_READY DQOK GCN_PRELIM_SENT	1242242376.474609	1242242377.474609	1242242380.922655	1.004e-08	2019-05-18 19:19:39 UTC
S190517h	PE_READY ADVOK SKYMAP_READY EMBRIGHT_READY PASTRO_READY DQOK GCN_PRELIM_SENT	1242107478.819517	1242107479.994141	1242107480.994141	2.373e-09	2019-05-17 05:51:23 UTC
S190513bm	ADVOK SKYMAP_READY EMBRIGHT_READY PASTRO_READY DQOK GCN_PRELIM_SENT	1241816085.736106	1241816086.869141	1241816087.869141	3.734e-13	2019-05-13 20:54:48 UTC
S190512at	PE_READY ADVOK SKYMAP_READY EMBRIGHT_READY PASTRO_READY DQOK GCN_PRELIM_SENT	1241719651.411441	1241719652.416286	1241719653.518066	1.901e-09	2019-05-12 18:07:42 UTC
S190510g	ADVOK SKYMAP_READY EMBRIGHT_READY PASTRO_READY DQOK GCN_PRELIM_SENT	1241492396.291636	1241492397.291636	1241492398.293185	8.834e-09	2019-05-10 03:00:03 UTC
S190503bf	ADVOK SKYMAP_READY EMBRIGHT_READY PASTRO_READY DQOK GCN_PRELIM_SENT	1240944861.288574	1240944862.412598	1240944863.422852	1.636e-09	2019-05-03 18:54:26 UTC
S190426c	PE_READY ADVOK SKYMAP_READY EMBRIGHT_READY PASTRO_READY DQOK GCN_PRELIM_SENT	1240327332.331668	1240327333.348145	1240327334.353516	1.947e-08	2019-04-26 15:22:15 UTC
S190425z	ADVOK SKYMAP_READY EMBRIGHT_READY PASTRO_READY DQOK	1240215502.011549	1240215503.011549	1240215504.018242	4.538e-13	2019-04-25 08:18:26 UTC
S190421ar	PE_READY ADVOK SKYMAP_READY EMBRIGHT_READY PASTRO_READY DQOK GCN_PRELIM_SENT	1239917953.250977	1239917954.409180	1239917955.409180	1.489e-08	2019-04-21 21:39:16 UTC
S190412m	PE_READY ADVOK SKYMAP_READY EMBRIGHT_READY PASTRO_READY DQOK GCN_PRELIM_SENT	1239082261.146717	1239082262.222168	1239082263.229492	1.683e-27	2019-04-12 05:31:03 UTC
S190408an	PE_READY ADVOK SKYMAP_READY EMBRIGHT_READY PASTRO_READY DQOK GCN_PRELIM_SENT	1238782699.268296	1238782700.287958	1238782701.359863	2.811e-18	2019-04-08 18:18:27 UTC
S190405ar	ADVNO SKYMAP_READY EMBRIGHT_READY PASTRO_READY DQOK	1238515307.863646	1238515308.863646	1238515309.863646	2.141e-04	2019-04-05 16:01:56 UTC

Superevent Info

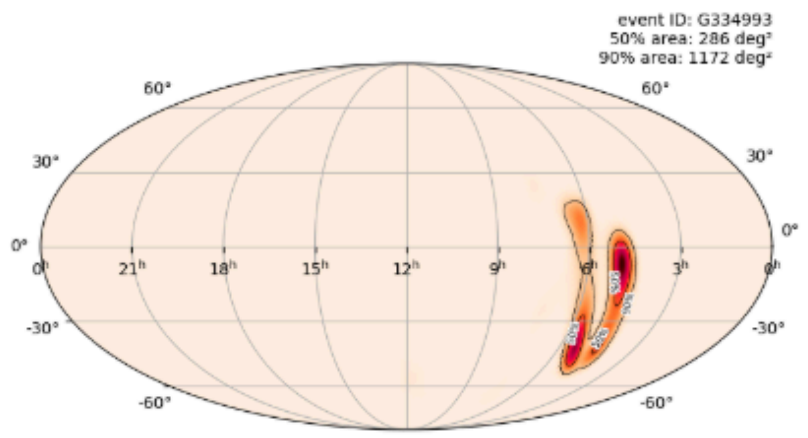
Superevent ID	Category	Labels	FAR (Hz)	FAR (yr⁻¹)	t_start	t_0	t_end	UTC ▾ Submission time	Links
S190602aq	Production	ADVOK SKYMAP_READY EMBRIGHT_READY PASTRO_READY DQOK GCN_PRELIM_SENT	1.901e-09	1 per 16.673 years	1243533584.081266	1243533585.089355	1243533586.346191	2019-06-02 17:59:51 UTC	Data

Preferred Event Info

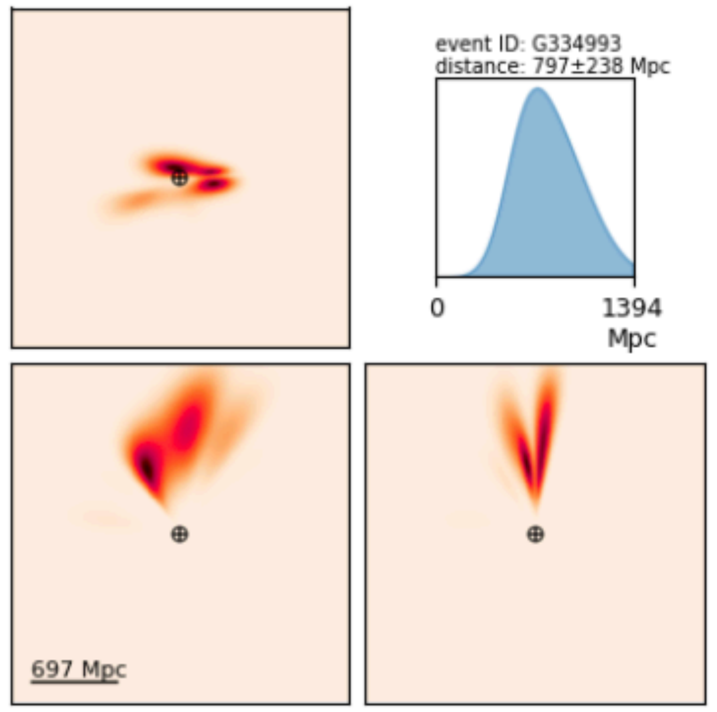
Group	Pipeline	Search	Instruments	GPS Time ▾ Event time	UTC ▾ Submission time
CBC	pycbc	AllSky	H1,L1,V1	1243533585.0894	2019-06-02 18:00:04 UTC

▾ Superevent Log Messages

▾ Sky Localization



Mollweide projection of bayestar.fits.gz bayestar.png. Submitted by LIGO/Virgo EM Follow-Up on Jun 2, 2019 18:05:43 UTC



Volume rendering of bayestar.fits.gz bayestar.volume.png. Submitted by LIGO/Virgo EM Follow-Up on Jun 2, 2019 18:06:55 UTC

- *"Releases will occur every 6 months, in blocks of 6 months of data, with a latency of 18 months from the end of acquisition of each observing block (Expect to shorten the 18 month period)"*

- O1 and O2 data available now

- O3A April 2019 + 6 months + 18 months = April 2021

Large Data Sets for High Performance Computing

For users of computing clusters, CernVM-FS is the preferred method to access large data sets:

CernVM FS

O2 Data Release

O2 Time Range: November 30, 2016 through August 25, 2017
Detectors: H1, L1 and V1

4KHz Data | 16KHz Data | Documents | Timeline

O1 Data Release

O1 Time Range: September 12, 2015 through January 19, 2016
Detectors: H1 and L1

4KHz Data | 16KHz Data | Documents | Timeline

- Fundamentally LIGO gravitational-wave data is CD-quality audio
  - 16 kHz sample rate, 16 bit, 2 x channels
  - + Virgo makes three channels
- ~ 1 hour of strain data can be downloaded for each event
- signal(t) = detector noise(t) + gravitational-wave strain(t)
- Small enough to download via http to your laptop

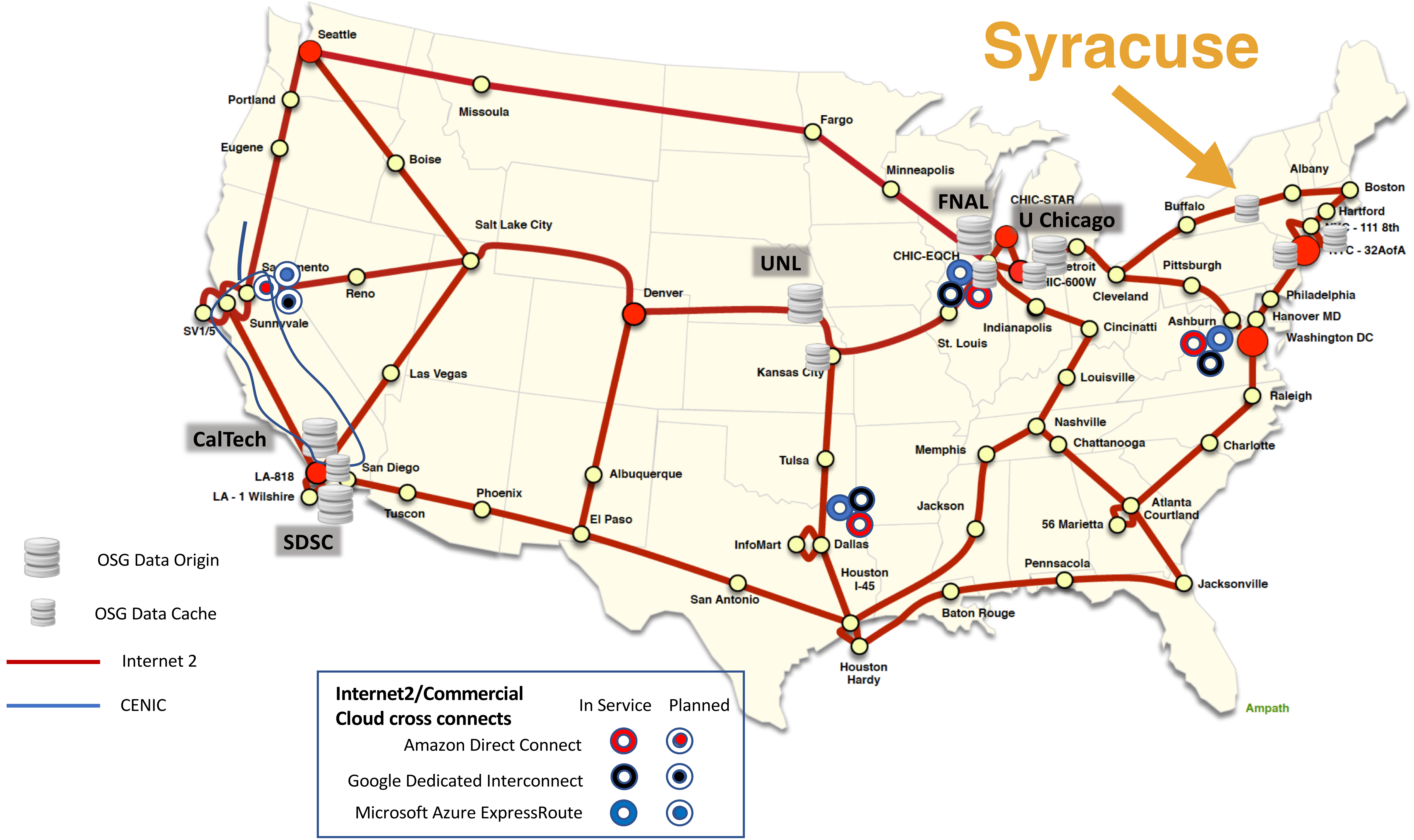
- LIGO-Virgo **only** releases the calibrated, cleaned strain data
- It does not release the raw data or the sub-set of the raw data needed to make the calibrated, cleaned data
- Internally, LIGO does not use GWOSC data
- Proprietary data is sanitized to make GWOSC releases

- Full O1 strain data set O(10 Tb)
- Best way to access the data is CERN Virtual File System (CVMFS)
- https://cernvm.cern.ch/portal/filesystem/quickstart
- Uses FUSE and http to make remote data look like a local filesystem
- Geolocation for optimal server, local caching of files for fast access, can use local http proxies.

```
Duncans-MacBook-2:~ root# df
Filesystem      512-blocks        Used   Available Capacity     iused      ifree %iused  Mounted on
/dev/disk1       974496000   901859432    72124568      93%  112796427    9015571   93%   /
devfs                  507         507           0     100%        878          0  100%   /dev
map -hosts               0           0           0     100%          0          0  100%   /net
map auto_home            0           0           0     100%          0          0  100%   /home
drivefs          974496000   905491264    69004736      93% 18446744069414608791 4294967295 7538514127263836 8%   /Volumes/GoogleDrive
cvmfs2         33554432000 2505007344 31049424656       8%         32          0  100%   /cvmfs/config-osg.opensciencegrid.org
cvmfs2          8388608000 6215123376  2173484624      75%     118085          0  100%   /cvmfs/gwosc.osgstorage.org
cvmfs2         33554432000 2505007344 31049424656       8%      81964   11615465    1%   /cvmfs/oasis.opensciencegrid.org
cvmfs2         33554432000 2505007344 31049424656       8%       2722  232938041    0%   /cvmfs/singularity.opensciencegrid.org
```

1125122048 — -bash — 80×24

```
[dbrown@Duncans-MacBook-2 1125122048]$ pwd
/cvmfs/gwosc.osgstorage.org/gwdata/01/strain.16k/frame.v1/H1/1125122048
[dbrown@Duncans-MacBook-2 1125122048]$ ls
H-H1_LOSC_16_V1-1126072320-4096.gwf     H-H1_LOSC_16_V1-1126113280-4096.gwf
H-H1_LOSC_16_V1-1126076416-4096.gwf     H-H1_LOSC_16_V1-1126117376-4096.gwf
H-H1_LOSC_16_V1-1126080512-4096.gwf     H-H1_LOSC_16_V1-1126121472-4096.gwf
H-H1_LOSC_16_V1-1126084608-4096.gwf     H-H1_LOSC_16_V1-1126125568-4096.gwf
H-H1_LOSC_16_V1-1126088704-4096.gwf     H-H1_LOSC_16_V1-1126137856-4096.gwf
H-H1_LOSC_16_V1-1126092800-4096.gwf     H-H1_LOSC_16_V1-1126146048-4096.gwf
H-H1_LOSC_16_V1-1126096896-4096.gwf     H-H1_LOSC_16_V1-1126150144-4096.gwf
H-H1_LOSC_16_V1-1126100992-4096.gwf     H-H1_LOSC_16_V1-1126154240-4096.gwf
H-H1_LOSC_16_V1-1126105088-4096.gwf     H-H1_LOSC_16_V1-1126158336-4096.gwf
H-H1_LOSC_16_V1-1126109184-4096.gwf     H-H1_LOSC_16_V1-1126162432-4096.gwf
[dbrown@Duncans-MacBook-2 1125122048]$
```


Syracuse
Seattle
Portland
Eugene
Missoula
Boise
Fargo
Minneapolis
FNAL
CHIC-STAR
U Chicago
CHIC-EQCH
Buffalo
Albany
Boston
Hartford
Pittsburgh
Cleveland
Philadelphia
Hanover MD
Washington DC
Ashburn
Cincinatti
Indianapolis
St. Louis
Louisville
Nashville
Chattanooga
Memphis
Raleigh
Charlotte
Atlanta
Courtland
56 Marietta
Jackson
Jacksonville
Pennsacola
Baton Rouge
Houston
I-45
Houston
Hardy
Dallas
InfoMart
Tulsa
Kansas City
UNL
Denver
Salt Lake City
Reno
Sacramento
Sunnyvale
SV1/5
Las Vegas
CalTech
LA-818
LA - 1 Wilshire
San Diego
SDSC
Tuscon
Phoenix
Albuquerque
El Paso
San Antonio
Ampath
OSG Data Origin
OSG Data Cache
Internet 2
CENIC
Internet2/Commercial
Cloud cross connects
In Service
Planned
Amazon Direct Connect
Google Dedicated Interconnect
Microsoft Azure ExpressRoute

Directory	Bytes
/gwdata/O1	1.227PB
/pnfs/fnal.gov/usr/des	744.692TB
/pnfs/fnal.gov/usr/minerva	502.826TB
/user/ligo	200.539TB
/user/bbockelm	184.699TB
/pnfs/fnal.gov/usr/dune	131.776TB
/pnfs/fnal.gov/usr/nova	34.639TB
/user/cwalter	18.966TB
/user/jeanjack	17.566TB

- CVMFS is available on the Open Science Grid and XSEDE clusters

dbrown — dabrown@comet-ln3:~ — ssh -l dabrown login.xsede.org — 80×24

```
     (b) Compute/GPU node local SSD storage: /scratch/$USER/$SLURM_JOBID
         (Meta-data intensive jobs, high IOPs)

     (c) Lustre projects filesystem: /oasis/projects/nsf

     (d) /home/$USER : Only for source files, libraries, binaries.
         *Do not* use for I/O intensive jobs.

[3] Comet User Guide: http://www.sdsc.edu/support/user_guides/comet.html
*******************************************************************************
[dabrown@comet-ln3 ~]$ ls /cvmfs/gwosc.osgstorage.org/gwdata/O2/strain.16k/frame
.v1/H1/1163919360/ | head
H-H1_GWOSC_O2_16KHZ_R1-1164558336-4096.gwf
H-H1_GWOSC_O2_16KHZ_R1-1164562432-4096.gwf
H-H1_GWOSC_O2_16KHZ_R1-1164566528-4096.gwf
H-H1_GWOSC_O2_16KHZ_R1-1164570624-4096.gwf
H-H1_GWOSC_O2_16KHZ_R1-1164574720-4096.gwf
H-H1_GWOSC_O2_16KHZ_R1-1164595200-4096.gwf
H-H1_GWOSC_O2_16KHZ_R1-1164599296-4096.gwf
H-H1_GWOSC_O2_16KHZ_R1-1164603392-4096.gwf
H-H1_GWOSC_O2_16KHZ_R1-1164660736-4096.gwf
H-H1_GWOSC_O2_16KHZ_R1-1164664832-4096.gwf
[dabrown@comet-ln3 ~]$
```

Funding for GWOSC is ~ 1 FTE at LIGO Caltech

Projects with GWOSC data

Some examples of projects using GWOSC data are shown on this page.

Listing a project here does not imply endorsement by LIGO Laboratory, the LIGO Scientific Collaboration or the Virgo Collaboration.

If you have completed a project with GWOSC data, please let us know!

Scientific Publications

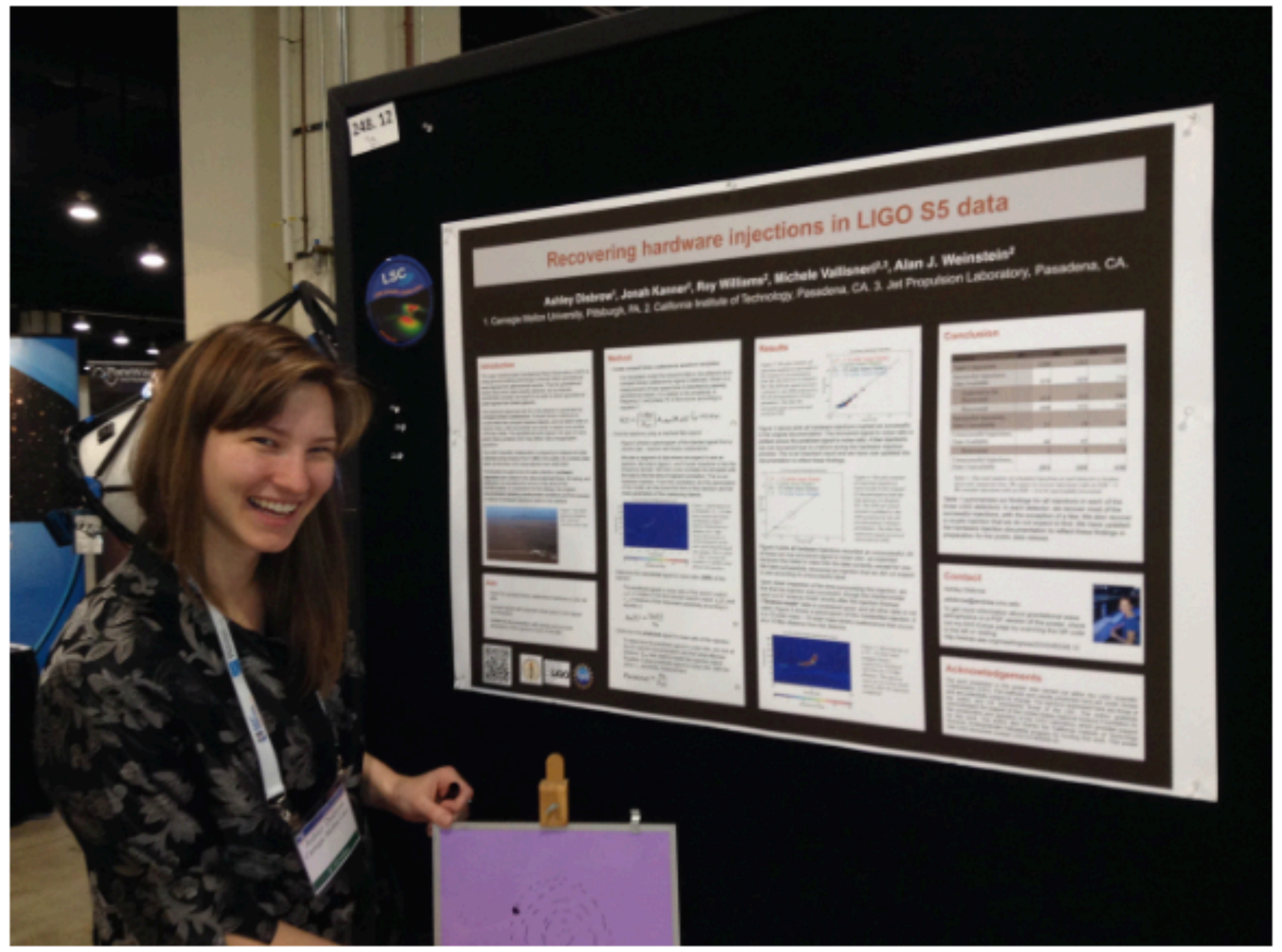
Below are the fifty most recent publications citing GWOSC, as listed by INSPIRE HEP.
For a complete list, please query INSPIRE HEP.

1) Custom Execution Environments with Containers in Pegasus-enabled Scientific Workflows

Karan Vahi, Mats Rynge, George Papadimitriou, *et al.*
arxiv:1905.08204 | INSPIRE

2) Searching for Dark Photon Dark Matter in LIGO O1 Data

Huai-Ke Guo, Keith Riles, Feng-Wei Yang, *et al.*
arxiv:1905.04316 | INSPIRE



Student Ashley Disbrow presents her work at the 2014 American Astronomical Society meeting in Washington, DC.

Software for Gravitational Wave Data

Many of these packages can be installed through LSCSoft Conda. See installation suggestions on the software setup page.

GWpy

GWpy is a python package for gravitational-wave astrophysics.

- GWpy Home Page

PyCBC

PyCBC is a software package used to explore astrophysical sources of gravitational waves. It is a python package that provides functionality to analyze gravitational-wave data, detect the signatures of compact binary mergers, and estimate the parameters of a potential source.

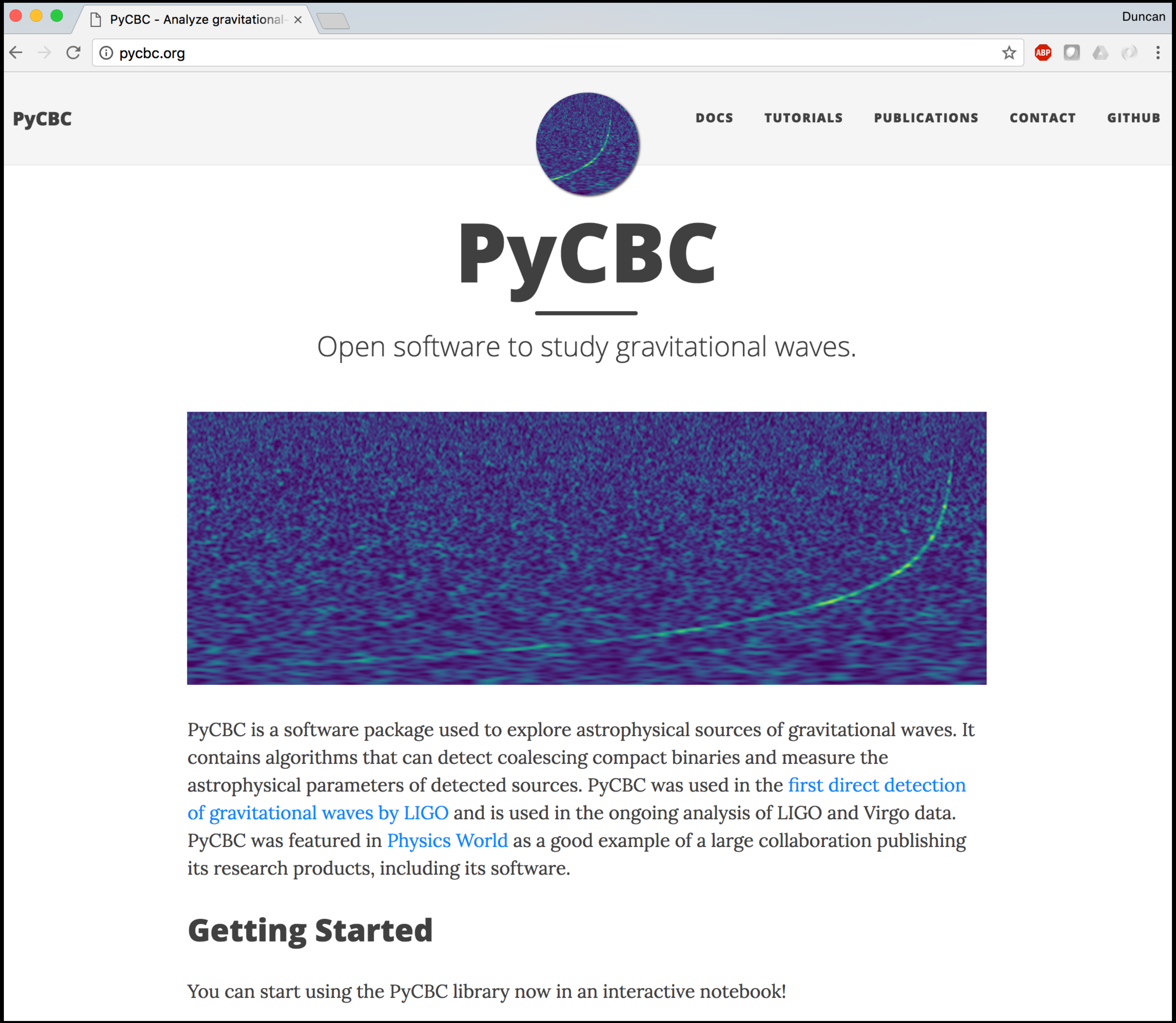
- Home Page
- Online Notebooks
- Docker container

- https://pycbc.org

Core science funding through: NSF Gravity program grants to PIs; Max Planck Society; UK/EU investigators

Infrastructure through NSF ACI grants

Developed by application scientists to solve science problems (c.f. Jim's talk)




Chris Biwer


Collin Capano


Soumi De


Alex Nitz


Miriam Cabero


Daniel Finstad


Tito Dal Canton

Ian Harry

PyCBC Tutorials

Learn how to use the PyCBC core library to study gravitational-wave data!

PyCBC: Python Software to Study Gravitational Waves

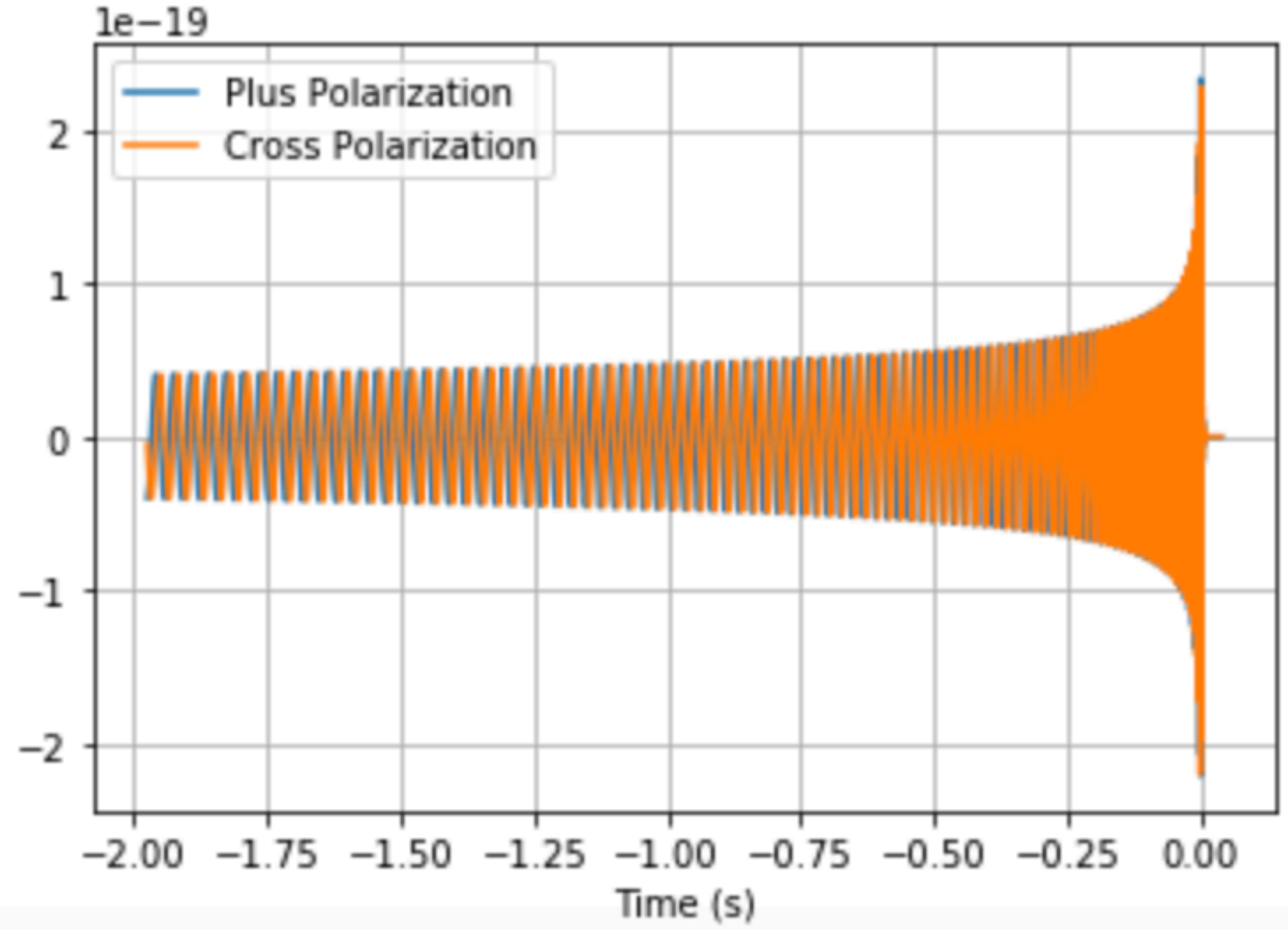
PyCBC is software developed by a collaboration of LIGO, Virgo, and independent scientists. It is open source and freely available. We use PyCBC in the detection of gravitational waves from binary mergers such as GW150914. These examples explore how to analyze gravitational wave data, how we find potential signals, and learn about them.

Browse the Tutorials

These notebooks are available to view, download, or run in interactive sessions. The repository of tutorials along with some additional code examples is available on github.

```
pylab.xlabel('Time (s)')
pylab.legend()
pylab.grid()
pylab.show()

# Zoom in near the merger time#
pylab.plot(hp.sample_times, hp, label='Plus Polarization')
pylab.plot(hp.sample_times, hc, label='Cross Polarization')
pylab.xlabel('Time (s)')
pylab.xlim(-.01, .01)
pylab.legend()
pylab.grid()
pylab.show()
```



https://hub.docker.com/r/pycbc/pycbc-el7/

NYTimes Wash Post LA Times WTF ADS KITP GitHub Overleaf LIGO GCN LHO LLO Pegasus BoA Summit

Search Explore Help Sign up Sign

PUBLIC REPOSITORY

pycbc/pycbc-el7

Last pushed: 16 hours ago

Repo Info Tags

Short Description

CentOS 7 based PyCBC container

Docker Pull Command

```
docker pull pycbc/pycbc-el7
```

Full Description

Welcome to PyCBC, a Python toolkit for analysis of data from gravitational-wave laser interferometer detectors with the goal of detecting and studying signals from compact binary coalescences (CBCs).

Owner

pycbc

THE ASTROPHYSICAL JOURNAL

OPEN ACCESS

1-OGC: The First Open Gravitational-wave Catalog of Binary Mergers from Analysis of Public Advanced LIGO Data

Alexander H. Nitz[1,2], Collin Capano[1,2], Alex B. Nielsen[1,2], Steven Reyes[3], Rebecca White[3,4], Duncan A. Brown[3], and Badri Krishnan[1,2]

Published 2019 February 25 •

The Astrophysical Journal, Volume 872, Number 2

Article PDF

Article ePub

README.md

Instructions for generating the 1-OGC catalog on the Open Science Grid

Alexander H. Nitz[1,2], Collin Capano[1,2], Alex B. Nielsen[1,2], Steven Reyes[3], Rebecca White[4,3], Duncan A. Brown[3], Badri Krishnan[1,2]

1. Albert-Einstein-Institut, Max-Planck-Institut for Gravitationsphysik, D-30167 Hannover, Germany
2. Leibniz Universitat Hannover, D-30167 Hannover, Germany
3. Department of Physics, Syracuse University, Syracuse, NY 13244, USA
4. Fayetteville-Manlius High School, Manlius, NY 13104, USA

This directory contains the scripts and configuration files necessary to reproduce the 1-OGC catalog using public data and code using the Open Science Grid.

These instructions are designed for users familiar with PyCBC, Pegasus WMS, HTCondor, and OSGConnect and who would like to reproduce our results. We assume that the reader has familiarity with running PyCBC in Singularity containers and is able to troubleshoot HTCondor errors that can happen when running large workflows.

The contents of this directory are:

1. A script for generating, planning, and running the workflow on the Open Science Grid
2. A script for generating, planning, and running the workflow on Syracuse University's Orange Grid

Accessing the Catalog: 1-OGC.hdf

There are two datasets within the file, `/complete` and `/bbh`. The `complete` set is the full dataset from our analysis. The `bbh` set includes BBH candidates from a select portion of the analysis. See the 1-OGC paper for additional information.

```
import h5py

catalog = h5py.File('./1-OGC.hdf', 'r')

# Get a numpy structured array of the candidate event properties.
all_candidates = catalog['complete']
bbh_candidates = catalog['bbh']

# Accessing a column by name
ranking_values = all_candidates['stat']

# Selecting parts of the catalog
region = all_candidates['mass1'] + all_candidates['mass2'] < 4
lowmass_candidates = all_candidates[region]
```

File format

Both datasets are structured arrays which have the following named columns. Some of these columns give information specific to either the LIGO Hanford or Livingston detectors. Where this is the case, the name of the column is prefixed with either a `H1` or `L1`.

$$p(\vec{\theta}|\vec{d}(t), H) = \frac{p(\vec{\theta}|H)\ p(\vec{d}(t)|\vec{\theta}, H)}{p(\vec{d}(t)|H)}$$

Need the data, $\vec{d}(t)$ from GWOSC ✓

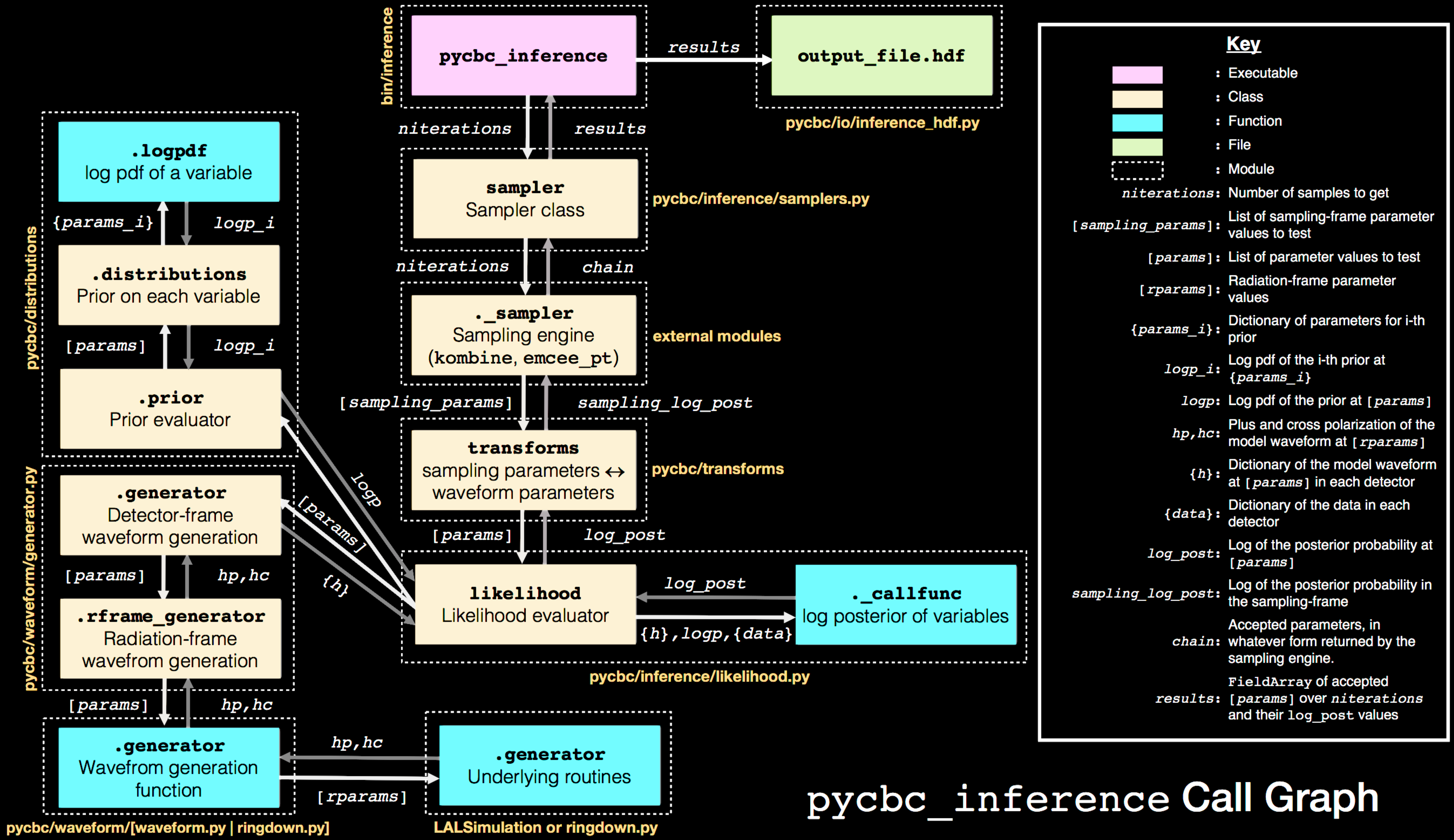
Need a model, $H \equiv h(t; \alpha, \delta, m_1, m_2, \vec{s}_1, \vec{s}_2, \lambda_1, \lambda_2, \ldots)$ from PyCBC ✓

Need a likelihood, $p(\vec{d}(t)|\vec{\theta}, H)$ from PyCBC ✓

Need priors, marginalization, and visualization, from PyCBC ✓

Biwer, Capano, De, Cabero, DAB, Nitz PASP **131** 024503 (2019)

pycbc_inference Call Graph



gwastro / **PyCBCInferenceWorkshopMay2019**

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Repository for the PyCBC Inference workshop in Portsmouth, UK, 14 May - 16 May 2019.

Edit

workshop | pycbc | gravitational-waves | ligo | virgo | bayesian-inference | data-analysis | Manage topics

78 commits | 2 branches | 0 releases | 5 contributors

Branch: master | Create new file | Find File | Clone or download | Gitpod

cdcapano Update README.md ... Latest commit e66c53e 22 hours ago

_images	Adding two more images	22 days ago
pesummary	Adding PESummary workshop (#3)	23 days ago
pycbc_inference_intro	minor typo	23 days ago
pycbc_inference_workflow	Fix typo.	21 days ago
pycbcinf_roadmap	update to work with sciserver	23 days ago
talk-EmceePT	add emcee pt talk	19 days ago
BayesianModelSelectionWithParallelTempering.pdf	add Veitch, Khan, and Reyes talks	19 days ago
Epsie.ipynb	update epsie for sciserver	23 days ago
GWSignalProcessing.ipynb	fix typo	22 days ago
ModelsAndPEByHand.ipynb	use more cores	22 days ago
PythonClassPrimer.ipynb	add primer on python classes tutorial	27 days ago

PyCBCInferenceWorkshopMay2019

Repository for the PyCBC Inference workshop in Portsmouth, UK, 14 May - 16 May 2019.

This repository contains all of the tutorials and talks that were presented at the workshop; it provides a good introduction to PyCBC Inference, and Bayesian inference in general. We recommend following the Program. The links listed there link to the tutorials/lectures in this repository.

How to run the tutorials

Using SciServer

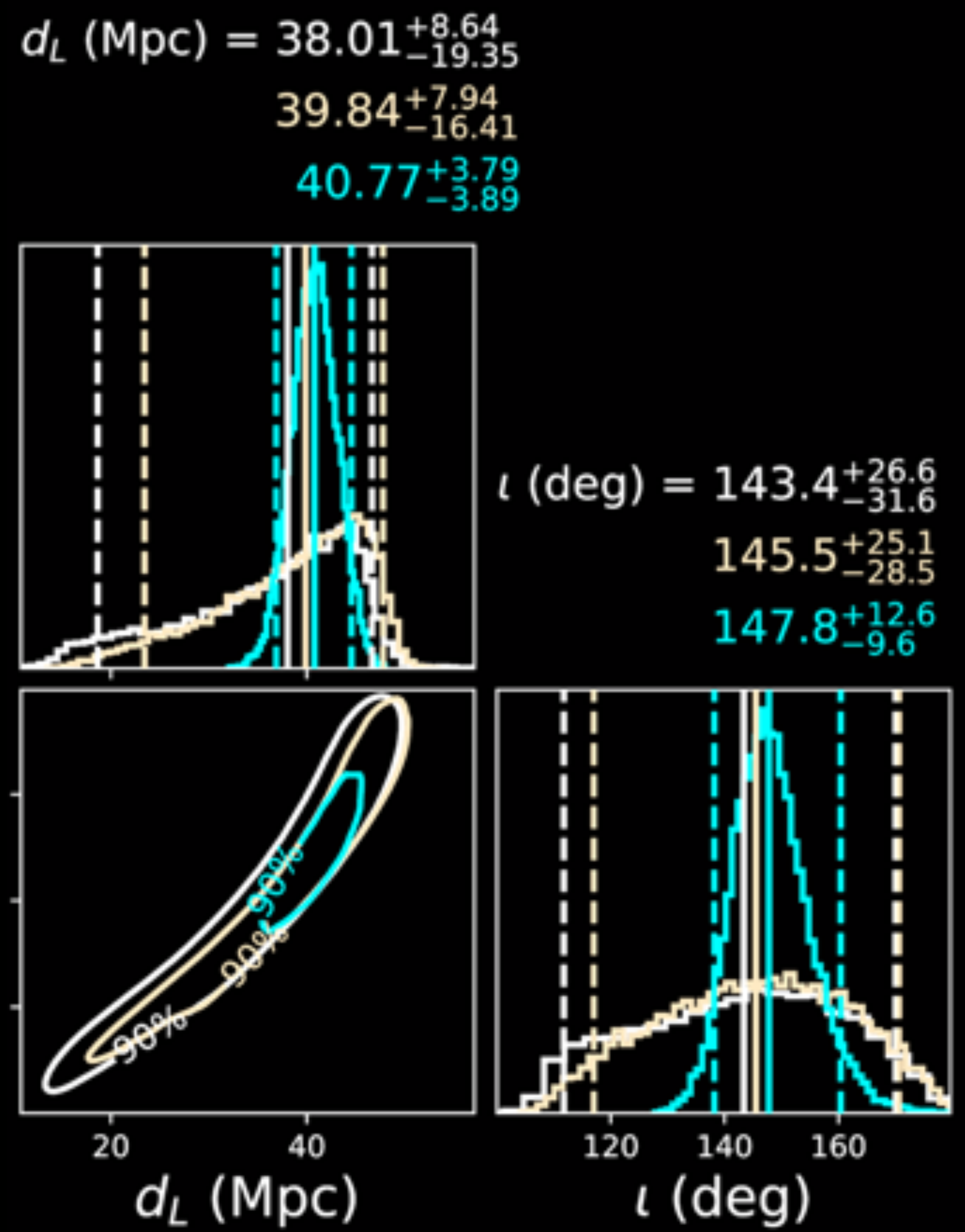
To run the tutorials, we recommend using SciServer:

1. If you don't already have one, create a SciServer account (it's free). Then go to apps.sciserver.org/compute.
2. Click "Create container". Give it a name; in the "Compute Image" drop-down menu click "Python + R". Then click "Create."
3. Click on the container you just created; this will open a new tab in your browser that is a Jupyter notebook interface.
4. Clone this repository into your SciServer container: Click "New" -> "Terminal". This will open another tab that with a bash terminal in it. Change directory into "workspace" by typing `cd workspace`. Now type:

   ```
   git clone https://github.com/gwastro/PyCBCInferenceWorkshopMay2019.git
   ```

   This will download a copy of this repository to your directory on SciServer.

Photo: Ian Harry



Viewing angle is $32^{+10}_{-13} \pm 1.7$ deg

Lower limit of $\geq 13\mathrm{deg}$

robust to choice of prior

Finstad, De, DAB, Berger, Biwer ApJ **860** L2 (2018)

https://github.com/sugwg/gw170817-inclination-angle

Using the posterior probability data

The posterior data is stored as flattened arrays in the `samples` group of the hdf files in this repository. The parameter names for each of the arrays that exist in a file can be accessed through a `variable_args` attribute of the file:

In [2]:
```
fp = h5py.File("gw_only_posteriors.hdf", "r")
print fp.attrs['variable_args']
fp.close()
```

```
['tc' 'ra' 'dec' 'mass1' 'mass2' 'coa_phase' 'inclination' 'polarization'
 'distance' 'spin1z' 'spin2z']
```

Each of these parameter names can then be used to access that parameter's data in the `samples` group of the file. For example, the inclination angle posterior samples (in radians) from our run using the GW signal as well as EM sky location and Gaussian distance prior can be accessed this way:

In [3]:
```
fp = h5py.File("gw_skyloc_and_dist_posteriors.hdf", "r")
inc_samples = fp['samples/inclination'][:]
fp.close()
print inc_samples
```

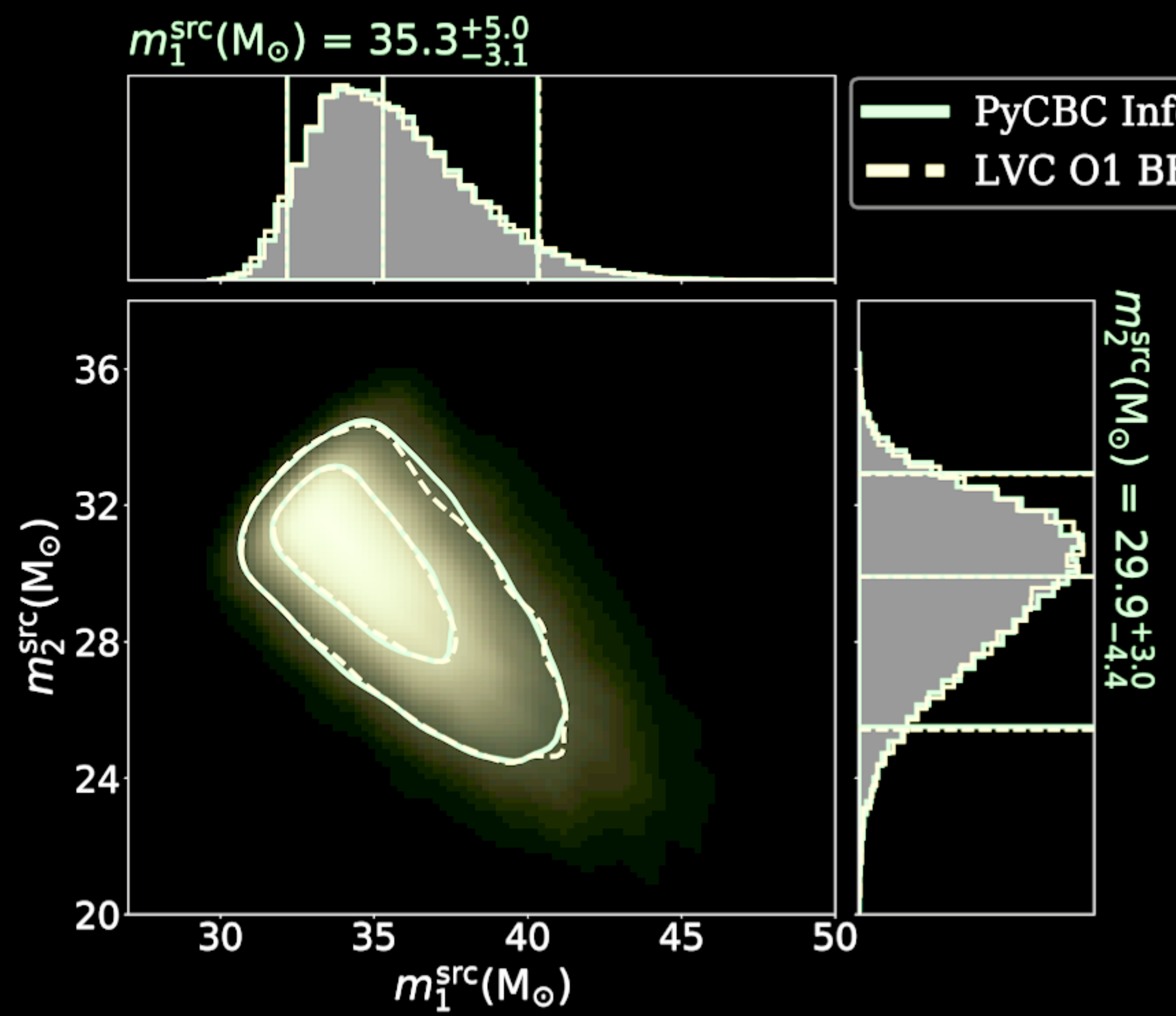
```
[2.74223087 2.58393159 2.49176962 ... 2.53901635 2.61125559 2.45446383]
```

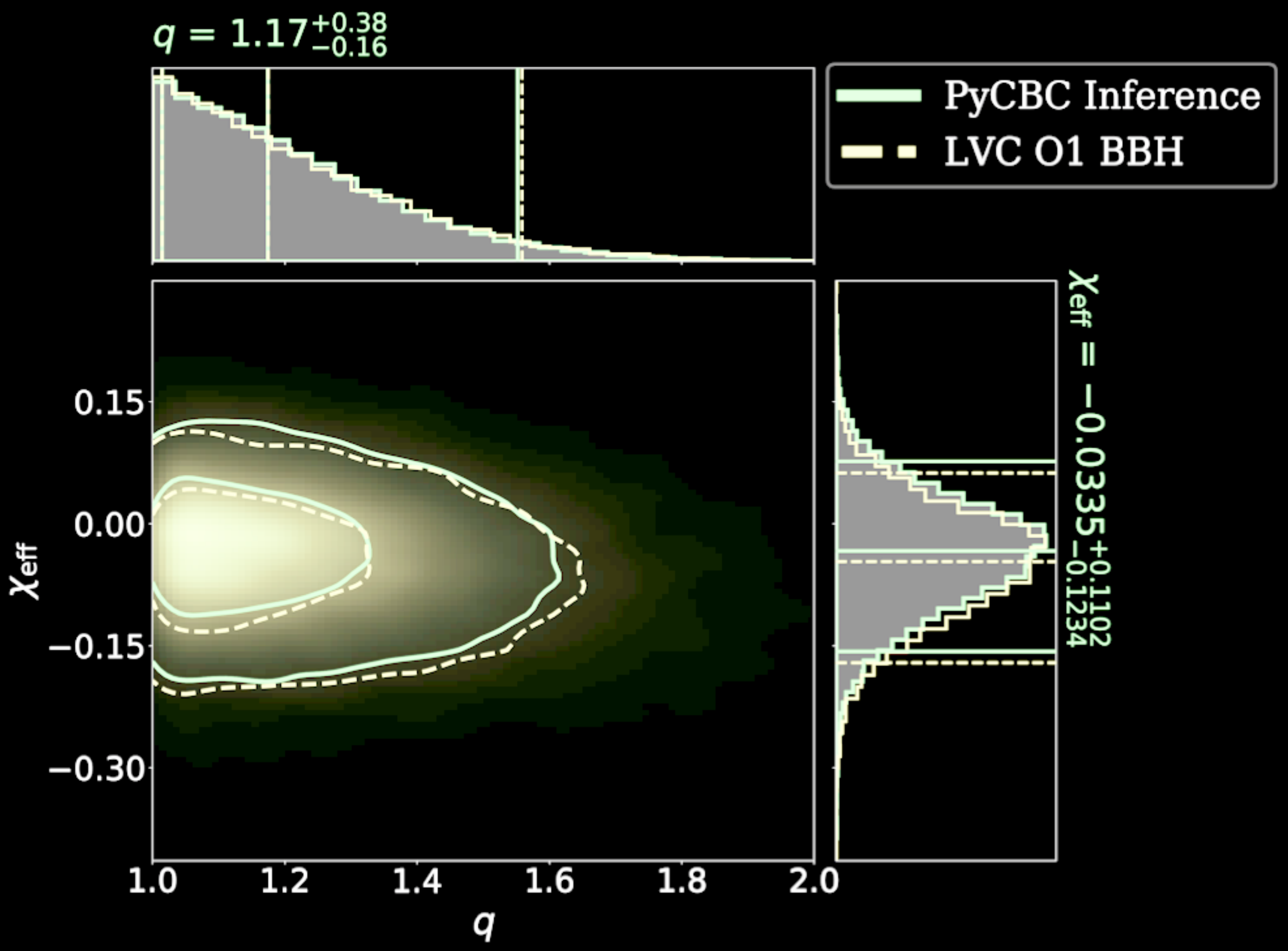
By default, the PyCBC software used to create these files stores the mass parameters only as `mass1` and `mass2`, but other mass parameters like chirp mass and mass ratio can be derived from these. For example, using the PyCBC toolkit:

In [4]:
```
from pycbc import conversions

fp = h5py.File("gw_and_skyloc_posteriors.hdf", "r")
mass1 = fp['samples/mass1'][:]
mass2 = fp['samples/mass2'][:]
fp.close()
```

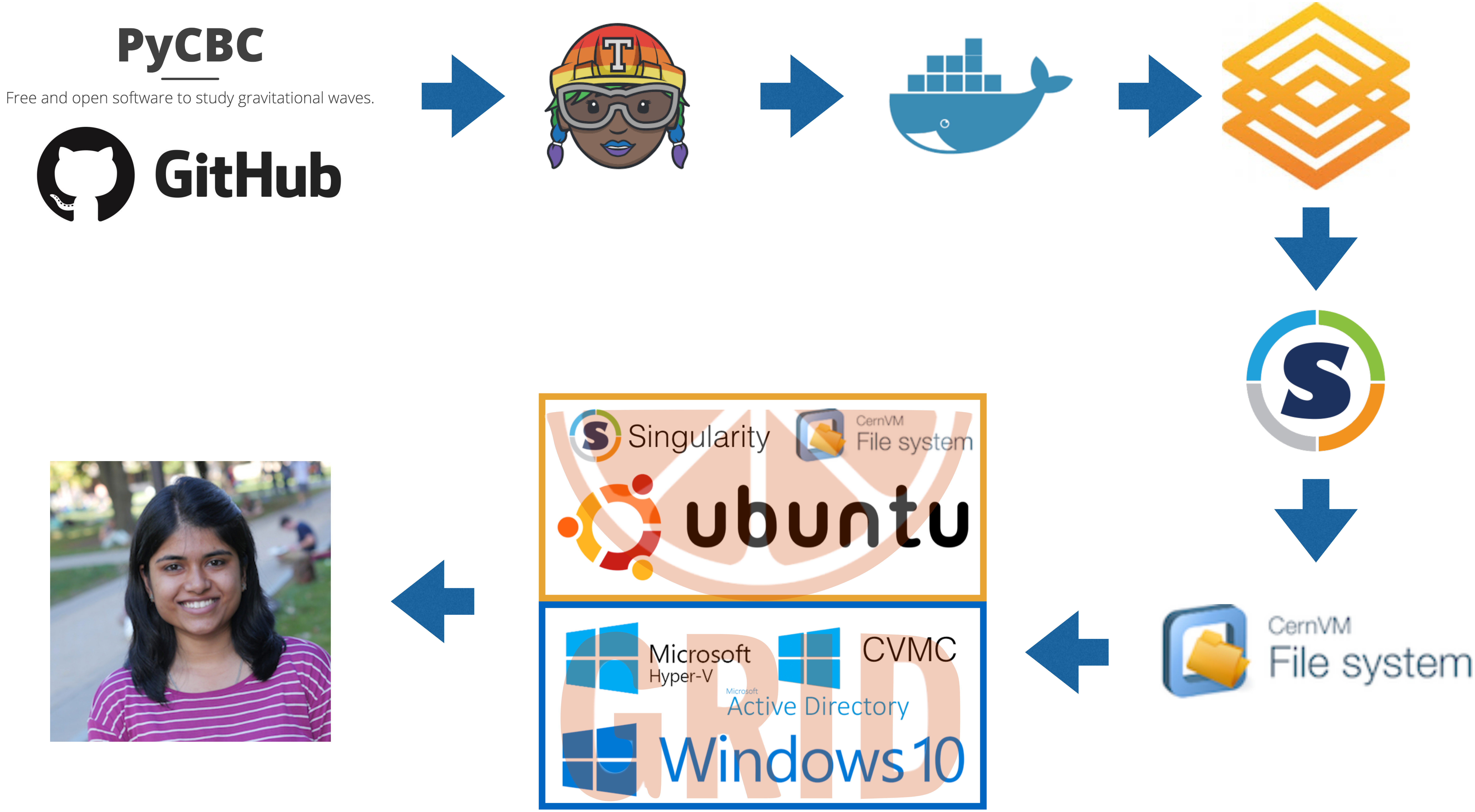
GW150914





Biwer, Capano, De, Cabero, DAB, Nitz PASP **131** 024503 (2019)

De, Biwer, Capano, Nitz, DAB Nature Scientific Data **6**, 81 (2019)


PyCBC
Free and open software to study gravitational waves.
GitHub
CernVM
File system
Singularity
CernVM
File system
ubuntu
Microsoft
Hyper-V
CVMC
Microsoft
Active Directory
Windows 10

dbrown — dabrown@comet-ln3:~ — ssh -l dabrown login.xsede.org — 117×24

```
[dabrown@comet-ln3 ~]$ module load singularity
[dabrown@comet-ln3 ~]$ singularity shell --home  /home/dabrown/pycbc_test/:/srv --pwd /srv --bind /cvmfs --bind /tmp
--contain --ipc --pid /cvmfs/singularity.opensciencegrid.org/sugwg/dbrown\:latest
Singularity: Invoking an interactive shell within container...

PyCBC Singularity d76c65d7aee60864bad32abe226cc761ddba479b757c144a0cf2c2cc888ec8:~> pycbc_inspiral --version
--- PyCBC Version --------------------------
Version: 786b52
Branch: master
Tag: None
Id: 786b5243147c94c9236d54617c3bd0fcd37cf618
Builder: Unknown User <>
Build date: 2019-05-18 00:06:43 +0000
Repository status is CLEAN: All modifications committed

Imported from: /usr/lib64/python2.7/site-packages/pycbc/__init__.pyc

--- LAL Version ----------------------------
Branch: None
Tag: lalsuite-v6.54
Id: 1dd42e82f34cab2e3e66c71823a60f4938ffaeb8
```

duncan-brown / pycbc-inference-comet

Unwatch | Star 1 | Fork

Code | Issues 0 | Pull requests 0 | Projects 0 | Wiki | More | Settings

Files for running PyCBC Inference on SDSC Comet

Edit

Manage topics

3 commits | 1 branch | 0 releases | 1 contributor

Branch: master | Create new file | Find File | Clone or download | Gitpod

duncan-brown Create README.md — Latest commit bd46995 5 days ago

Dockerfile	initial entry	6 days ago
README.md	Create README.md	5 days ago
astropy.tar.gz	initial entry	6 days ago
inference_chi_0.4.ini	initial entry	6 days ago
mpi-demo-sub.sh	initial entry	6 days ago
mpi-demo-wrapper.sh	initial entry	6 days ago
mpi-demo.py	initial entry	6 days ago
pycbc-inference-sub.sh	initial entry	6 days ago
pycbc-inference-wrapper.sh	initial entry	6 days ago

Improvements to docker image #2724

Edit Gitpod

Open **duncan-brown** wants to merge 11 commits into `gwastro:master` from `duncan-brown:docker`

Conversation 8 | Commits 11 | Checks 0 | Files changed 15 | +255 −75

duncan-brown commented 19 days ago — Member

This pull request simplifies the base PyCBC Docker container. It uses the standard `centos:centos7` container as a base and only installs the minimal set of software needed for a PyCBC install.

LALSuite is installed via `requirements.txt` so it the image will contain the latest release, since that is currently what is specified there. The Docker image is populated with a few ROM files, but not the complete set.

The appropriate files needed for OSG to turn this into a working singularity image are also included.

duncan-brown added the **work in progress** label 19 days ago

`simplify docker image` ✗ 15fabd8

duncan-brown force-pushed the `duncan-brown:docker` branch from **67ea2bb** to **15fabd8** a day ago

duncan-brown requested a review from **ahnitz** a day ago

ahnitz requested a review from **spxiwh** a day ago

ahnitz a day ago — Member

Adding Ian as a reviewer too, since this is probably something more than one person should understand how is going to work.

Reviewers

ahnitz

spxiwh

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

Assignees – assign yourself

Labels

Projects

Milestone

Unsubscribe

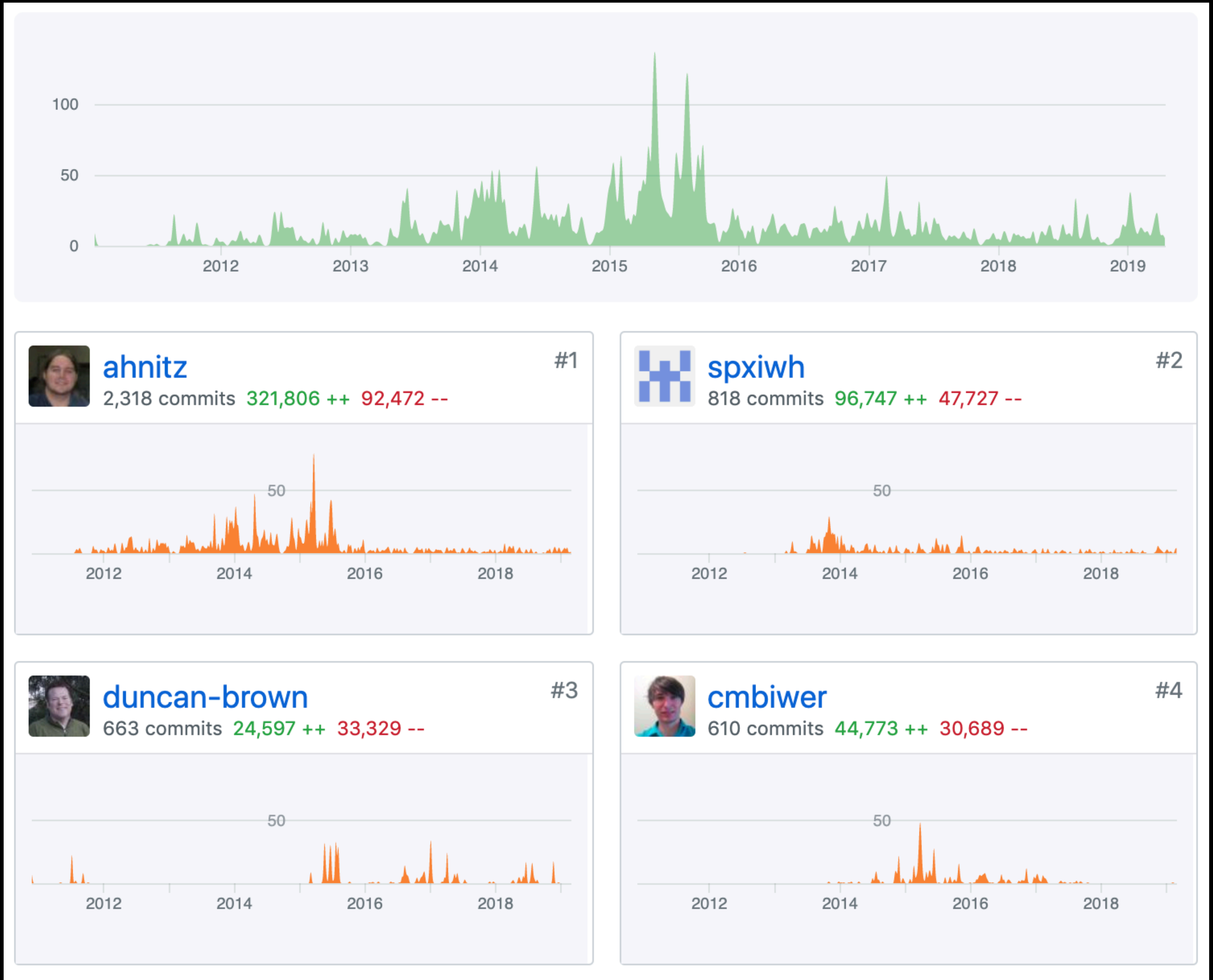
Mark as unread

3 participants

Lock conversation

Allow edits from maintainers

How many users does your instrument's community have and how is this tracked?



70 people have committed code to PyCBC

90% male, 10% female

How is communication with the user base conducted, and at what frequency?

https://gw-astro.slack.com

#pycbc-code

100 | 0 | General PyCBC code discussion, including Travis and GitHub infrastructure.

Search

Yesterday

Derek White 12:27 PM

Hi all, I'm a student of Jocelyn Read's at California State University, Fullerton. I've recently been working on setting up a new environment on our research group's new computing cluster, including installing PyCBC (done via pip install). I tried running a script that works on our old cluster, and ran into an error from the scheme.py file: "Failed to find implementation of (<function _getvalue at 0x7f5ad317b500>) for cpu scheme." Does anyone know if this might be due to a package that wasn't correctly installed? (the _getvalue function comes from decorator.py)

Alexander Harvey Nitz 12:29 PM

@Derek White Can you open up a ipython terminal in the same environment and try the following (or run in a script if you prefer). Also, just to verify, you aren't running pycbc from the src folder are you?

```
import pycbc.types.array_cpu
```

Does this import result in any error message or does it just work?

Derek White 12:32 PM

importing it doesn't generate any errors. I'm running my script from an anaconda environment that has pycbc installed

Alexander Harvey Nitz 12:33 PM

Hmm, strange. All that message is saying is that it failed to do the following.

```
from pycbc.types.array_cpu import _getvalue
```

What are the bibliometrics for your instrument over time?

Use of PyCBC in Scientific Publications

If you use any code from PyCBC in a scientific publication, then we ask that you include a citation to the software through its DOI and that you cite the publications relevant to the sections of the code that you are using, as described below.

Citing the PyCBC Software

A bibtex key and DOI for each release is avaliable from Zenodo and DOIs for releases can be found on the PyCBC release page. A key for the latest release is available at:

DOI 10.5281/zenodo.2801307

If you do not use a specific release, please cite the DOI for the latest release, or the release closest to the version that you are using.

Citing the scientific publications that describe the algorithms

PyCBC implements a large number of data-analysis algorithms and so it is not possible to give one single citation. To give proper scientific credit for the development of PyCBC, in addition to citing the DOI from the software, please cite the appropriate scientific publications below.

Bayesian Inference

If you use the Bayesian inference modules, or code derived from those modules, please cite the paper:

- PyCBC Inference: A Python-based parameter estimation toolkit for compact binary coalescence signals. [INSPIRES BibTeX Key] [ADS BibTeX key]

Searches for Compact Binary Coalescence

If you use the PyCBC search algorithms, please cite all four of these papers:

- FINDCHIRP: an algorithm for detection of gravitational waves from inspiraling compact binaries. [INSPIRES BibTeX Key] [ADS BibTeX key]
- A chi-squared time-frequency discriminator for gravitational wave detection. [INSPIRES BibTeX Key] [ADS BibTeX key]
- Detecting binary compact-object mergers with gravitational waves: Understanding and Improving the sensitivity of the PyCBC search. [INSPIRES BibTeX Key] [ADS BibTeX key]
- Implementing a search for aligned-spin neutron star – black hole systems with advanced ground based gravitational wave detectors. [INSPIRES BibTeX Key] [ADS BibTeX key]

VIEW

Abstract

Citations (132)

References (71)

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Papers that cite

The PyCBC search for gravitational waves from compact binary coalescence

view this list in a search results page

1 2019MNRAS.485..843O 2019/05

Matched-filter study and energy budget suggest no detectable gravitational-wave `extended emission' from GW170817

Oliver, Miquel; Keitel, David; Miller, Andrew L. *and 2 more*

2 2019MNRAS.485.4260S 2019/05

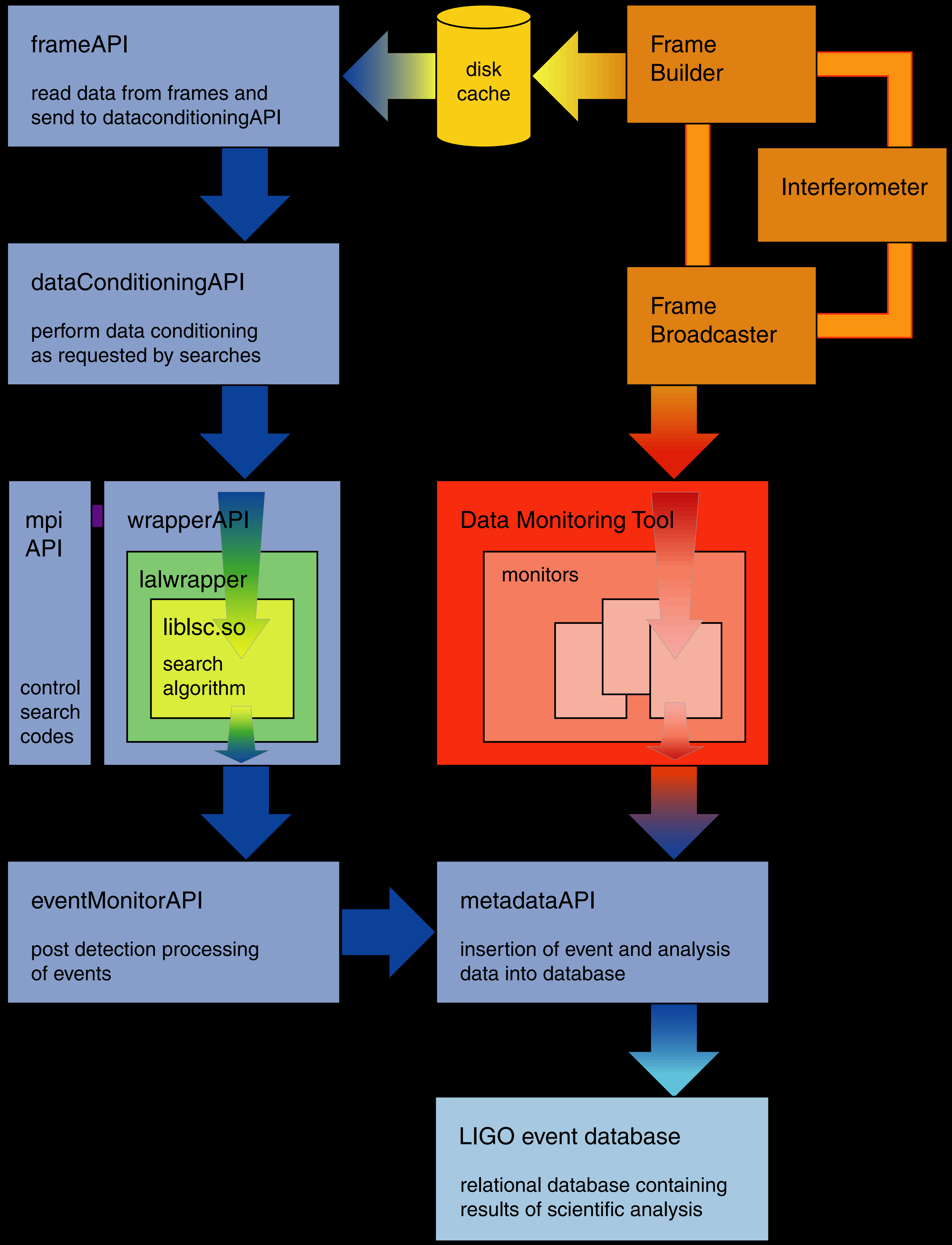
Serendipitous discoveries of kilonovae in the LSST main survey: maximizing detections of sub-threshold gravitational wave events

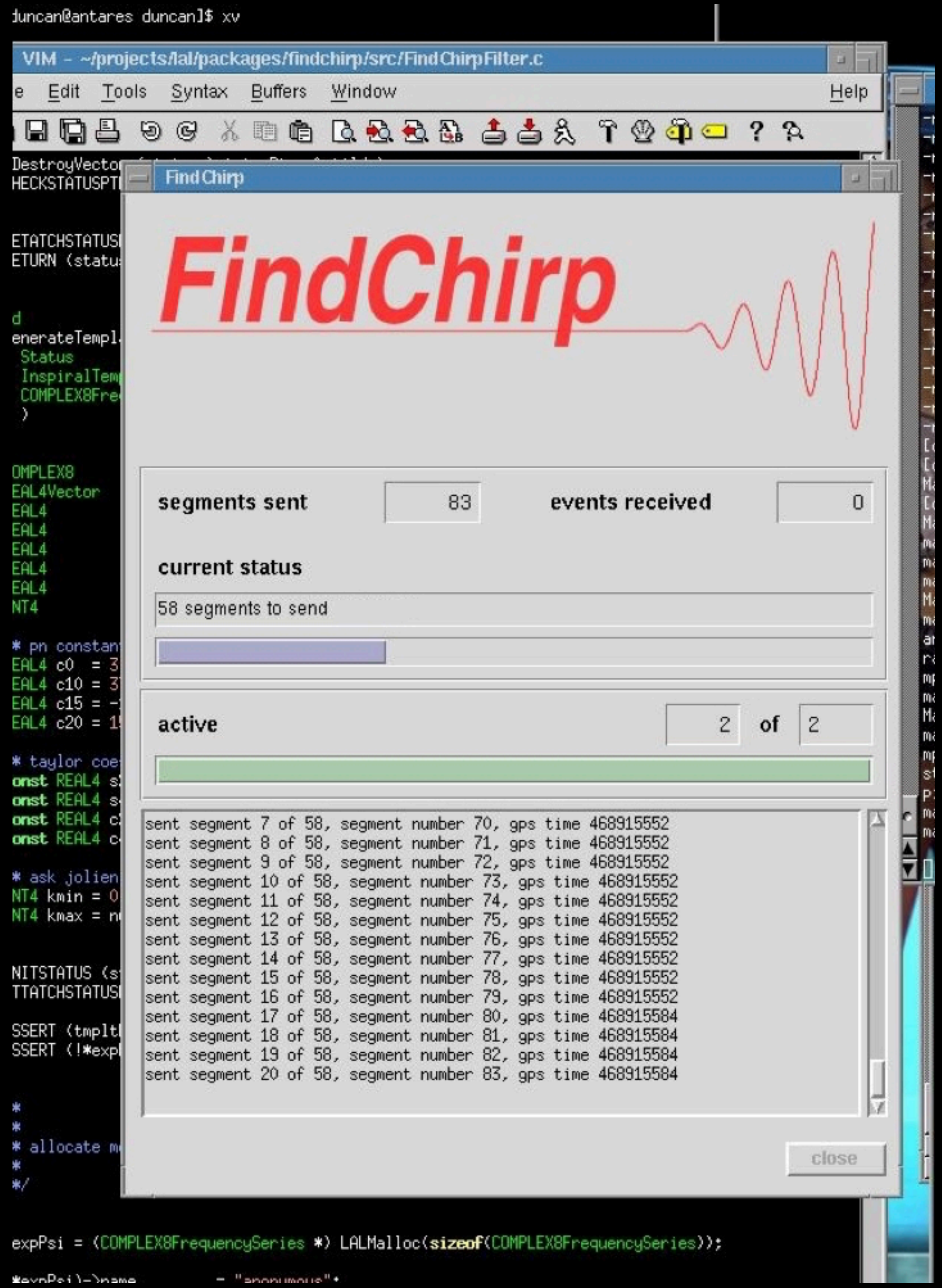
Setzer, Christian N.; Biswas, Rahul; Peiris, Hiranya V. *and 3 more*

3 2019PhRvD..99j4012N 2019/05

Parameter estimation and statistical significance of echoes following black hole signals in the first Advanced LIGO observing run

Nielsen, Alex B.; Capano, Collin D.; Birnholtz, Ofek *and 1 more*


frameAPI
read data from frames and send to dataconditioningAPI
disk cache
Frame Builder
Interferometer
Frame Broadcaster
dataConditioningAPI
perform data conditioning as requested by searches
mpi API
control search codes
wrapperAPI
lalwrapper
liblsc.so
search algorithm
Data Monitoring Tool
monitors
eventMonitorAPI
post detection processing of events
metadataAPI
insertion of event and analysis data into database
LIGO event database
relational database containing results of scientific analysis


duncan@antares duncan]$ xv
VIM - ~/projects/lal/packages/findchirp/src/FindChirpFilter.c
Edit Tools Syntax Buffers Window Help
Find Chirp
FindChirp
segments sent 83
events received 0
current status
58 segments to send
active 2 of 2
sent segment 7 of 58, segment number 70, gps time 468915552
sent segment 8 of 58, segment number 71, gps time 468915552
sent segment 9 of 58, segment number 72, gps time 468915552
sent segment 10 of 58, segment number 73, gps time 468915552
sent segment 11 of 58, segment number 74, gps time 468915552
sent segment 12 of 58, segment number 75, gps time 468915552
sent segment 13 of 58, segment number 76, gps time 468915552
sent segment 14 of 58, segment number 77, gps time 468915552
sent segment 15 of 58, segment number 78, gps time 468915552
sent segment 16 of 58, segment number 79, gps time 468915552
sent segment 17 of 58, segment number 80, gps time 468915584
sent segment 18 of 58, segment number 81, gps time 468915584
sent segment 19 of 58, segment number 82, gps time 468915584
sent segment 20 of 58, segment number 83, gps time 468915584
close
expPsi = (COMPLEX8FrequencySeries *) LALMalloc(sizeof(COMPLEX8FrequencySeries));

sugwg / qm Private

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Code | Issues 0 | Pull requests 0 | Projects 0 | Wiki | More | Settings

Quick and dirty CBC data-analysis toolkit

Edit

Manage topics

661 commits | 1 branch | 0 releases | 8 contributors

Branch: master | Create new file | Find File | Clone or download | Gitpod

prayush commenting out functions which have API mismatches with LAL libraries… ··· Latest commit 68bdaed on Mar 13, 2014

contrib	added the updated banksim program for use with 2.5pn spa	7 years ago
include	commenting out functions which have API mismatches with LAL libraries…	5 years ago
src	commenting out functions which have API mismatches with LAL libraries…	5 years ago
test	add 2.5pn to SPA and set spintaylor to INTERACTION_ALL	7 years ago
.gitignore	sucessfully compiling a simple cuda kernel	8 years ago
README	Updated email in readme file	8 years ago
log.py	added better logging to setup.py	8 years ago
nvcccompiler.py	removed profiling modifications	8 years ago
setup.py	added chisq to qm.h and to setup.py	7 years ago
test.txt	testing	6 years ago

sugwg / gw170817-pg-modes

Unwatch 7 | Star 1 | Fork 0

Code | Issues 0 | Pull requests 0 | Projects 0 | Wiki | Insights | Settings

Branch: master | gw170817-pg-modes / pg_mode_notebook.ipynb | Find file | Copy path

Steven Reyes clean up. 2b6514a on Aug 23

1 contributor

7.56 MB | Download | History

Constraints on non-linear tides due to p-g mode coupling from the neutron-star merger GW170817

Steven Reyes[1] and Duncan A Brown[1]

[1]**Department of Physics, Syracuse University, Syracuse, NY 13244, USA**

License

Introduction

This notebook is a companion to the paper presented at arXiv:1808.07013. It demonstrates how to make the figures in the paper and compute the Bayes factors comparing the analyses with and without the effect of nonlinear tides.

We encourage use of these data in derivative works. If you use the material provided here, please cite the paper using the reference:

```
@article{Reyes:2018bee,
      author         = "Reyes, Steven and Brown, Duncan A.",
      title          = "{Constraints on non-linear tides due to $p
$-$g$ mode
                        coupling from the neutron-star merger GW170
817}",
      year           = "2018",
      eprint         = "1808.07013",
      archivePrefix  = "arXiv",
      primaryClass   = "astro-ph.HE",
      SLACcitation   = "%%CITATION = ARXIV:1808.07013;%%"
}
```

Data

We provide the data from thinned posterior samples from the MCMC chains used to produce Bayes factor calculations and posterior distribution data. All of the files contain the thinned chained of the posterior samples using the sky localization constraint, chirp mass constraint, common equation of state constraint from De et al. (2018), with mass distribution prior distributions for each of the binary neutron stars from De et al. (2018). Each file refers to two different mass priors from De et al. (2018) and with different choices of the range of f0, the turn-on frequency of the p-g mode energy loss.

sugwg / gw170817-pg-modes

Unwatch 7 | Star 1 | Fork 0

Code | Issues 0 | Pull requests 0 | Projects 0 | Wiki | Insights | Settings

Branch: master | gw170817-pg-modes / pg_mode_notebook.ipynb | Find file | Copy path

Steven Reyes clean up. 2b6514a on Aug 23

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7.56 MB | Download | History

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      archivePrefix  = "arXiv",
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      SLACcitation   = "%%CITATION = ARXIV:1808.07013;%%"
}
```

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A Comparison of p-g Tidal Coupling Analyses

Reed Essick[1] and Nevin N. Weinberg[2]

[1]*Kavli Institute for Cosmological Physics, University of Chicago, Chicago, IL 60637, USA*

[2]*Department of Physics, and Kavli Institute for Astrophysics and Space Research, Massachusetts Institute of Technology, Cambridge, MA 02139, USA*

arXiv:1809.00264v2 [astro-ph.HE] 1 Nov 2018

Two recent studies have attempted to constrain the proposed p-g tidal instability with gravitational-wave data from GW170817. The studies use Bayesian methods to compare a model that includes p-g tidal effects with one that does not. Using the same data, they arrive at very different conclusions. Reyes & Brown find that the observations of GW170817 strongly disfavor the existence of p-g mode coupling. However, the LIGO and Virgo Collaborations find that neither model is strongly favored. We investigate the origin of this discrepancy by analyzing Reyes & Brown's publicly available posterior samples. Contrary to their claims, we find that their samples do not disfavor p-g mode coupling.

I. INTRODUCTION

The gravitational wave (GW) observation of a coalescing binary neutron star (NS) system (GW170817 [1]) provides new insights into NS physics, including constraints on the high-density equation of state [2, 3] and tidal deformability [2, 4, 5]. Recently, two papers have attempted to constrain the p-g tidal instability with GW170817 ([6, 7]; hereafter RB and LVC, respectively). The instability involves a non-resonant coupling of the linear tidal bulge to high-frequency, pressure-supported modes (p-modes) and low-frequency, gravity-supported modes (g-modes) within the NS [8–11]. Once unstable, the excited modes continuously drain energy from the orbit and accelerate the rate of GW-driven inspiral. The precise impact on the phasing of the GW signal is, however, unknown due to theoretical uncertainties in how the instability grows and saturates, although studies suggest that its impact might be observable with the current LIGO [12] and Virgo [13] interferometers [10, 14].

RB and LVC attempt to constrain p-g effects in GW170817 using the phenomenological model developed by [14]. Both studies employ a modification of the `TaylorF2` frequency-domain waveform (see, e.g., [15]) that includes an additional phase correction induced by p-g effects. Using Bayesian methods, they compare models with p-g effects ($\mathcal{H}_{pg}$) to models without p-g effects ($\mathcal{H}_{!pg}$) and compute Bayes Factors $B^{pg}_{!pg} \equiv p(\mathrm{D}|\mathcal{H}_{pg})/p(\mathrm{D}|\mathcal{H}_{!pg})$, where D refers to the data from GW170817.

While RB and LVC analyze the same data and use the same phenomenological p-g waveform, there are differences in their models and priors, which we describe in Section II. Most notably, RB constructs an $\mathcal{H}_{pg}$ model that only includes "detectable p-g effects" whereas LVC uses a wider $\mathcal{H}_{pg}$ model. RB finds that their models yield $B^{pg}_{!pg} < 10^{-4}$ and LVC finds that their models yield $B^{pg}_{!pg} \approx 1$. Thus, RB concludes that the observations strongly disfavor their $\mathcal{H}_{pg}$ model and LVC concludes that the observations do not favor either of their models.

A priori, the disparate $B^{pg}_{!pg}$ could be due to differences in the studies' models and priors. However, we show in Section III that this cannot be the explanation. We use the posterior samples from RB[1] to compute $B^{pg}_{!pg}$ using LVC's method for calculating Bayes Factors [7]. We find that LVC's method applied to RB's posterior samples, and thus their models and priors, yield $B^{pg}_{!pg} \approx 1$ and not $B^{pg}_{!pg} < 10^{-4}$. This indicates that there is an error in how RB calculates $B^{pg}_{!pg}$. Our estimate implies that their $\mathcal{H}_{pg}$ model is not disfavored by the data.

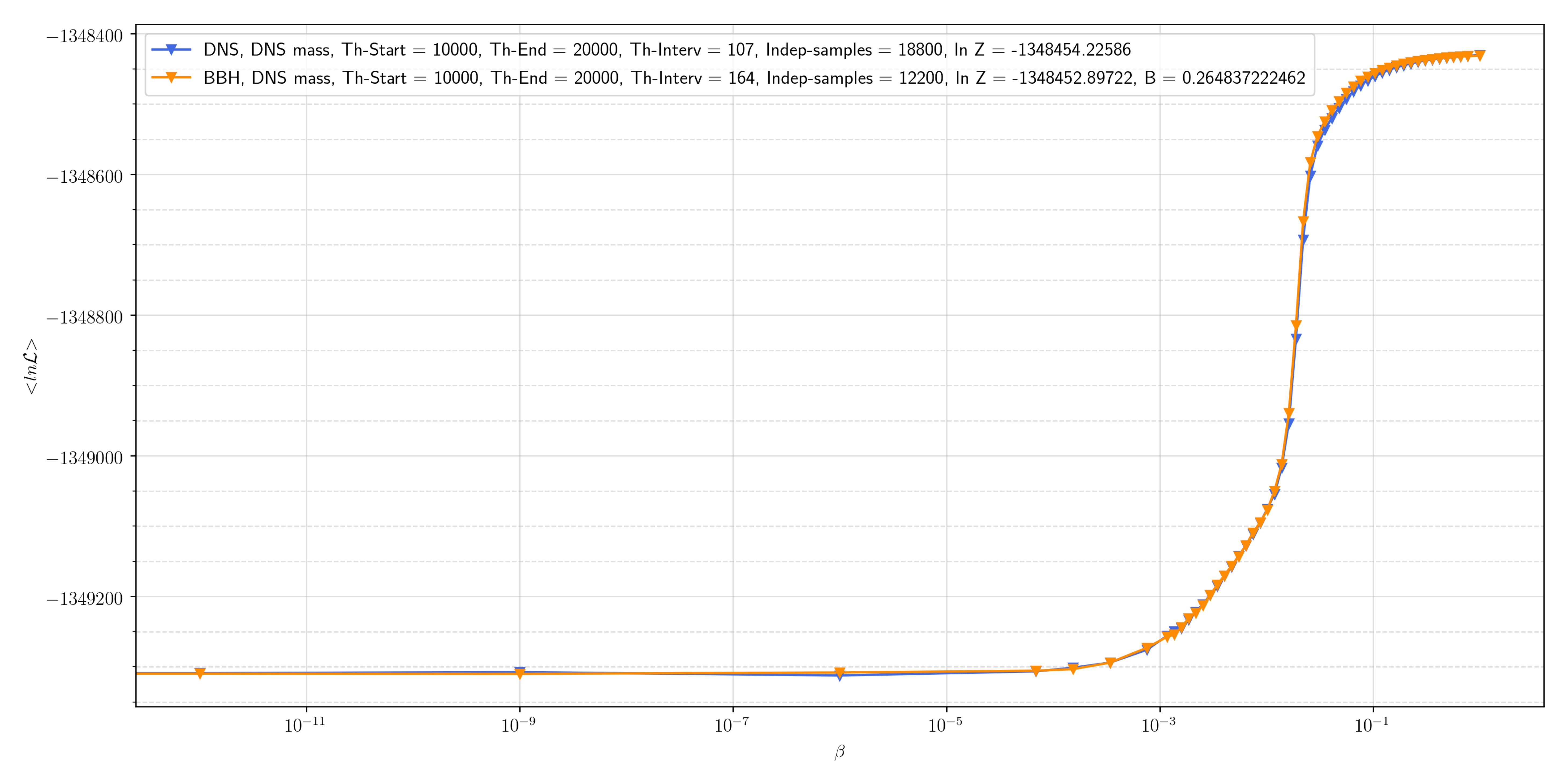
II. COMPARISON OF MODELS AND PRIORS

The phenomenological model presented in [14] introduces three p-g parameters per NS (indexed by $i \in \{1, 2\}$): an overall amplitude (A_i) related to how many modes become unstable, how quickly they grow, and the energy at which they saturate; a turn-on/saturation frequency (f_i) that is related to when the modes first become unstable; and a spectral index (n_i) that describes how the rate of energy dissipation evolves with the orbital frequency (see [14], RB, and LVC).

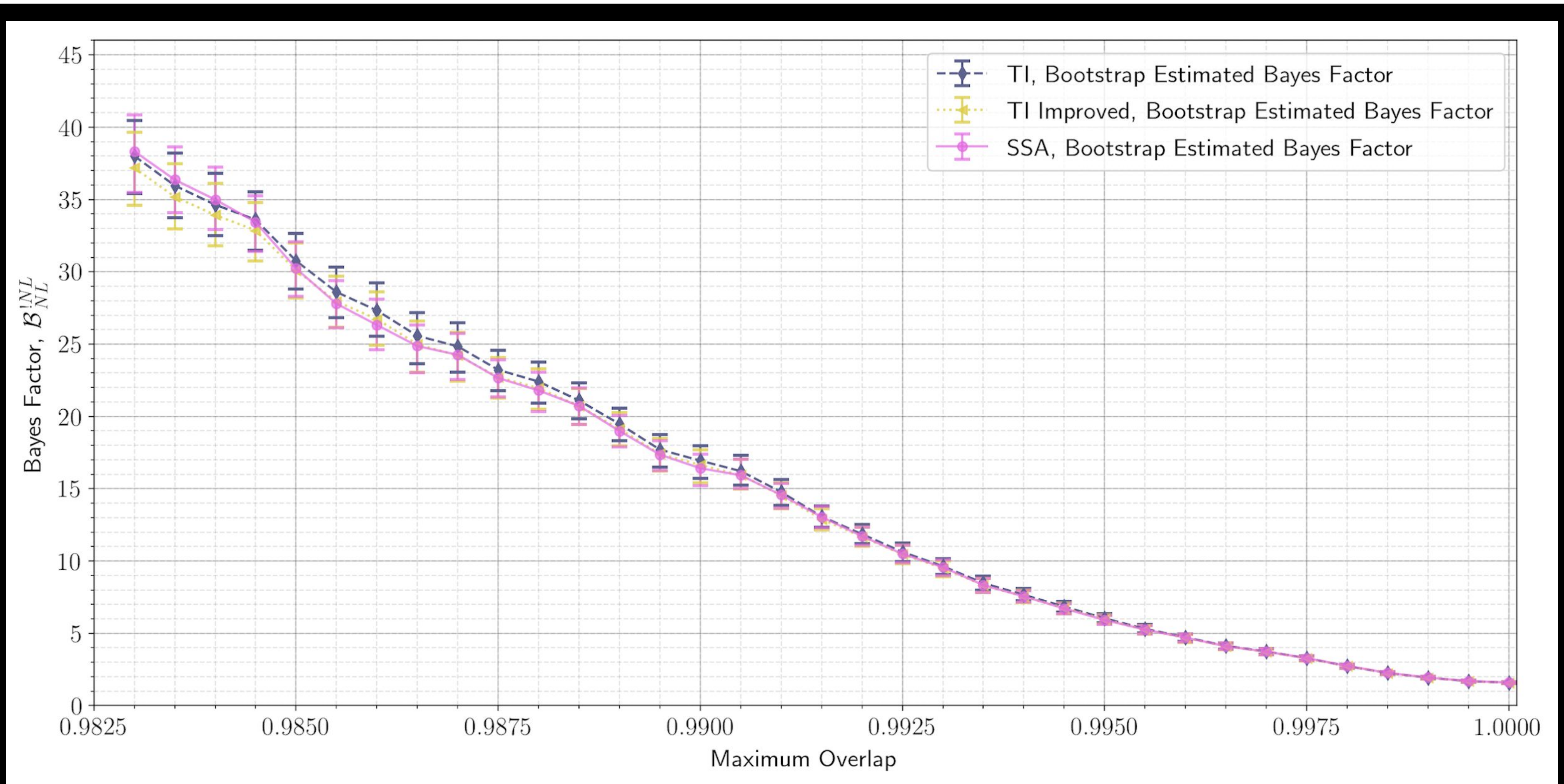
The frequency-domain phase shift $\Delta\Psi(f)$ induced by p-g effects is given by Equation (3) in RB and Equation (1) in LVC. To account for a possible dependence on the component masses (m_i), [14] introduces a Taylor expansion of the p-g parameters around $m_i = 1.4M_\odot$. LVC keeps the zeroth- and first-order coefficients of the expansion (their Equation (2)). RB keeps only the zeroth order coefficients. However, this should not introduce large discrepancies since LVC and [14] find that the first order terms are not measurable.

In their Equation (3), RB neglects a dependence on the component masses that exists independent of the Taylor expansion. Specifically, in the expression for $\Delta\Psi(f)$,

[1] RB have kindly made their posterior samples available at `https://github.com/sugwg/gw170817-pg-modes`.



Close examination of our public results and code allowed us to correct errors and improve the analysis!



Better tools for computing evidences using ptemcee and thermodynamic integration

PHYSICAL REVIEW LETTERS

Tidal Deformabilities and Radii of Neutron Stars from the Observation of GW170817

Soumi De, Daniel Finstad, James M. Lattimer, Duncan A. Brown, Edo Berger, and Christopher M. Biwer

Phys. Rev. Lett. **121**, 091102 – Published 29 August 2018; Erratum Phys. Rev. Lett. **121**, 259902 (2018)

Syracuse University

VE RI TAS HARVARD

Stony Brook University

https://incommon.org/federation/info/all-entity-categories.html#IdPs

InCommon FEDERATION

BETA

Federation Info: About Organizations Entities

InCommon Entity Categories

Entity Category	# of SPs	# of IdPs
hide-from-discovery	0	30
research-and-scholarship	109	105
research-and-scholarship	0	78

Check out these **NEW** Entity Categories!

- Hide From Discovery Category
- Registered By InCommon Category

Entities in the latter category are filtered from these web pages since currently *all entities in production metadata are in the Registered By InCommon Category*.

Note: Service Providers (SPs) marked in green meet the requirements of the REFEDS R&S Entity Category specification. Identity Providers (IdPs) marked in green release attributes to **all** R&S SPs, including R&S SPs in other federations, whereas the remaining IdPs release attributes to R&S SPs *registered by InCommon only*.

IdPs SPs

The following identity providers either belong to or support the indicated entity category:

Identity Provider Name	Entity Category
American Museum of Natural History - Richard Gilder Graduate School	research-and-scholarship
American University	research-and-scholarship
Arizona State University	research-and-scholarship
Auburn University	research-and-scholarship
Augusta University	research-and-scholarship
Bates College	research-and-scholarship
Baylor University	research-and-scholarship
Binghamton University	research-and-scholarship
Boston College	research-and-scholarship
Boston University	research-and-scholarship
Bowling Green State University	hide-from-discovery
Brookhaven National Laboratory	research-and-scholarship
Brookhaven National Laboratory	research-and-scholarship
Brown University	research-and-scholarship
Bucknell University	research-and-scholarship
California Community Colleges Chancellors Office	hide-from-discovery
California Institute of Technology	research-and-scholarship

https://wiki.shibboleth.net/confluence/display/SP3/Apache

Apache

Created by Rod Widdowson, last modified by Scott Cantor on Oct 16, 2018

Apache 2.4 Support
You should review this page and the htaccess page thoroughly because Apache 2.4 is much more complicated than earlier versions. In particular, if you're trying to combine Shibboleth with other authentication schemes (like Basic), you may need to enable the `ShibCompatValidUser` option, documented below.

Half of Shibboleth runs within the web server. For Apache, this half is implemented in a module called *mod_shib_13.so, mod_shib_20.so, mod_shib_22.so,* or *mod_shib_24.so* depending on the Apache version. Like all Apache modules, the initial configuration is controlled with Apache's configuration file(s), but one of the primary options there (normally implicit/defaulted) is to point the module at the overall SP configuration file *(shibboleth2.xml)* where a lot of the options not specific to Apache are controlled.

At runtime, the module has the ability to process both a variety of Apache commands and rules specified in the SP configuration and make sense of both. This allows for a choice of approaches based on the need for native integration with Apache or for portability between web servers. Native integration using Apache commands is the better choice and is more secure.

Syracuse University Gravitatior ×

https://sugwg-jobs.phy.syr.edu/shibboleth-ds/index.html?entityID=https%3A%2F%2Fsugwg-job...

NYTimes Wash Post ADS GitHub Overleaf LIGO GCN LHO LLO Pegasus Bo

Please select an identity provider to login

Choose an identity provider from the options in the box below

The first time that you log in, you should pick from the list or enter an or organization name. Your previous choice(s) will l different provider from this list.

Use a suggested selection:

Syracuse University | ORCID Id | MAX-PLANCK-GESELLSCHAFT Max-Planck Institutes (in MetaDir...

Or enter your organization's name

Continue

Allow me to pick from a list Help

Which provider should I choose?

- LSC/Virgo collaboration members should select one of the LIGO providers and log in with their LIGO.ORG creden is available at my.ligo.org.
- Syracuse University Gravitational Wave Group members who are not part of the LSC can log in with their NetID. Y myslice.syr.edu
- Other scientists can log in with an ORCID Id, which can be obtained from orcid.id.

Using a .htaccess file to control access

You can override the default access settings to any sub-directory in your `~/secure_html` directory by creating a file in that directory called `.htaccess` and adding authorization directives in there.

Setting up Shibboleth

The first two lines of this file should be the directives that turn on Shibboleth authentication and authorization:

```
AuthType shibboleth
ShibRequestSetting requireSession true
```

Then you can add lines to give access to specific people. These are implemented as a logical OR so you can specifiy multiple people on multiple lines.

Syracuse users

For Syracuse users, you can authorize people using their `eduPersonPrincipalName`, which is their [Syracuse NetID.]() For example, the following lines authorize people in our group:

```
require shib-attr eduPersonPrincipalName dabrown@syr.edu
require shib-attr eduPersonPrincipalName sde101@syr.edu
require shib-attr eduPersonPrincipalName sdreyes@syr.edu
require shib-attr eduPersonPrincipalName dfinstad@syr.edu
require shib-attr eduPersonPrincipalName elawsonk@syr.edu
require shib-attr eduPersonPrincipalName chafle@syr.edu
require shib-attr eduPersonPrincipalName cmbiwer@syr.edu
```

LIGO/Virgo users

LIGO users can be authorized using their [LIGO.ORG username]() as the `eduPersonPrincipalName`, for example:

But...

Only 94 of 530 IdPs in InCommon support research and scholarship internationally (many don't support R&S at all!)

- Open data, open code, and open analysis allow new, reproducible science

- The community should push for more openness in gravitational-wave astronomy to get the best science for everyone and for the long-term health of the field

- Federated identity management tools can make collaboration much easier

HTCondor
High Throughput Computing

CernVM
File system

globus

Open Science Grid

INTERNET2®

Pegasus

INTERNET2®

eduGAIN

Shibboleth®

Grouper™

InCommon®

COmanage™

CILogon

MOO

spherical cow
group

Friday, 04 March, 2011 01:13:57

PyCBC Development History