

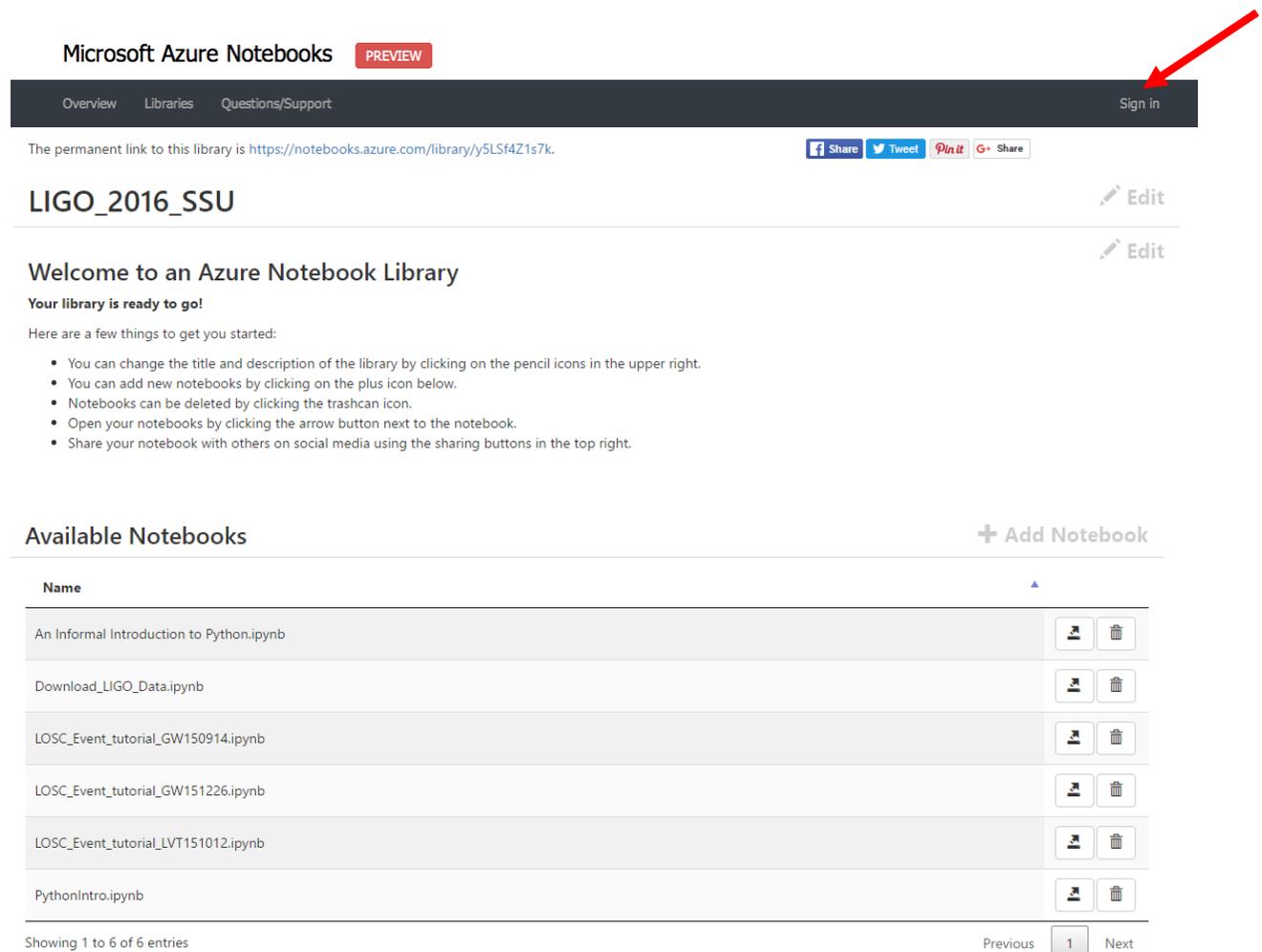
## Analyzing the data from the LIGO Open Science Center

We have setup a Jupyter library for you to use to examine the analysis flow and data products created for the three different interesting events that LIGO detected during its first Observing Run: GW150914, LVT151012 and GW151226. The original files, data and tutorials can be viewed at <http://losc.ligo.org> but it is rather complicated to understand how to run them if you are not an expert in Python and signal processing. In the following, we show you how to run the tutorials using free services provided by the Microsoft Cloud, called Azure.

1) In order to run the tutorials, navigate to this website using any browser:

<https://notebooks.azure.com/library/y5LSf4Z1s7k>

It should look like this:



Microsoft Azure Notebooks PREVIEW

Overview Libraries Questions/Support Sign In

The permanent link to this library is <https://notebooks.azure.com/library/y5LSf4Z1s7k>. Share Tweet Pin It G+ Share

### LIGO\_2016\_SSU

Edit

#### Welcome to an Azure Notebook Library

Your library is ready to go!

Here are a few things to get you started:

- You can change the title and description of the library by clicking on the pencil icons in the upper right.
- You can add new notebooks by clicking on the plus icon below.
- Notebooks can be deleted by clicking the trashcan icon.
- Open your notebooks by clicking the arrow button next to the notebook.
- Share your notebook with others on social media using the sharing buttons in the top right.

#### Available Notebooks + Add Notebook

Name	
An Informal Introduction to Python.ipynb	<span>▶</span> <span>🗑️</span>
Download_LIGO_Data.ipynb	<span>▶</span> <span>🗑️</span>
LOSC_Event_tutorial_GW150914.ipynb	<span>▶</span> <span>🗑️</span>
LOSC_Event_tutorial_GW151226.ipynb	<span>▶</span> <span>🗑️</span>
LOSC_Event_tutorial_LVT151012.ipynb	<span>▶</span> <span>🗑️</span>
PythonIntro.ipynb	<span>▶</span> <span>🗑️</span>

Showing 1 to 6 of 6 entries Previous 1 Next

Look to the top-right. If it says "Sign In", you need to click there, and sign in with a Microsoft account, or get one. If you do not already have a Microsoft account, you will need to make one by clicking "Sign In" and then "Get a new account." Then it should look like this:

# Azure Notebooks

Work or school, or personal Microsoft account

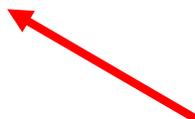
Keep me signed in

Sign in

[Can't access your account?](#)

[Other sign in options](#)

[Get a new account](#)



When you click "Get a new account" you should see this:

# Create account

Microsoft account opens a world of benefits.

Send me promotional emails from Microsoft

[Use a phone number instead](#)

[Get a new email address](#)

Choosing Next means that you agree to the [Privacy Statement](#) and [Microsoft Services Agreement](#).

Microsoft

Here is an example of the verification screen:

# Verify email

We sent an email to [lync@charmian.sonoma.edu](mailto:lync@charmian.sonoma.edu) to make sure you own it. Please check your inbox and follow the instructions to finish setting up your Microsoft account.

[Use a different email address as your Microsoft account](#)

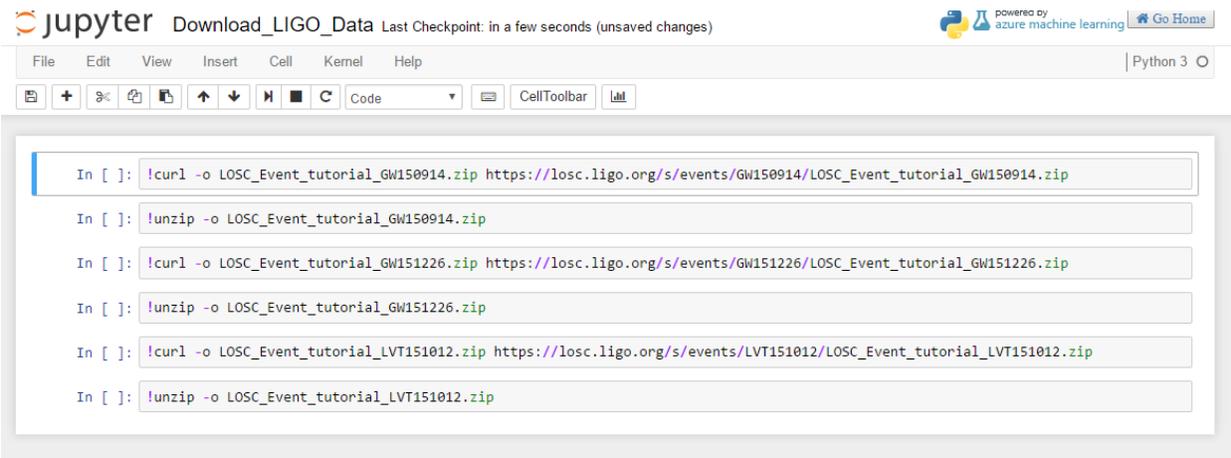
The account-name is an email address ([lync@charmian.sonoma.edu](mailto:lync@charmian.sonoma.edu) in this example) and you will need to respond to a message sent to that address.

5) Go back to <https://notebooks.azure.com/library/y5LSf4Z1s7k> and "Sign In".

6) Now you can run the different Jupyter notebooks in this library. Start with the notebook called Download\_LIGO\_Data.ipynb by clicking on the arrow to the right.

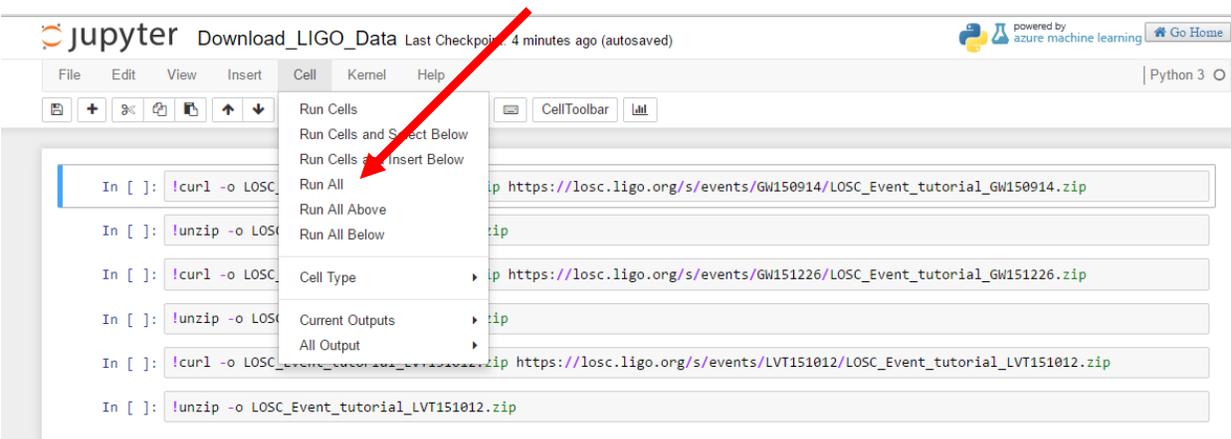


7) The notebook will open in a different tab of the browser:



In this notebook, there are 3 pairs of commands. Each pair will download a specific LIGO data set from the LOSC repository, and unzip it. You may choose to run any pair of these commands or run all 6 at this time.

To run a single command, move your cursor into the block and type CTRL-enter (for both Windows and Macs). Or go to the top menu where it says Cell and choose Run All.



When it has finished running successfully, it should look like this:

```
In [3]: !curl -o LOSC_Event_tutorial_GW150914.zip https://losc.ligo.org/s/events/GW150914/LOSC_Event_tutorial_GW150914.zip
% Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
         Dload  Upload   Total   Spent    Left   Speed
100 2454k  100 2454k    0     0 4136k    0  0:01:00  0:01:00  0:00:00 4146k

In [4]: !unzip -o LOSC_Event_tutorial_GW150914.zip
Archive:  LOSC_Event_tutorial_GW150914.zip
  inflating:  GW150914_4_template.hdf5
  inflating:  H-H1_LOSC_4_V1-1126259446-32.hdf5
  inflating:  L-L1_LOSC_4_V1-1126259446-32.hdf5
  inflating:  LOSC_Event_Tutorial.ipynb
  inflating:  LOSC_Event_tutorial.py
  inflating:  O1_events.json
  inflating:  readligo.py

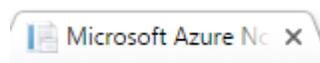
In [5]: !curl -o LOSC_Event_tutorial_GW151226.zip https://losc.ligo.org/s/events/GW151226/LOSC_Event_tutorial_GW151226.zip
% Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
         Dload  Upload   Total   Spent    Left   Speed
100 2477k  100 2477k    0     0 3637k    0  0:01:00  0:01:00  0:00:00 3643k

In [6]: !unzip -o LOSC_Event_tutorial_GW151226.zip
Archive:  LOSC_Event_tutorial_GW151226.zip
  inflating:  GW151226_4_template.hdf5
  inflating:  H-H1_LOSC_4_V1-1135136334-32.hdf5
  inflating:  L-L1_LOSC_4_V1-1135136334-32.hdf5
  inflating:  LOSC_Event_Tutorial.ipynb
  inflating:  LOSC_Event_tutorial.py
  inflating:  O1_events.json
  inflating:  readligo.py

In [7]: !curl -o LOSC_Event_tutorial_LVT151012.zip https://losc.ligo.org/s/events/LVT151012/LOSC_Event_tutorial_LVT151012.zip
% Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
         Dload  Upload   Total   Spent    Left   Speed
100 2468k  100 2468k    0     0 4867k    0  0:01:00  0:01:00  0:00:00 4878k

In [8]: !unzip -o LOSC_Event_tutorial_LVT151012.zip
Archive:  LOSC_Event_tutorial_LVT151012.zip
  inflating:  H-H1_LOSC_4_V1-1128678884-32.hdf5
  inflating:  L-L1_LOSC_4_V1-1128678884-32.hdf5
  inflating:  LOSC_Event_tutorial.ipynb
  inflating:  LOSC_Event_tutorial.py
  inflating:  LVT151012_4_template.hdf5
  inflating:  O1_events.json
  inflating:  readligo.py
```

8) Now you can run the individual notebooks for the different data sets: LOSC\_Event\_Tutorial\_GW150914.ipynb, LOSC\_Event\_Tutorial\_GW151226.ipynb, and LOSC\_Event\_Tutorial\_LVT151012.ipynb by returning to the browser tab



and clicking the arrow for each one. Each will open in its own browser window.

For the first tutorial, try to run each cell by hand and read through the tutorial so that you can see what plots and other data products are being created as well as looking at the Python analysis code. You can also modify the code in the cell and run it, getting a different result. This is the great thing about the Jupyter notebook: you can modify it and run again.

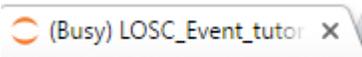
If you choose this option, the first cell to run looks like this:

### Set the event name to choose event and the plot type

```
In [4]: #-- SET ME Tutorial should work with most binary black hole events
eventname = 'GW150914'
#eventname = 'GW151226'
# eventname = 'LVT151012'

# want plots?
make_plots = 1
plottype = "png"
#plottype = "pdf"
```

If instead you choose “Run All” from the Cells menu, it takes a while to run, and while it is still running, the browser tab for that notebook will look like this:



Once the (Busy) is no longer there, you can read through the entire notebook and examine the plots at your leisure.

9) Once you have successfully run all three tutorials, you will be able to finish the homework assignment for Section 5) which is described in a different Moodle entry below.

**NOTE: Ignore any pink warnings that appear after you have run the tutorials. They are just messages about different versions of Python or similar.**