Orbyts at KCLMS

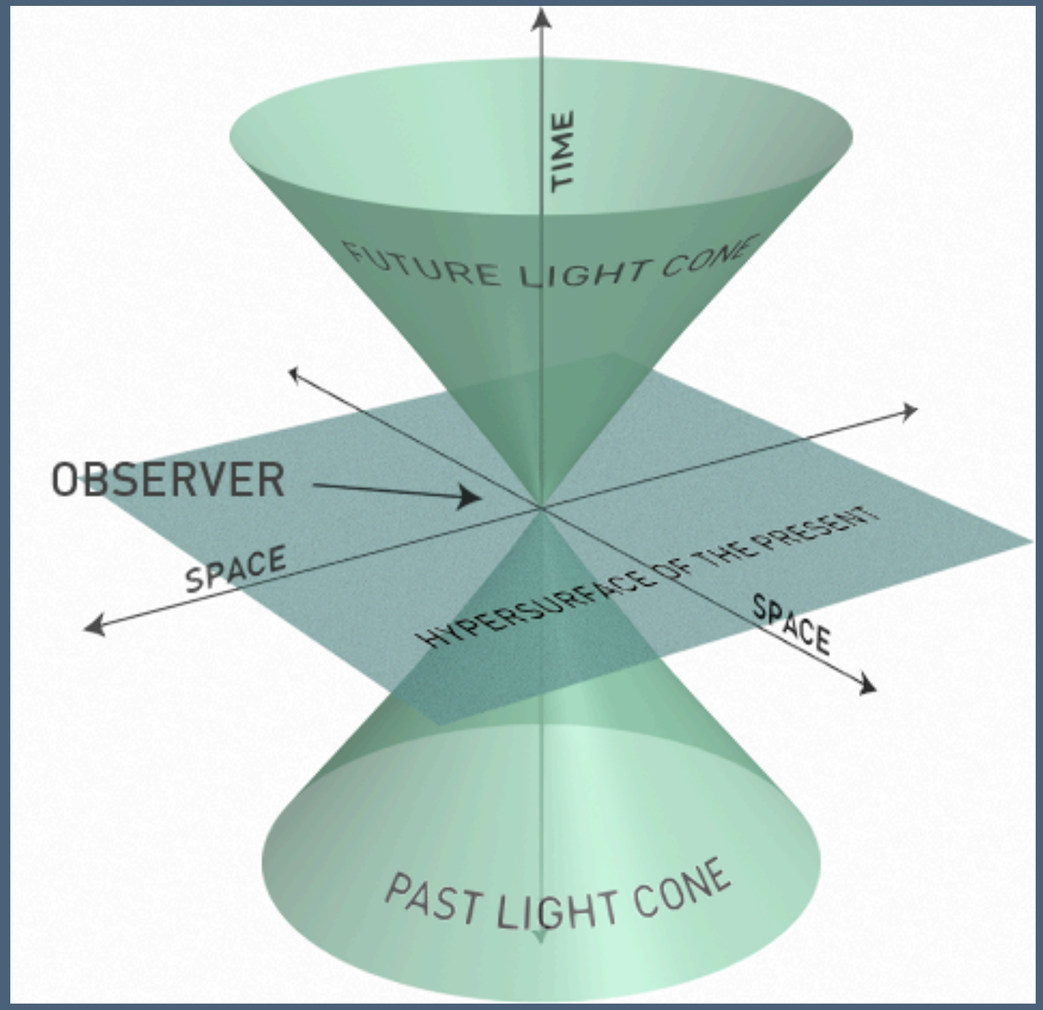
Science background

Jules Buet - 13/01/2026

Orbyts Student Survey 2025/2026

Speed of light

Can you think of consequences of light speed being finite?

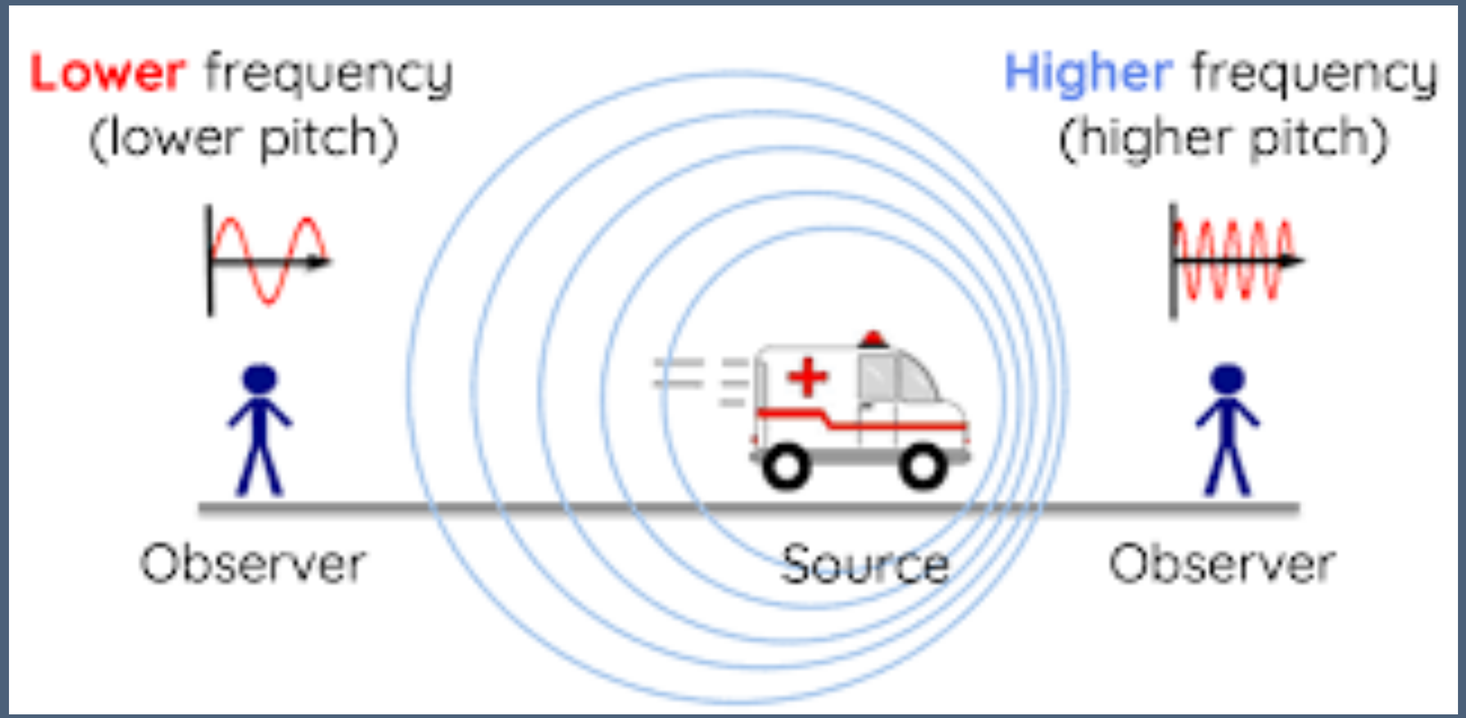


Doppler Effect

Also applies to light

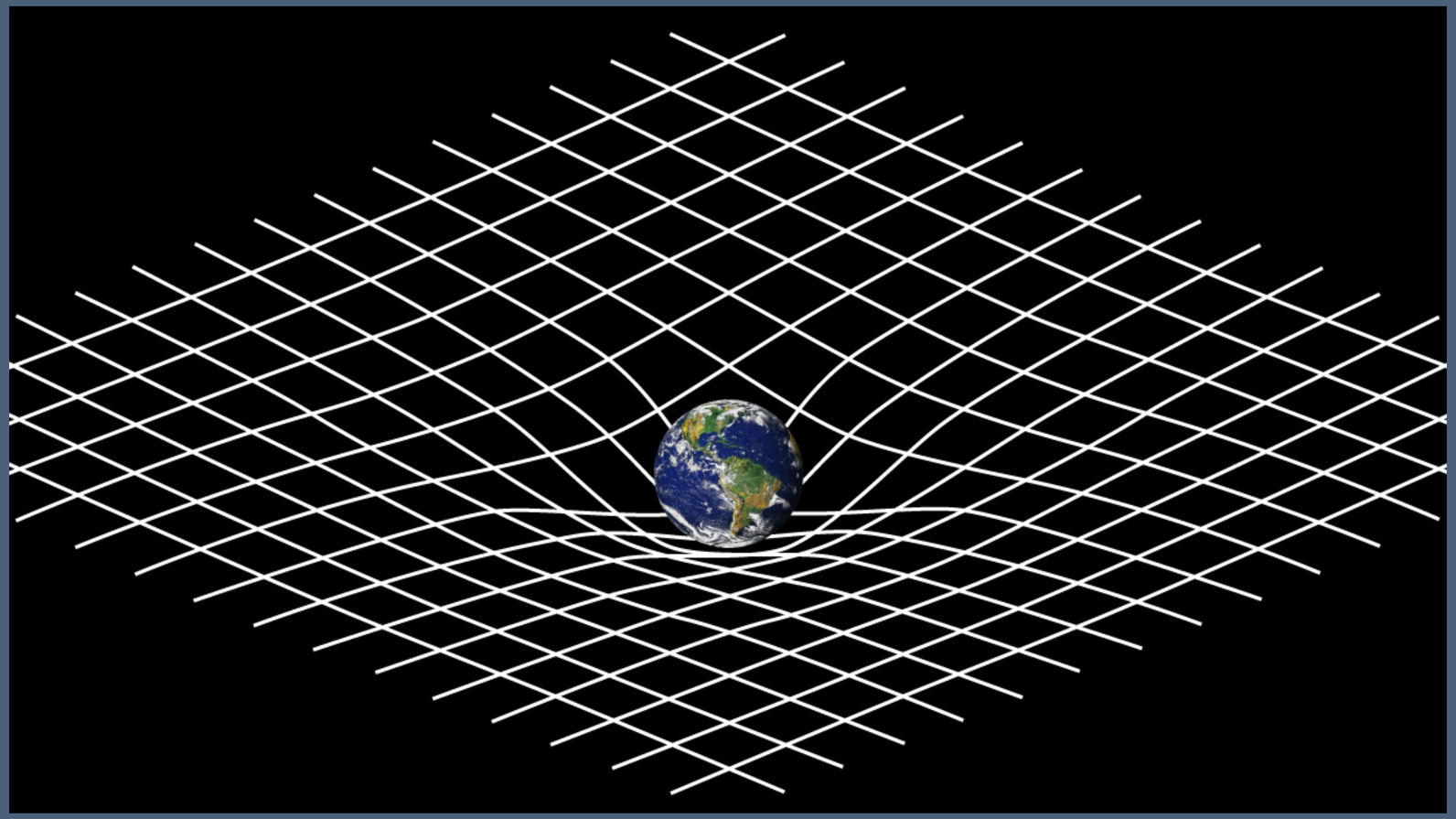
$$\nu_{observed} = \nu_{source}\sqrt{\frac{1+\frac{v}{c}}{1-\frac{v}{c}}}$$

$$\nu_{observed} = \nu_{source}\sqrt{\frac{1+\beta}{1-\beta}}$$



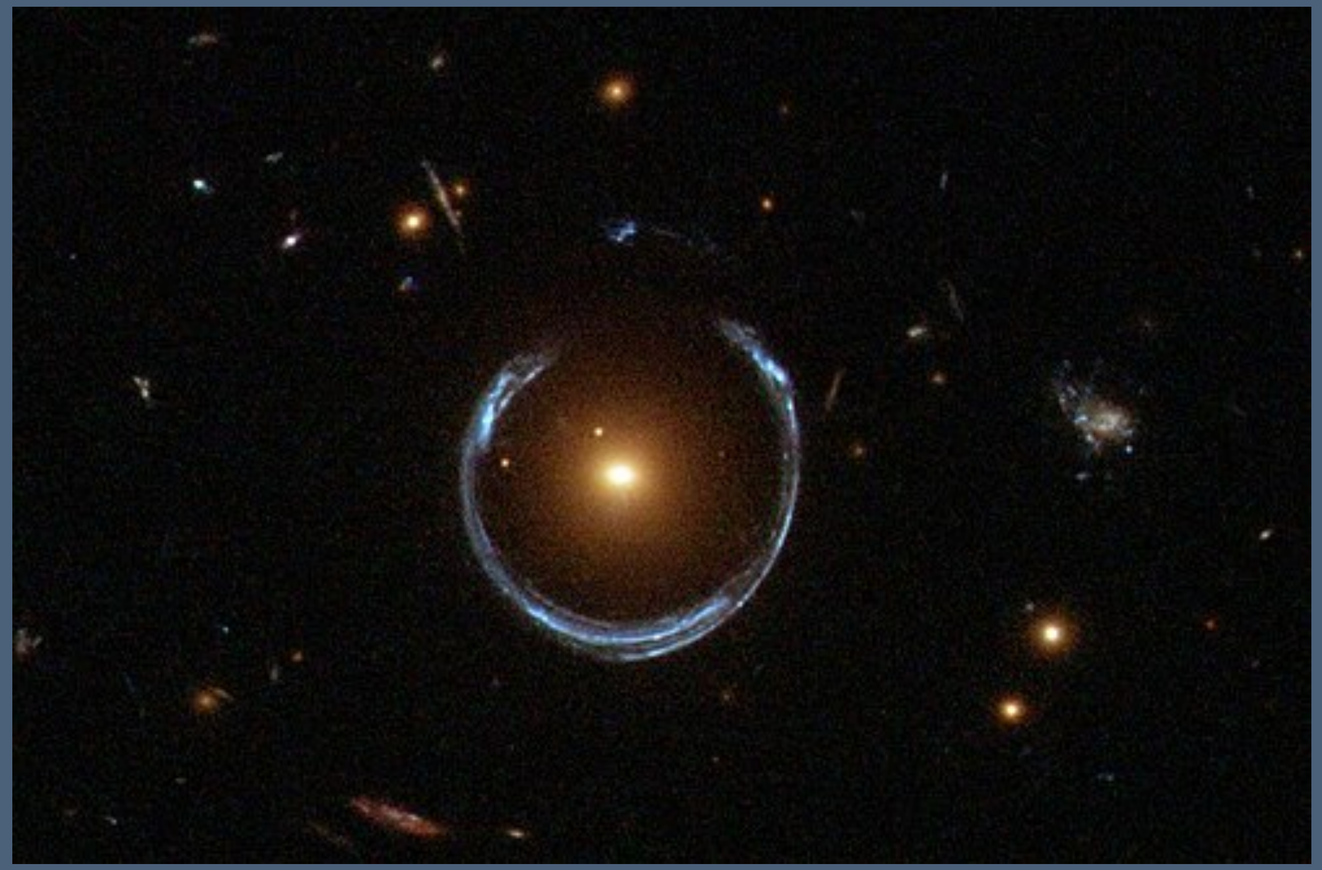
Gravity as “bending” spacetime

Quick introduction to general relativity

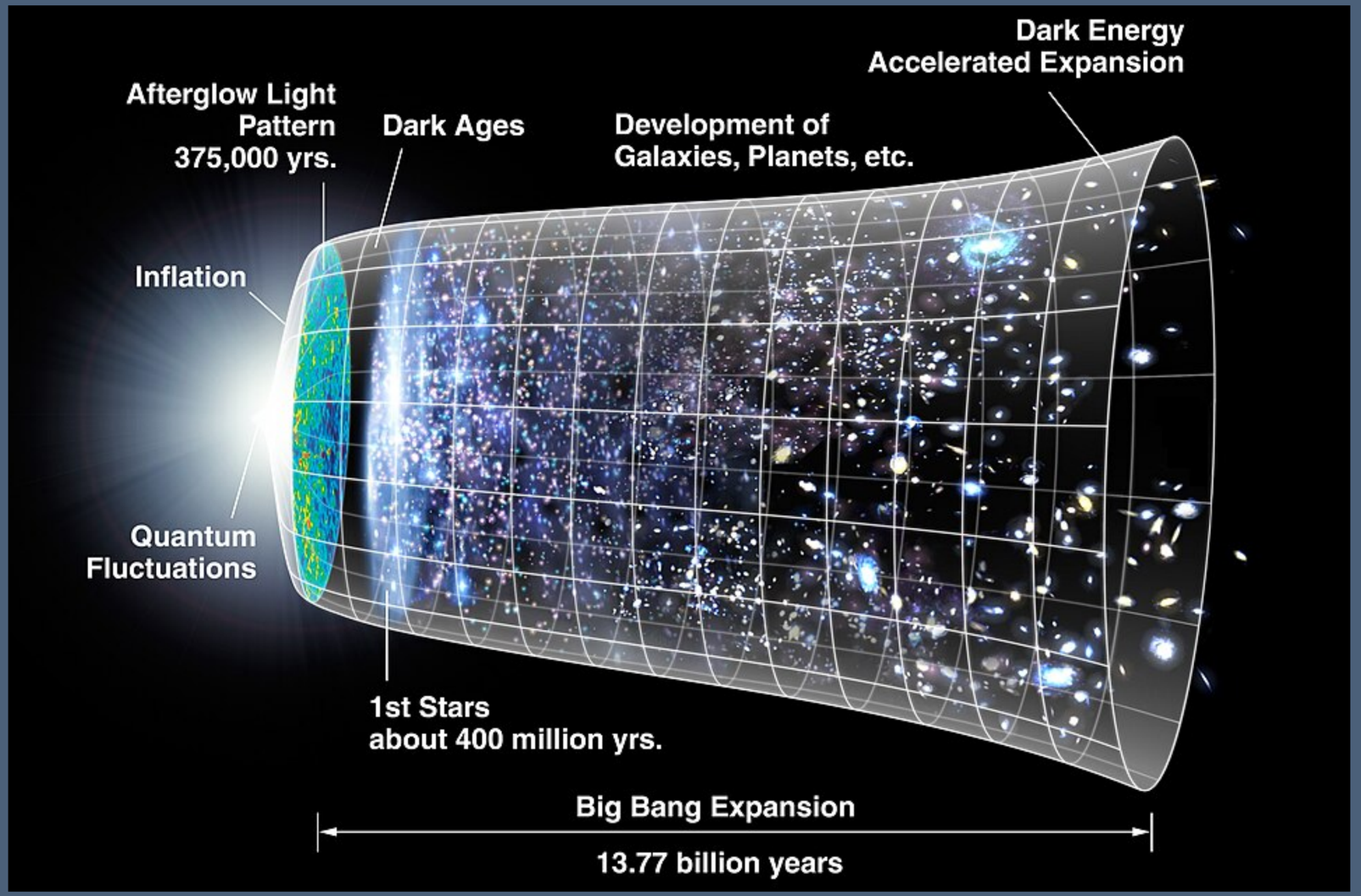


A few fun things that this leads to:

- Definition of a black hole
- Do you live longer on the ground or at the top of a mountain?
- Galaxies may appear to move faster than light, how?
- Gravitational waves
- Gravitational lensing



Cosmological history



Friedmann equation

The Friedmann Equation

$$\left(\frac{1}{a}\frac{da}{dt}\right)^2 = \frac{8}{3}\pi G(\rho_R + \rho_M + \rho_\Lambda) - \frac{kc^2}{l_0^2 a^2}$$

a = dimensionless scale factor
ρ_R = relativistic matter density
ρ_M = non-relativistic matter density
ρ_Λ = dark energy density
k = curvature of the universe
c = speed of light
l_0 = present distance between two galaxies

- Simplified representation of the expansion of the universe that works quite well
- Describes 3 main eras of the universe: radiation dominated, matter dominated and dark energy dominated
- If you know the basics of differential equations I can give you an exercise sheet to find those eras from the Friedmann equation

Introduction to coding

A little bit about Git

- Python tutorial available online on Github
- Go to: https://github.com/P-12/Orbyts-2026 to see what you will be working with
- Open a terminal
- Type “git clone https://github.com/P-12/Orbyts-2026" in the right folder
- You should now have the files on your computer locally! Let me know if there are any issues
- If you are completely new to Python, I’ll take you through the Python101 together, if you know about coding already, look through the “bootcamp_1 “ and “bootcamp_OOP” files and try the exercises

What is git / GitHub?

A helpful version manager

Git is a software on your computer to manage versions of your code

GitHub is an online platform that works hand in hand with git to share your code or store it online

I highly recommend you use git, this can be downloaded for free and there are free graphic versions available for easier use (GitHub Desktop or SourceTree for example)

The default requires to use the terminal / command interface which is less user-friendly

Three main key words for git you need to know (you don't really need much more): clone, branch and commit.

Clone: copy an existing git repository (aka code base or folder) - you can clone an online code base from GitHub (what we did last week)

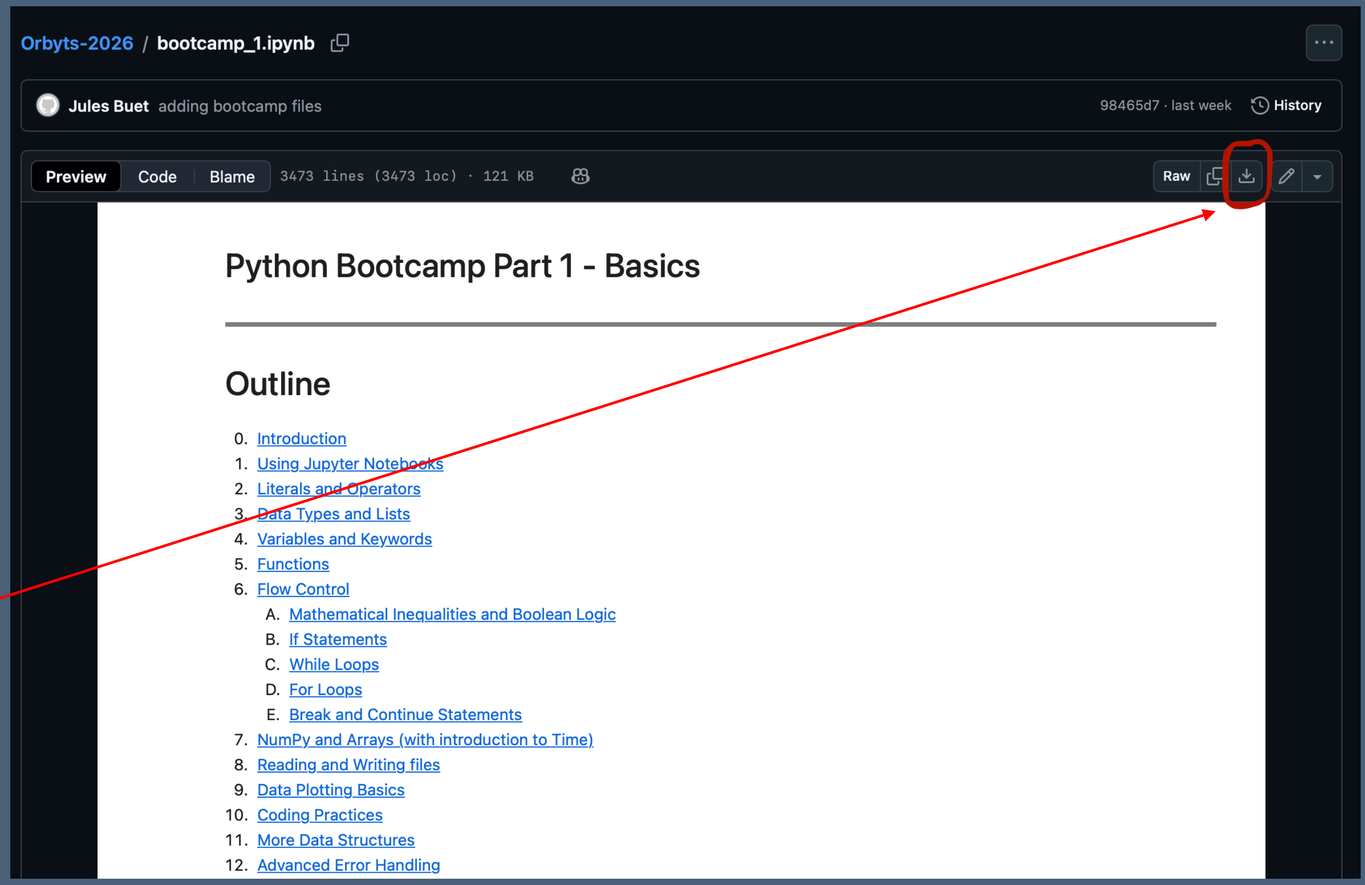
Branch: when you want to edit a code base that you share with other people or make changes you aren't sure will work, you create a separate BRANCH where you can save your code without modifying the original code (which will typically be stored on the branch MAIN)

Commit: the equivalent of save, when you have a version of your code that you would like git to remember for you, you should COMMIT it to your branch (better to do so with a helpful message explaining the changes you wrote), if you then accidentally delete or break your code, you can REVERT back to any commit you wish

Python tutorial

Independent coding time

- Tutorials you can follow at various different levels depending on how comfortable you are with coding
- If you are completely new start with “bootcamp_1.ipynb”, even if you don’t have git or Python you can download it and then go to “Google Colab” online and open it
- I will be going around to try and get everyone set up with git and Python on their computer for next time



DESI data: getting started

A good place to start is looking at what has already been done

- PROVABGS: https://github.com/changhoonhahn/provabgs
- Latest wCDM paper: https://arxiv.org/abs/2510.09074
- DESI data: https://www.desi.lbl.gov/
- Those are just suggestions on where to start; now it is up to you!
- I would advise making groups of 2 to 4, and start exploring the existing resources on DESI, and try to get some code running
- If unsure start by installing PROVABGS and try to get nb/example.ipynb and nb/tutorial_desispec.ipynb running