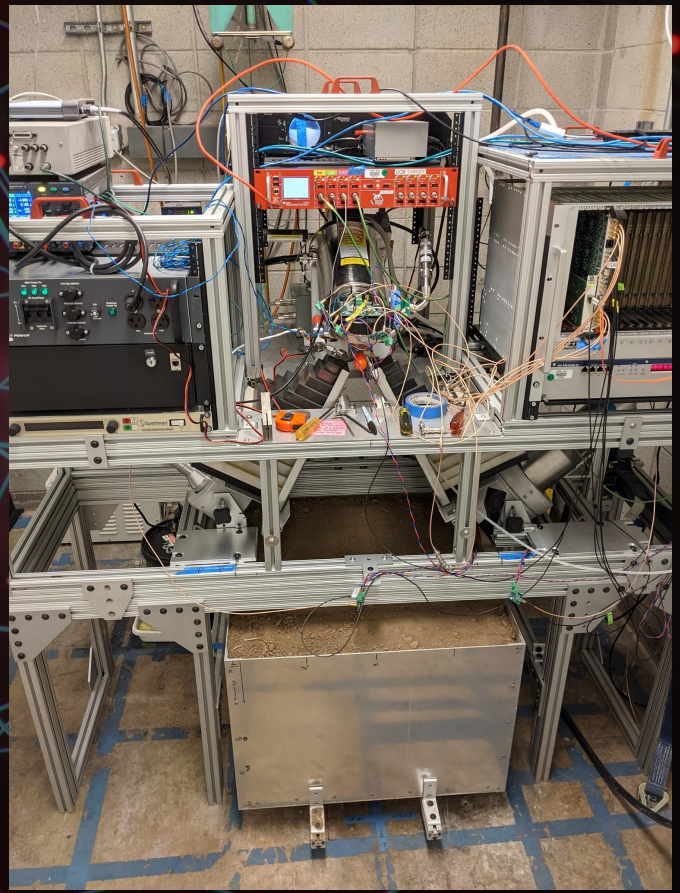

Lecture 16
Practical Python in Research

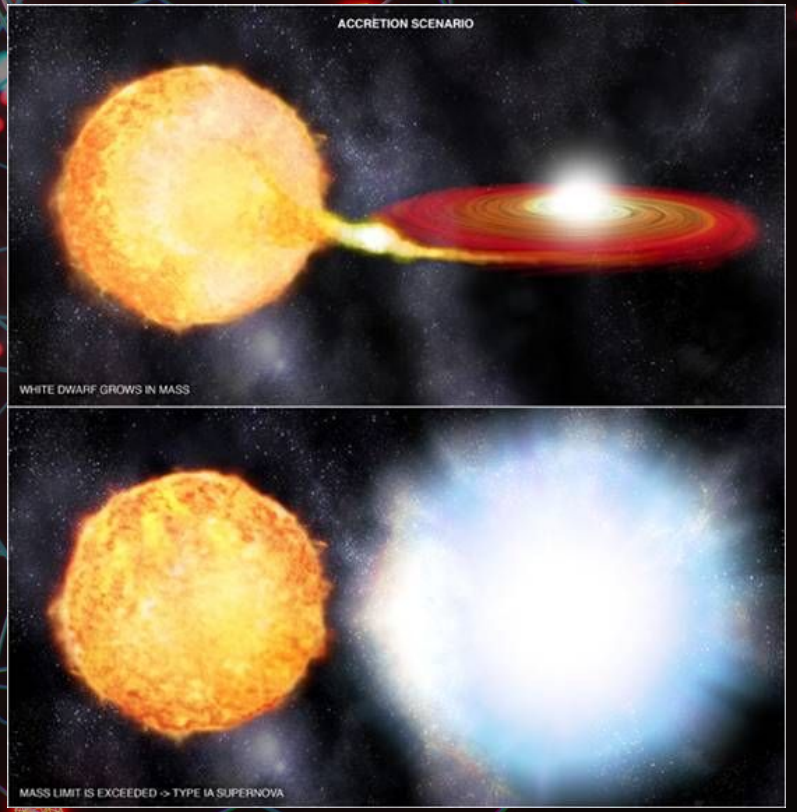
Daniel's Research Experiences

- UC Davis COSMOS 2016
- Planets and Life in Space with Professor Courtney Dressing
- 2020-2021 Senior Thesis: Exoplanet Orbit Simulations
- Ion Beam Technology Group at LBL

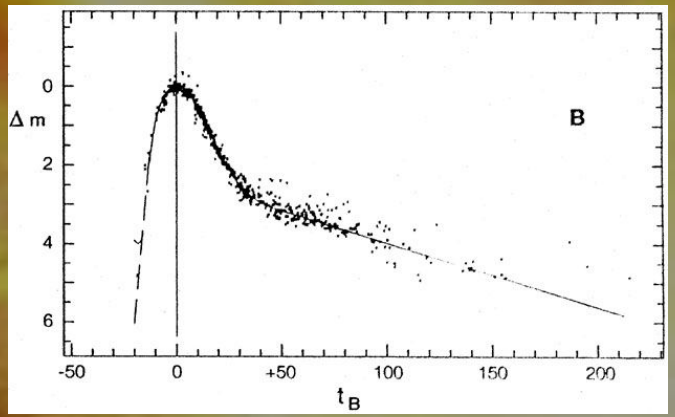


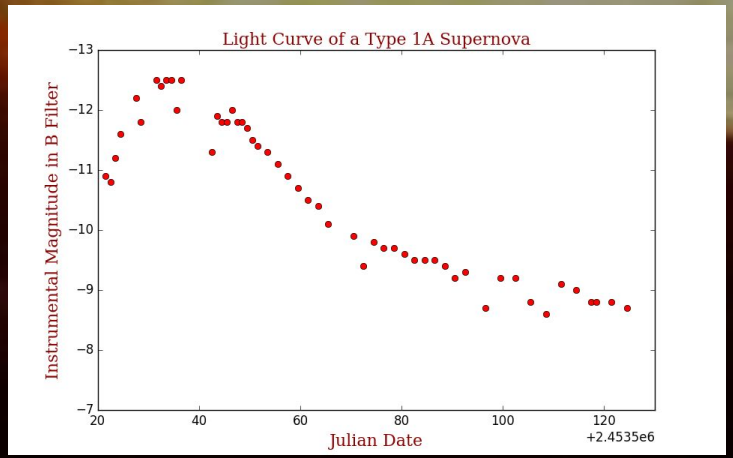
COSMOS (2016)

- My first introduction to astronomy research and coding in python
- COSMOS is a program for high school students to take college level courses in a single subject and conduct a research project
- Like we did in class, my project involved data analysis of a type-1a supernova, determining its distance to extrapolate the age of the universe



Type 1a Supernovae

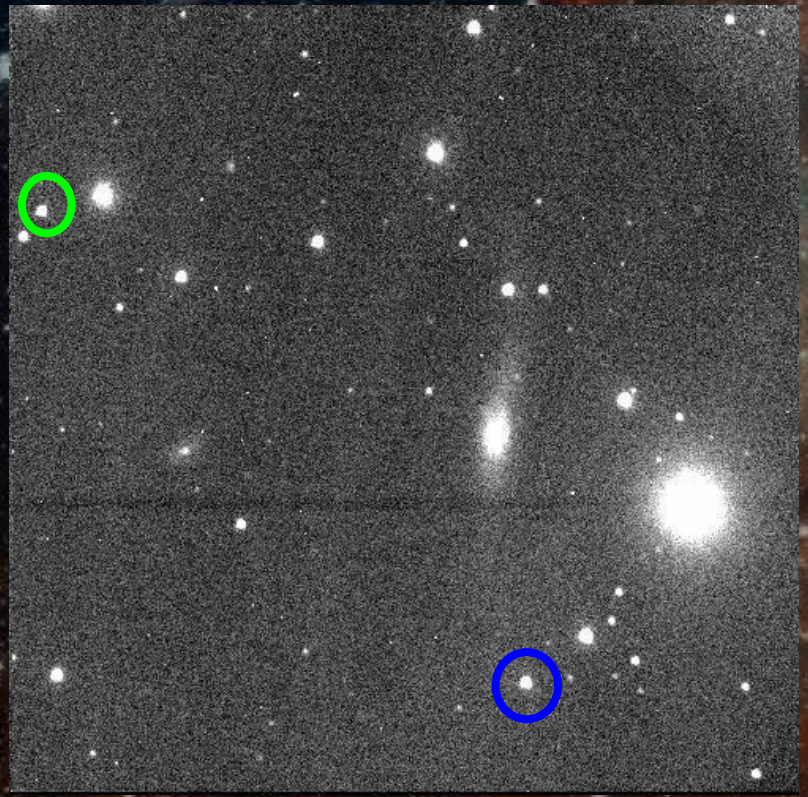




- Type 1a Supernovae are formed in a Binary Star System
- The White Dwarf absorbs the mass of the partner star
- The White Dwarf will eventually collapse resulting in a Supernova
- These supernovae have an almost constant Absolute Magnitude
- Because of this they can easily be used as *Standard Candles*

Names:
SN2005cf (Kid FLash)
MCG-01-39-003 (Nightwing)
Redshift: 0.006461
Velocity: 1937 km/s

Finding the Distance Cont.



Process:

- Identify the Supernova and Reference Star
- Run the data through the Source Extractor program which will identify all objects in the image and take measurments of them
- Locate the needed data for your objects in each picture
- Find the picture for which the Supernova has its peak instrumental magnitude
- Use the equation $m_{IT} - m_{IC} = m_T - m_C$ to solve for the apparent magnitude of the supernova
- Use the equation $M = m - 5\log_{10}(R/10PC)$ with the absolute magnitude -19.03 +/- .03 to find the Distance to the supernova

Distance

Calculated Distance:
29.4 MPC
Distance with △M15 Correction: 30.3 MPC

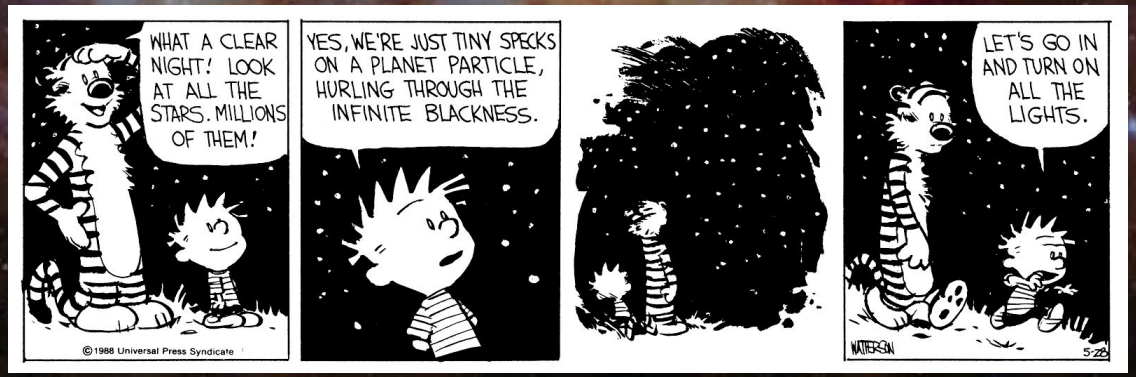
Scale

- 9.60*10^7 Light Years
- 9.08*10^20 Km
- About 960 Milky Way Galaxies
- 7.13*10^16 Lengths of the Earth
- 1.07*10^20 Mount Everests

Why Do We Care?

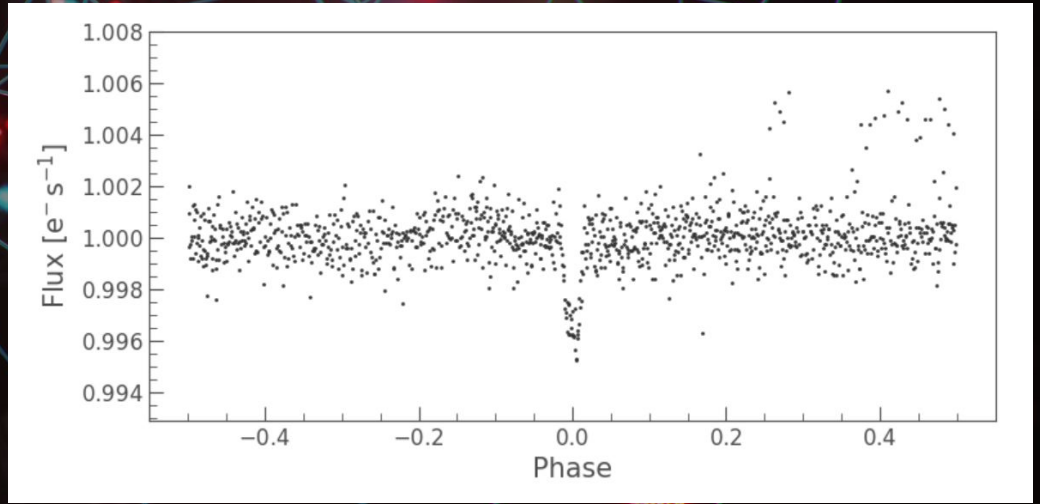
How Old Is The Universe?

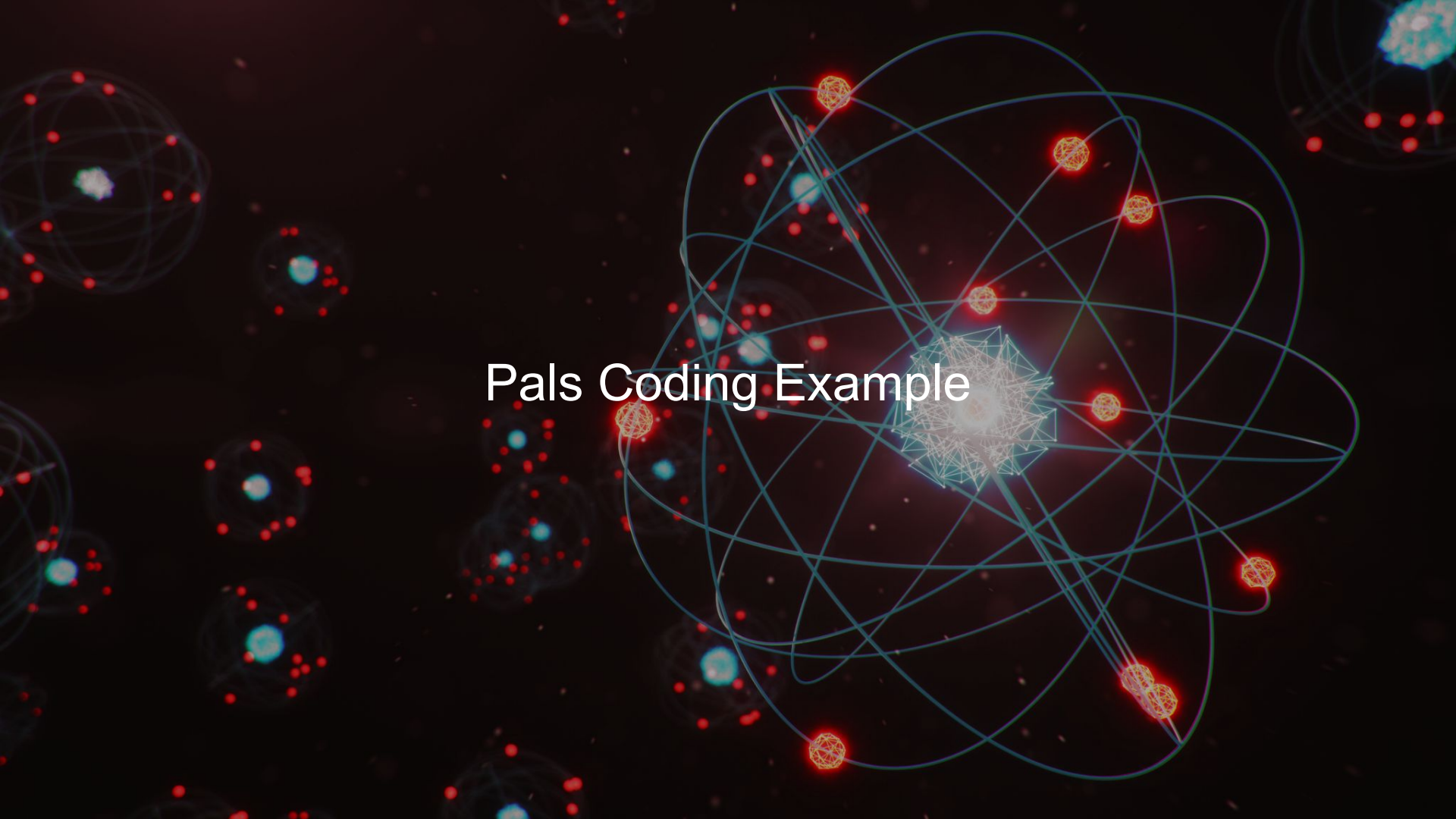
- By taking a Spectra of the Galaxy in which the Supernova is located, the redshift can be found, and therefore the velocity can be found
  https://ned.ipac.caltech.edu/cgi-bin/objsearch?objname=MCG+-01-39-003&extend=no&hconst=73&omegam=0.27&omegav=0.73&corr_z=1&out_csys=Equatorial&out_equinox=J2000.0&obj_sort=RA+or+Longitude&of=pre_text&zv_breaker=30000.0&list_limit=5&img_stamp=YES
- Using the velocity and the Distance, Hubble's Constant can be found with the Equation $V=H_0D$ (About 66 km/s/MPC with this data)
- The Age of the Universe can be found with the inverse of the Hubble Constant ($1/H_0$)
- With this: The Universe is about 14.8*10^9 Years Old



Planets and Life In Space (2019-2021)

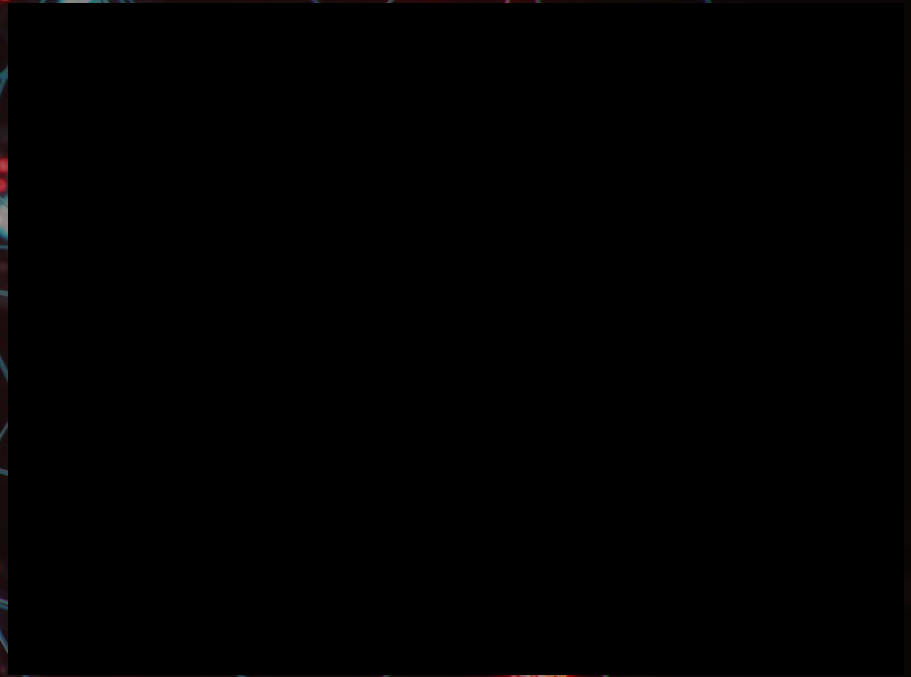
- In 2019 I joined the research group of Professor Courtney Dressing
- This is where I began to study exoplanets and transit light curves
- This group taught me a lot about using python in a research context and how modern research is done




Pals Coding Example

Senior Thesis (2021-2022)

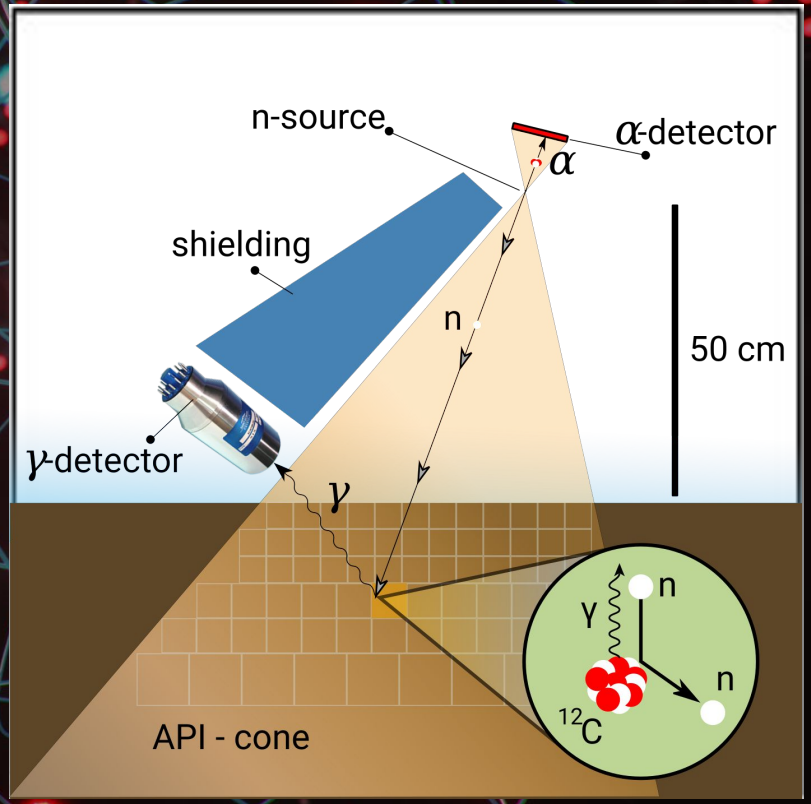
- During my senior year there was this little global pandemic
- My entire project needed to be completed online
- I opted for a computational project to simulate exoplanet orbits
- I wrote some code that would output a simulation based on given exoplanet variables.

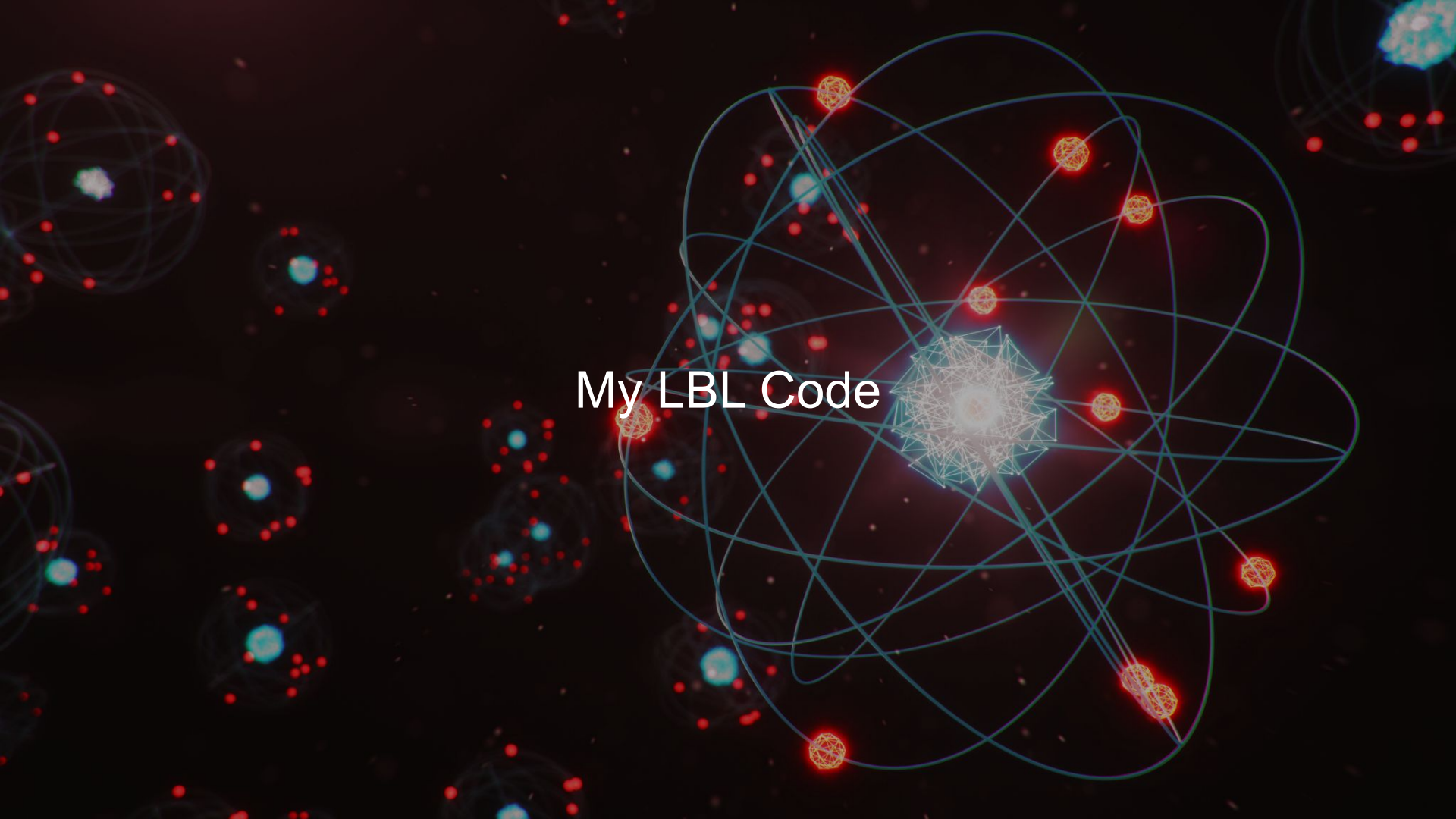



My Thesis Code

My LBL Project (2021-2022)

- My group was working on a project which uses Associated Particle Imaging
- Want to use it to measure Carbon in Soil
- I worked on fixing the associated particle (alpha particles) measurement




My LBL Code

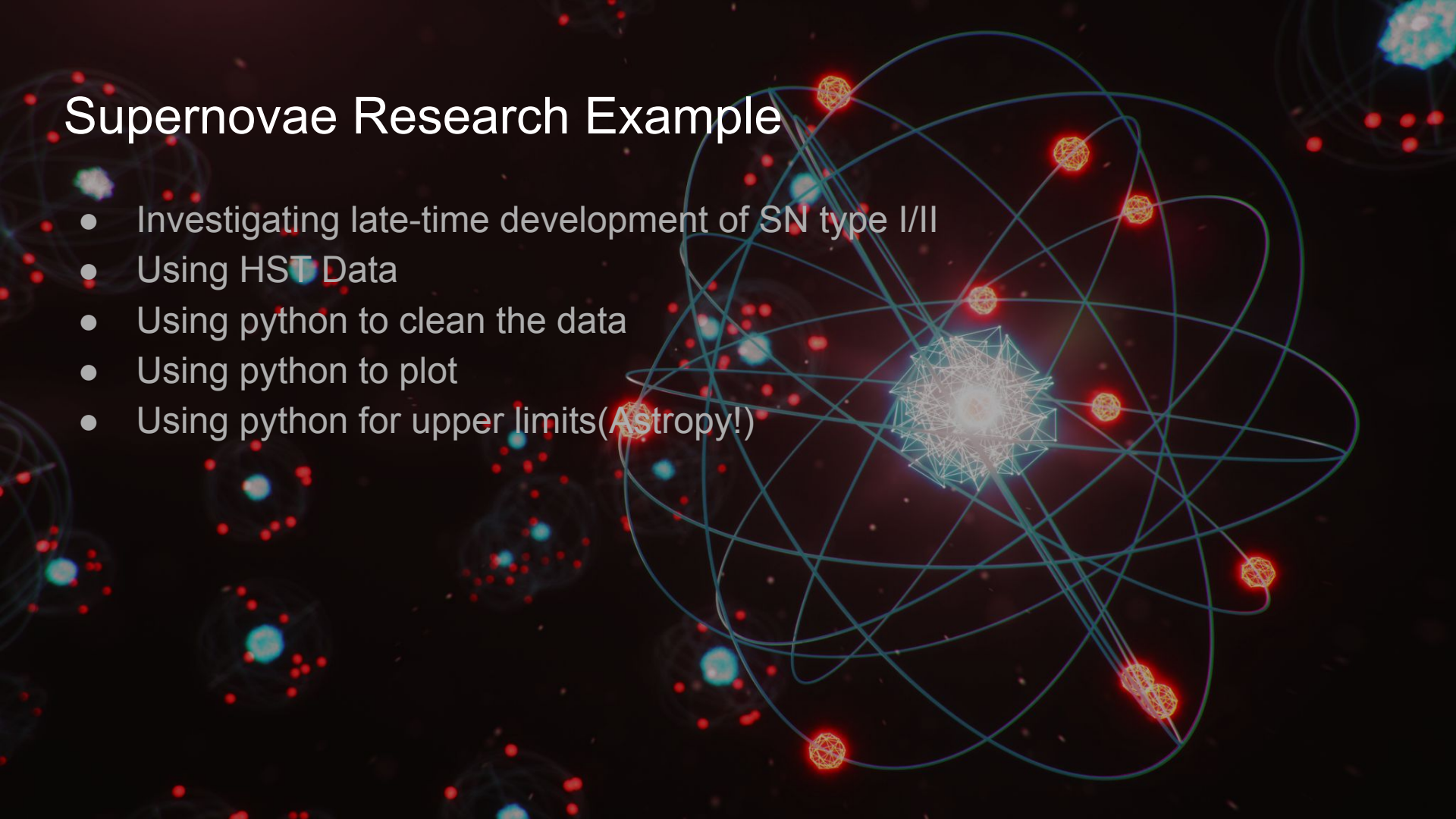
Raphael’s Research Experience

- Supernovae Research-HST/Astrodrizzle/python

- Variable star research-python pipeline(MCMC etc)

Supernovae Research Example

- Investigating late-time development of SN type I/II
- Using HST Data
- Using python to clean the data
- Using python to plot
- Using python for upper limits(Astropy!)



Variable Star research example

- Using python for photometry pipeline(built in python at Berkeley!)
- Similar to exoplanet datastes
- Using PIPS to find periods