

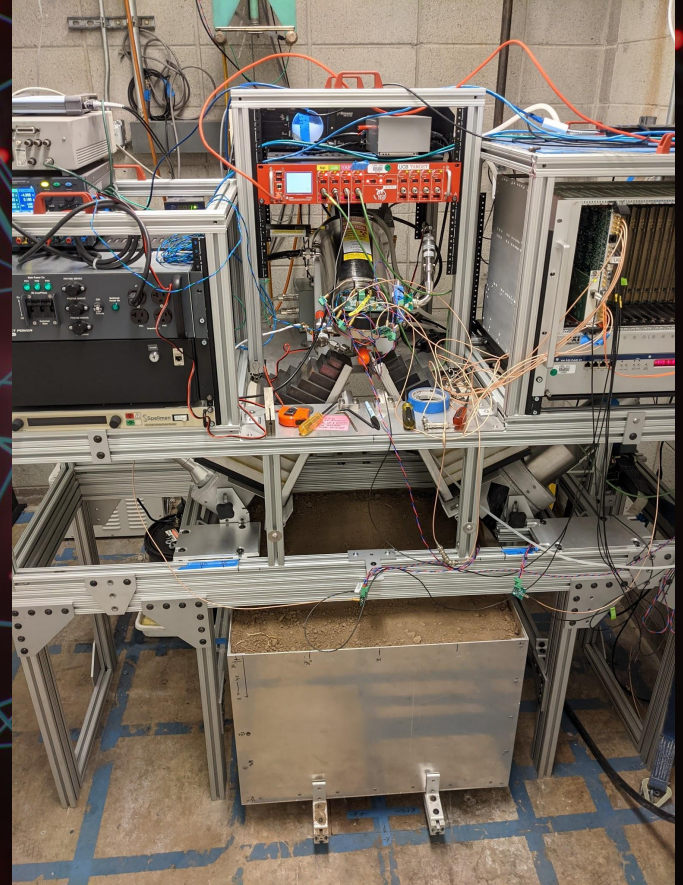
The background is a dark, deep red or black space filled with numerous glowing, abstract structures. These structures resemble stylized atomic models or complex network graphs. They consist of bright blue and red nodes (spheres) connected by thin, glowing blue lines that form elliptical or circular orbits. Some nodes are solid and brightly lit, while others are fainter or part of larger, more complex clusters. The overall effect is one of dynamic energy and scientific complexity.

Lecture 16

Practical Python in Research

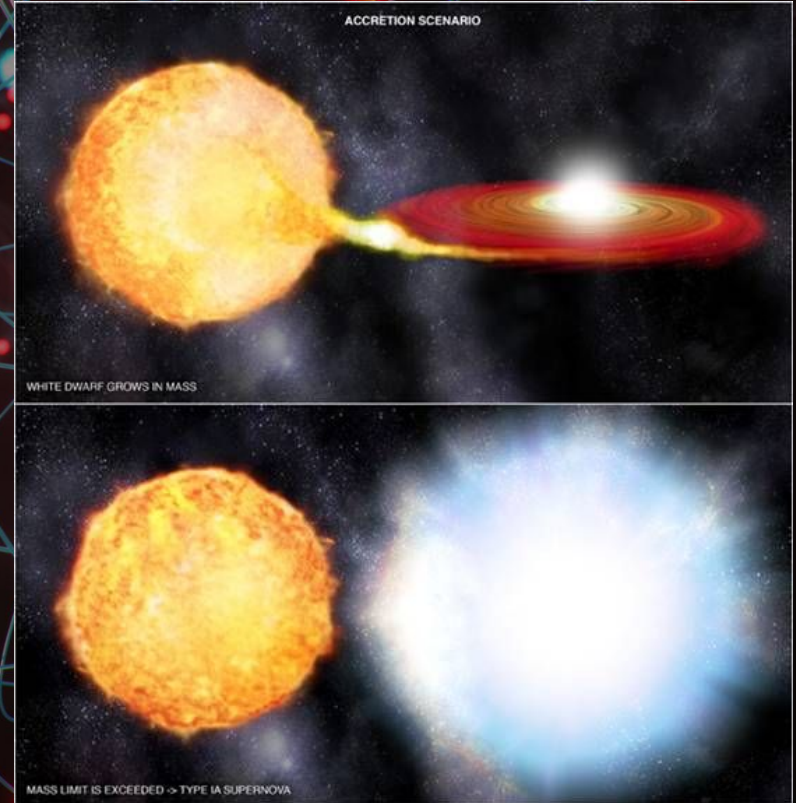
Daniel's Research Experiences

- 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

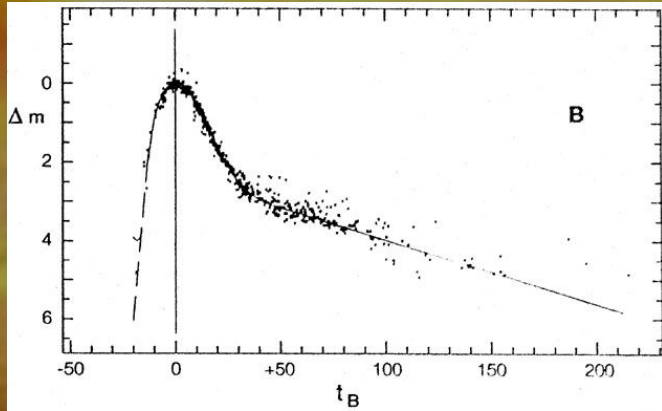


COSMOS (2016)

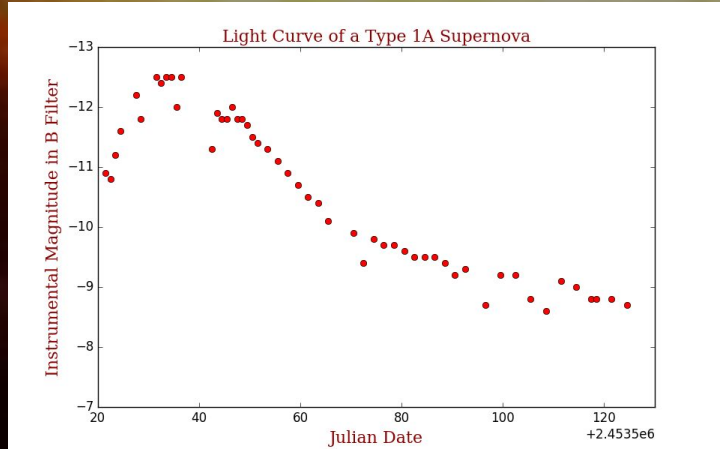
- My first introduction to astronomy research and coding in python
- COSMOS is a program for high school students to take college level courses in a single subject and conduct a research project
- Like we did in class, my project involved data analysis of a type-1a supernova, determining its distance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



Type 1a Supernovae

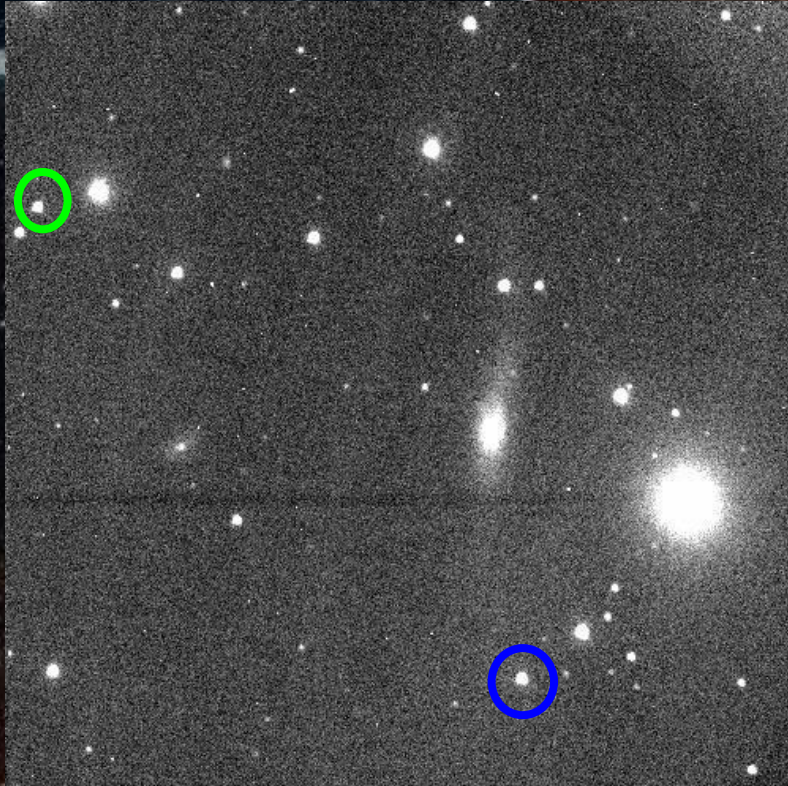


- Type 1a Supernovae are formed in a Binary Star System
- The White Dwarf absorbs the mass of the partner star
- The White Dwarf will eventually collapse resulting in a Supernova
- These supernovae have an almost constant Absolute Magnitude
- Because of this they can easily be used as *Standard Candles*



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 measurements 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 $M = m - 5\log_{10}(R/10\text{PC})$ with the absolute magnitude $-19.03 \pm .03$ to find the Distance to the supernova



Distance

Calculated Distance:
29.4 MPC
Distance with $\Delta M15$
Correction: 30.3 MPC



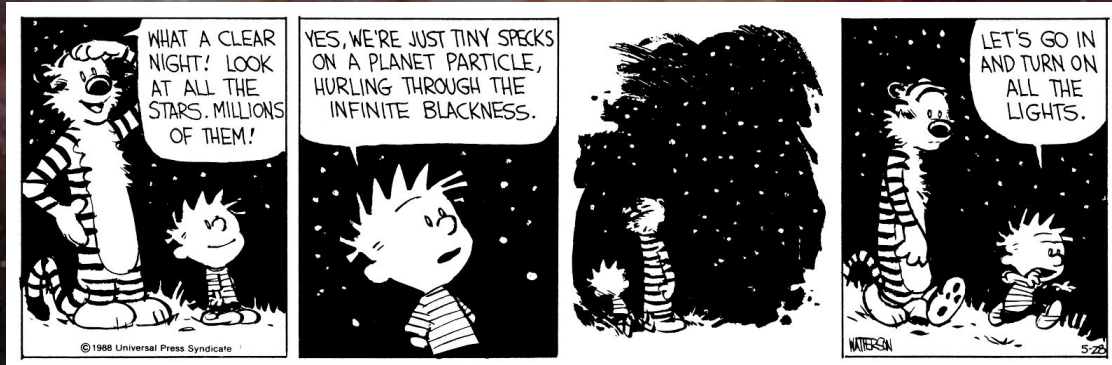
Scale

- 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?

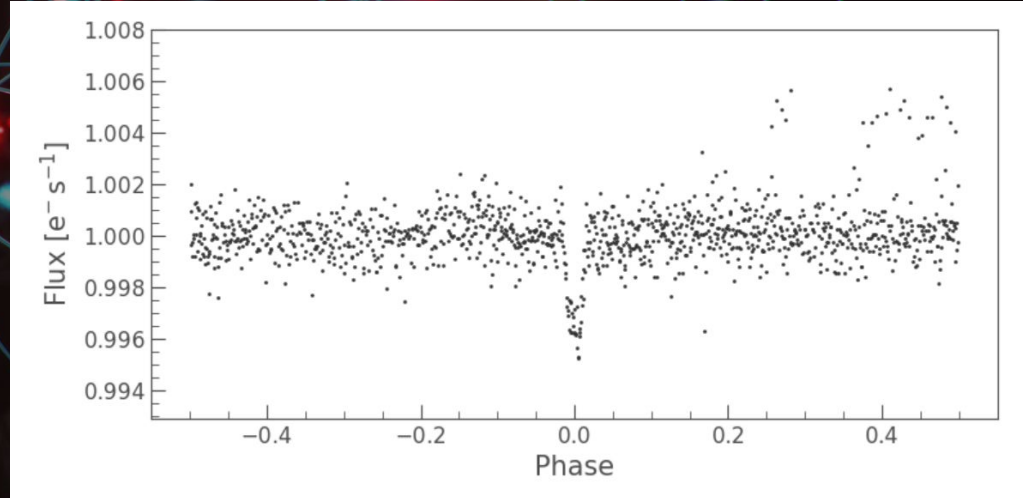
How Old Is The Universe?

- 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_csy=s=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 $V=H_0 D$ (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

A large, stylized atomic model is centered on the right side of the image. It features a complex, multi-faceted nucleus made of small, light blue and white cubes. Surrounding the nucleus are several intersecting elliptical orbits in a light blue color. Small, glowing red spheres are positioned along these orbits, representing electrons. The background is a dark, deep red with a subtle pattern of smaller, fainter atomic models scattered throughout, creating a sense of depth and a scientific theme.

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.

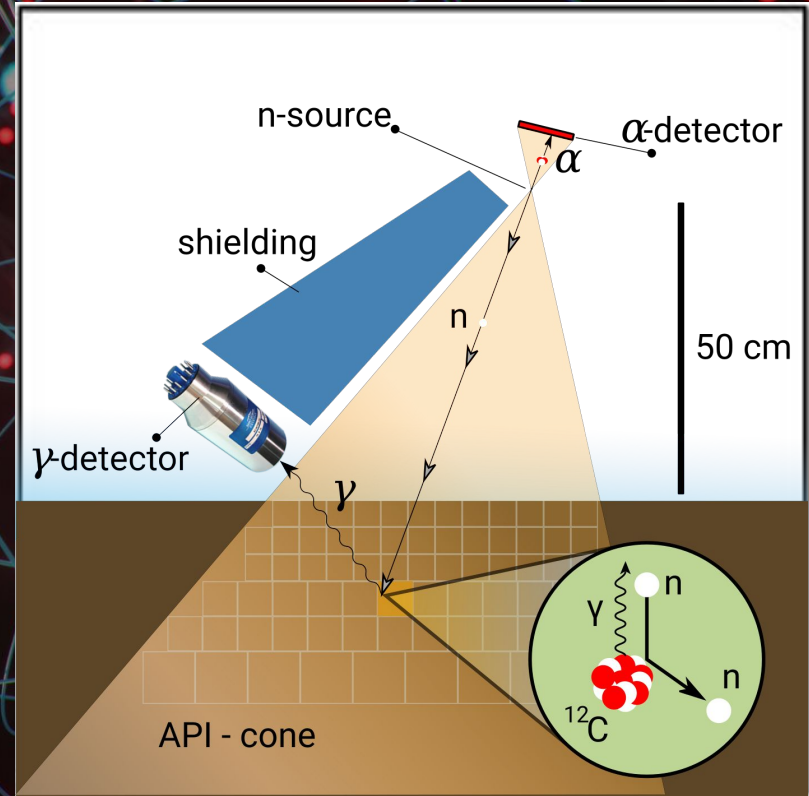


The background is a dark, deep red space filled with numerous small, faint atomic models. These models consist of a central nucleus (colored blue or cyan) and several red dots representing electrons orbiting in elliptical paths. A large, prominent atomic model is centered on the right side of the image. It features a complex, multi-layered geometric structure at its core, resembling a crystalline or molecular framework, with a bright white and yellow glow. This central structure is surrounded by several concentric, intersecting elliptical orbits. Red dots, representing electrons, are positioned at various points along these orbits. The overall aesthetic is scientific and futuristic, evoking themes of quantum mechanics and atomic structure.

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



A large, stylized atomic model is centered on the right side of the image. It features a complex, multi-faceted nucleus with a bright white and blue core. Surrounding the nucleus are several intersecting elliptical orbits in a light blue color. Small, glowing red spheres are positioned along these orbits, representing electrons. The background is a dark, deep red with a subtle pattern of smaller, similar atomic models and faint white specks, suggesting a vast field of atoms or a cosmic space theme.

My LBL Code

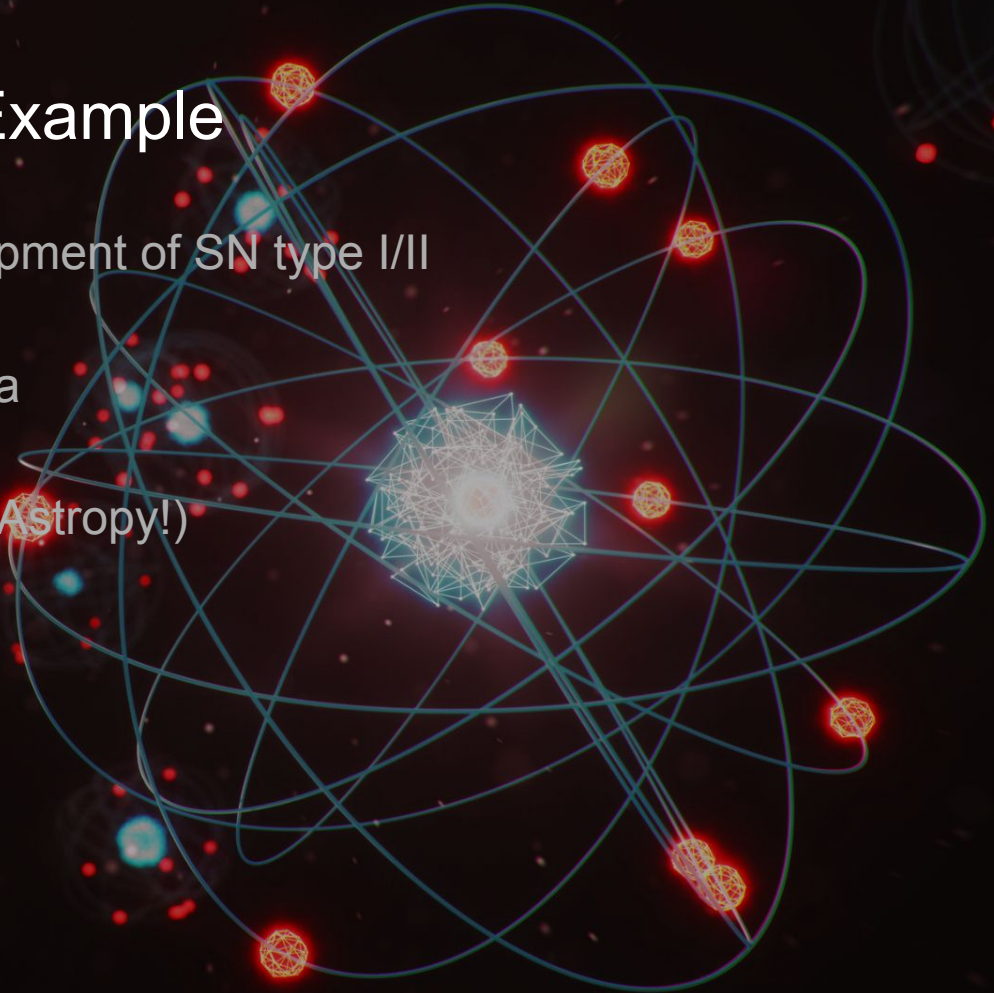
Raphael's Research Experience

- 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

