



# Undergraduate Research in Astronomy

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# Introduction to Me

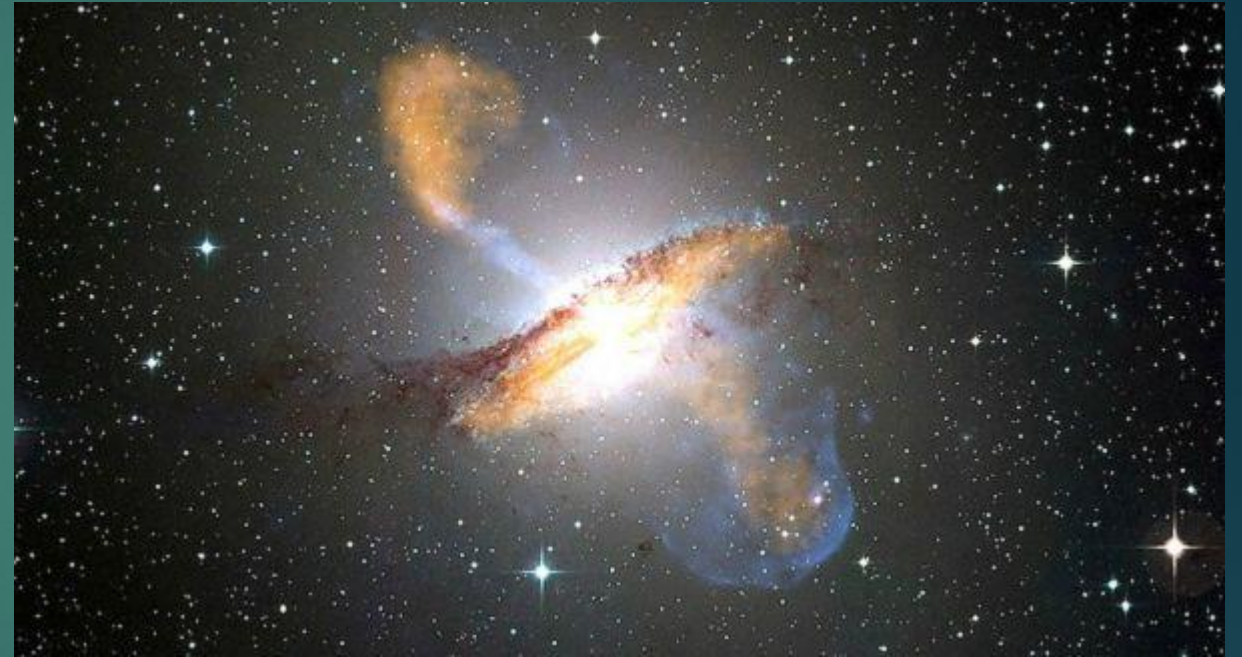
- ▶ 3<sup>rd</sup> year at UF, admitted as a freshman
- ▶ Astronomy / Physics double major
- ▶ Director of Outreach for AAS
- ▶ Research in observational cosmology with Dr. Jian Ge
  - ▶ Started August 2016



me

# My Work: Introduction

- ▶ 2175 Å Dust Absorbers in SDSS DR7
  - ▶ A unique feature in the UV dust extinction curve
  - ▶ Observed in the Milky Way and Large Magellanic Clouds
    - ▶ But what about in quasars?
- ▶ Quasars are bright
  - ▶ Can be seen in  $z \sim 0.7 - 2.4$  in SDSS
  - ▶ Examination of the feature at higher redshifts enables the study of galaxy evolution throughout the universe's history

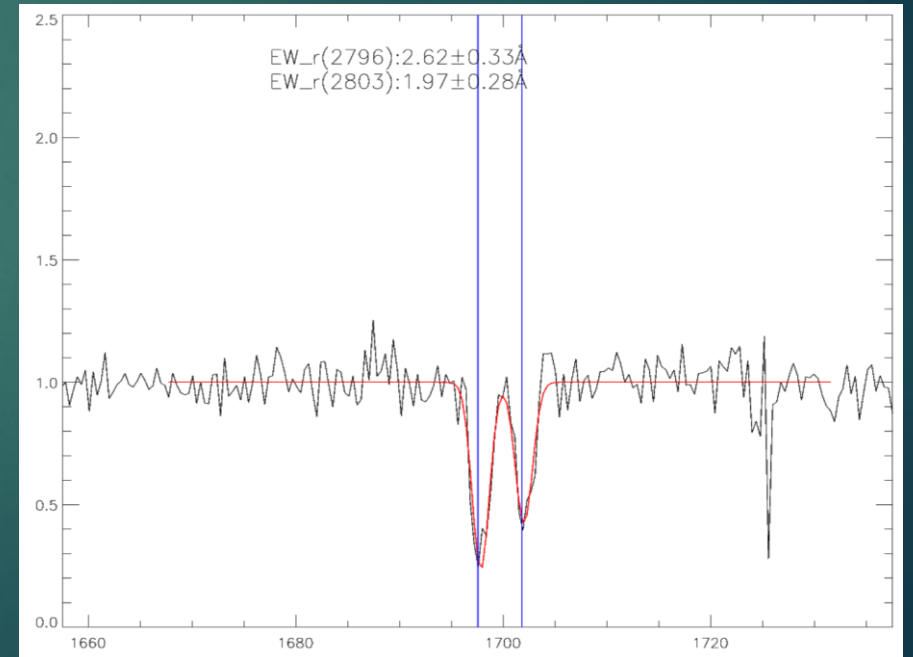
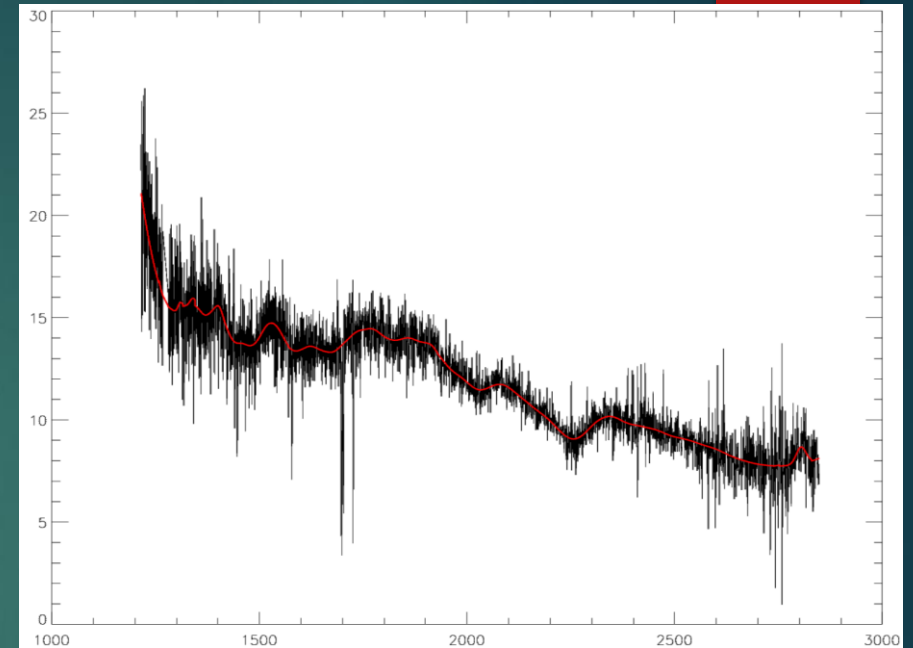


# My Work: Continued

- ▶ Goal: apply the techniques for Quasar Absorption-Line Systems (QALs) in the SDSS DR12 to find more candidates in the SDSS DR7
  - ▶ Looking for candidates pulled from a list of strong Mg II doublets with absorption redshift between 0.7 and 2.67, because these ranges fit within the wavelength coverage of the SDSS spectrograph
- ▶ Procedure: IDL program fits continuum without absorption doublet, then measures area between the fit and the continuum

# Searching for Candidates

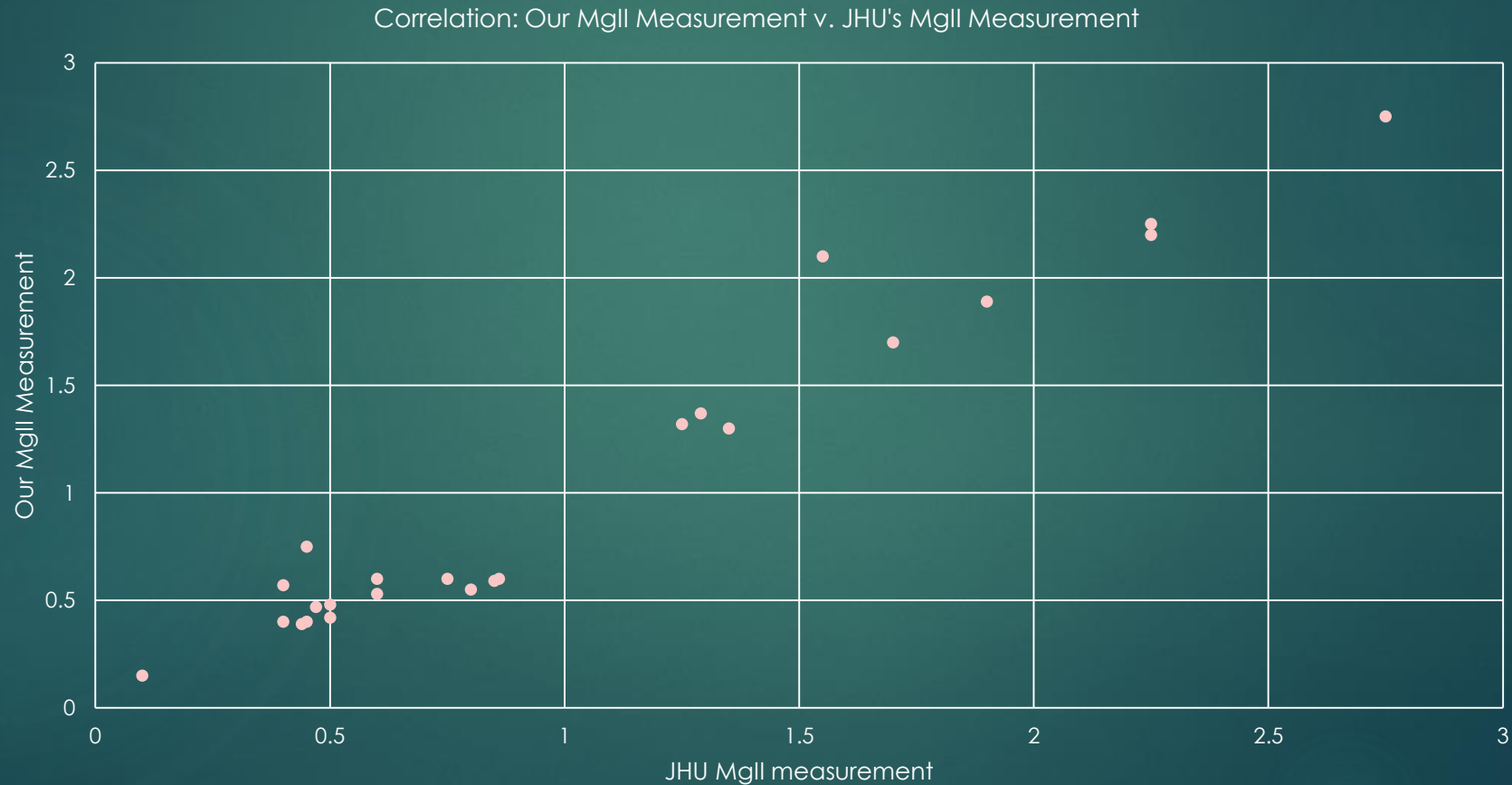
- ▶ Must ensure that the bump region is included in the window
  - ▶ Absorbers with redshift  $< 0.7$  do not fit this window
- ▶ SDSS DR7 includes a catalog of 35,751 individual spectra
  - ▶ Program plots the spectrum (flux vs. wavelength)
  - ▶ Continuum is divided by fit (normalized)
  - ▶ Area of absorption features is measured and quantified





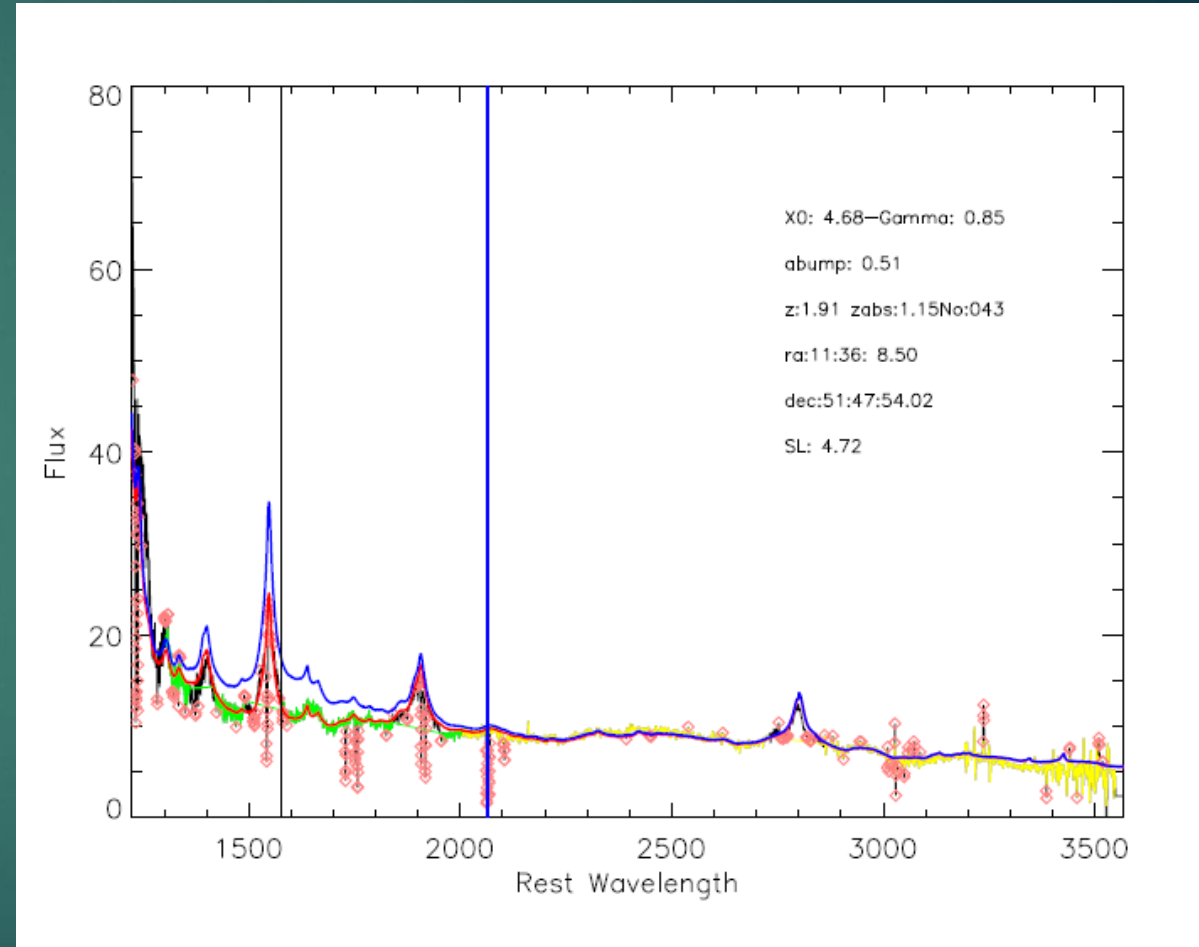
# Data Comparison

- ▶ Correlation plot of the first 30 Mg II absorption bumps compared with Johns Hopkins University



# Fitting and Plotting

- ▶ The bump region (green) is what we're interested in
  - ▶ Mg II features are just for initial identification of possible 2175 dust absorber (2DA) candidates
- ▶ The extinction curve is modeled by a linear region and a Drude component
- ▶ Distribution of bump strengths is assumed to be Gaussian, based on a control sample
  - ▶ Candidates with at least  $3\sigma$  significance level are looked at closer



# How I Got Started

- ▶ Summer after my freshman year at UF
- ▶ Talked to professors
  - ▶ Sarajedini, then Ge
- ▶ Submitted brief summary of skills, classwork
- ▶ Interview
  - ▶ Not like a job interview. Like a “what do you want to do” interview.
  - ▶ Choice of topic
- ▶ I had no research or coding experience whatsoever

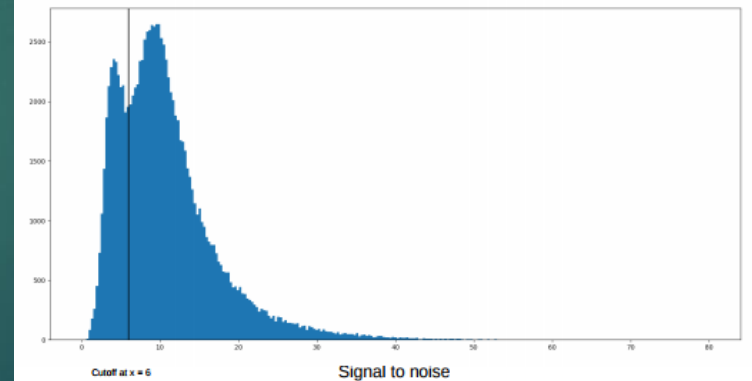


# Structure of My Research

- ▶ My research topic is only being worked on by myself and one grad student
  - ▶ The whole “research team” consists of many other people working on different projects
- ▶ Weekly meeting with grad student to answer coding questions, fix bugs, and get new tasks to complete by next week
- ▶ Weekly group meetings with professor and our team of grad students / undergrad researchers
  - ▶ Each gives a 5 min presentation of their progress that week
- ▶ Individual meetings with professor to discuss progress

## Progress

- 105,783 candidates in complete DR7 QSO catalog
- 80,805 of them have  $S/N > 6$  (our cut-off value)
- In total:
  - Mean  $S/N$ : 12.8228
  - Median  $S/N$ : 11.1206
- SN measured from spectra for the entire catalog, time elapsed 30 min 21 sec



Next step

# What Do I Even Do

- ▶ Mostly franken-coding
- ▶ Grad student has been performing analysis using an old grad student's code, which I now have to adapt to work for a different data release
  - ▶ It has completely different file handling – super annoying
- ▶ Run, debug, edit, repeat
  - ▶ There are upwards of 17 different programs that must be adapted to work on a new set of data
- ▶ Occasionally, write my own code to speed things up
  - ▶ File grabbing, mass data relocation, automation, etc.

# Things I Wish I Had Known

\*Note: Research experiences differ vastly professor to professor

1. Programming is everything
  - ▶ The two things that can actually benefit your research work are learning how to code and learning some basic statistics
2. Linux
  - ▶ Some people have done it, but interfacing with the UF Astro servers is significantly more difficult on windows
  - ▶ Setting up a dual-boot or virtual machine isn't difficult if your laptop can handle it
3. Astro IT, SSH, and You
  - ▶ There is a lot to learn about the servers before you can start being productive. You'll need an Astro account, and a few bash commands.
4. Completely understanding your project is nice, but not necessary
  - ▶ Professors think of complicated things way above undergrad coursework level, and grad students have similarly complicated ways to approach them

# Things I Wish I Had Known - Continued

## 5. Use git

- ▶ MARVELS and ET computers have had databank shutdown issues recently – don't risk it
- ▶ You might also accidentally delete your entire directory

## 6. Don't be afraid to ask questions

- ▶ A good professor will understand that the best way for you to make progress is to make sure you have all the information you need
- ▶ A bad professor might think asking questions means you're incapable / lazy



# Things I Wish I Had Known - Continued

7. Communicate your problems, concerns, and progress CLEARLY.
  - ▶ May be especially difficult with language barriers
  - ▶ If your exact meaning is not understood, it can cause more problems!
8. **Always CC your professor when emailing your grad student.**

# What You Get From It

- ▶ Certainly not money (unless you apply for research scholarships!)
  - ▶ University Scholars Program – Application for 2018-2019 is due in March
- ▶ A chance to do actual astronomy / astrophysics that's way above the level of your classes
  - ▶ Grad students working on highly specific projects are sometimes the world's leading experts on that topic
- ▶ Skills you didn't know you needed
  - ▶ Some practical skills are never covered in classes, ex: fits file handling, mass data manipulation, IT troubleshooting with the server, debugging code written by someone else
- ▶ Credit for AST4911
  - ▶ And the option to write an honors thesis
- ▶ If you're lucky...
  - ▶ Publications



# You're doing research? Great!

This section will be helpful if you're just starting out, or hoping to start out soon.

## 1. Get set up with an Astro account

- ▶ Forms are available with IT downstairs. You'll need your professor's signature.
- ▶ Juan is your friend

## 2. VPN

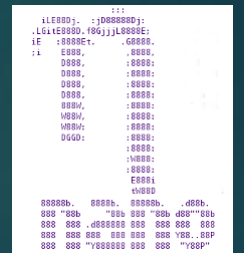
- ▶ UF requires a secure connection before using the Astro Server
- ▶ Download & run Cisco Anyconnect, connect to "vpn.ufl.edu", type in gatorlink credentials

## 3. Learn how to SSH the real way

- ▶ Depending on your version of Ubuntu, or if you're running Windows (god forbid), the command you use to start communicating with the Astro server is different
- ▶ `ssh -oHostKeyAlgorithms=+ssh-dss user@login.astro.ufl.edu`

# You're doing research? Great!

4. Set up aliases so you never have to type that crap again
  - ▶ Have an alias to SSH into UF, have an alias to SSH into your work computer, have an alias to navigate to your working directory, HAVE AN ALIAS TO OPEN YOUR DOCUMENT FULL OF OTHER ALIASES
  - ▶ I went crazy with this when I first started
5. Get familiar with the Linux command line, and find a terminal-based text editor
  - ▶ vim, emacs, nano
  - ▶ NOT: PyCharm, Atom, Spyder
  - ▶ Use a low-powered text editor to avoid system lag
    - ▶ Remember the long chain of computers you're dangling off the end of?



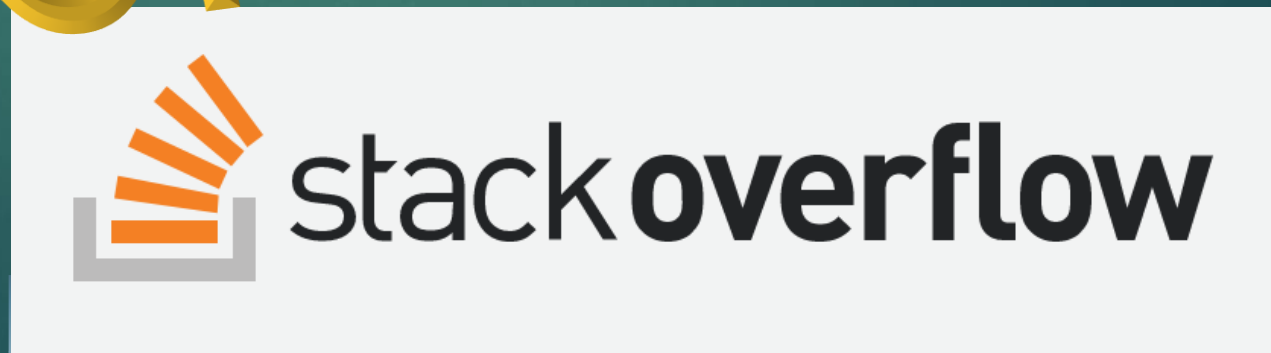
The Big Three, in all their glory

# You're Doing Research? Look stuff up!

6. Look stuff up!
7. Look stuff up
8. Look stuff up, and look stuff up
9. Things are better when you look stuff up
10. LOOK
11. STUFF
12. UP
13. GOOGLE
14. IS
15. FRIENDLY



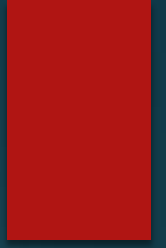
LOOK STUFF UP



Look Stuff Up

Look stuff up!

# You're doing research? Great!



## Where do I go with questions?

1. Questions about Ubuntu, Python, IDL, command line, Bash, etc.
  - ▶ All can be answered online.
  - ▶ Odds are someone has had the exact same problem.
2. Questions about directory organization in the Astro server, where the data is located for your specific project, debugging code, etc.
  - ▶ Go to your grad student (if you have one)
  - ▶ They should show you around the file structure, and show you where you can make your own working directory
3. Questions about your progress, long-term issues, and results you find
  - ▶ Your professor *probably* won't be annoyed to talk with you about these things.

# Conclusion

- ▶ It seems intimidating, but there is a long grace period while you get settled and practice the interface before you're actually expected to make progress
- ▶ If you're nervous about starting, GOOD. Go find a professor.
  - ▶ The only way to get past that feeling is to get into it.
  - ▶ It's OK to feel like an amateur. You are.
  - ▶ It's also OK to have no idea what you're doing most of the time.
- ▶ Talk to other researchers for tips and tricks! Everyone will have something useful to say, and everyone will have had a different experience.