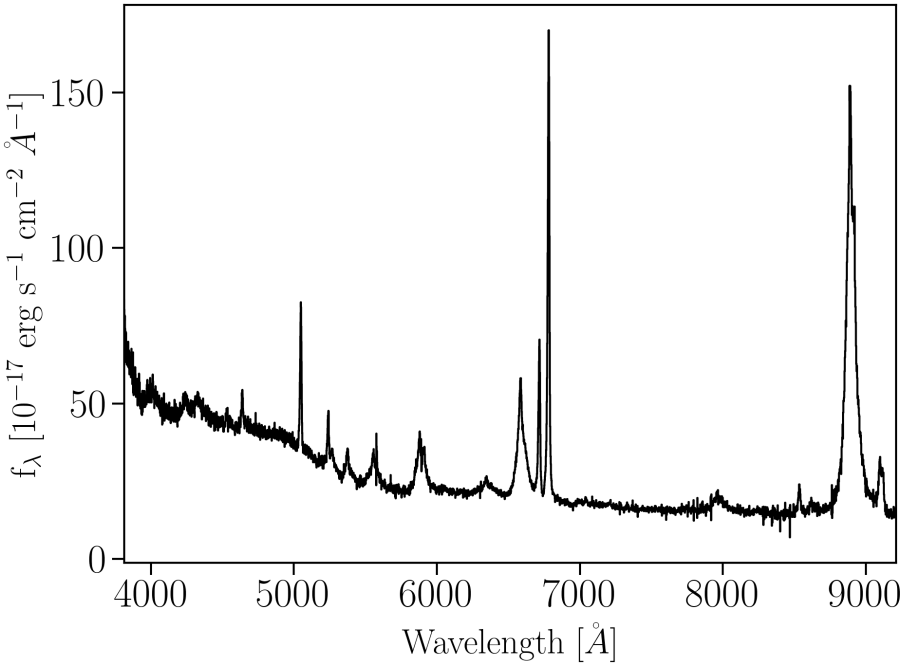
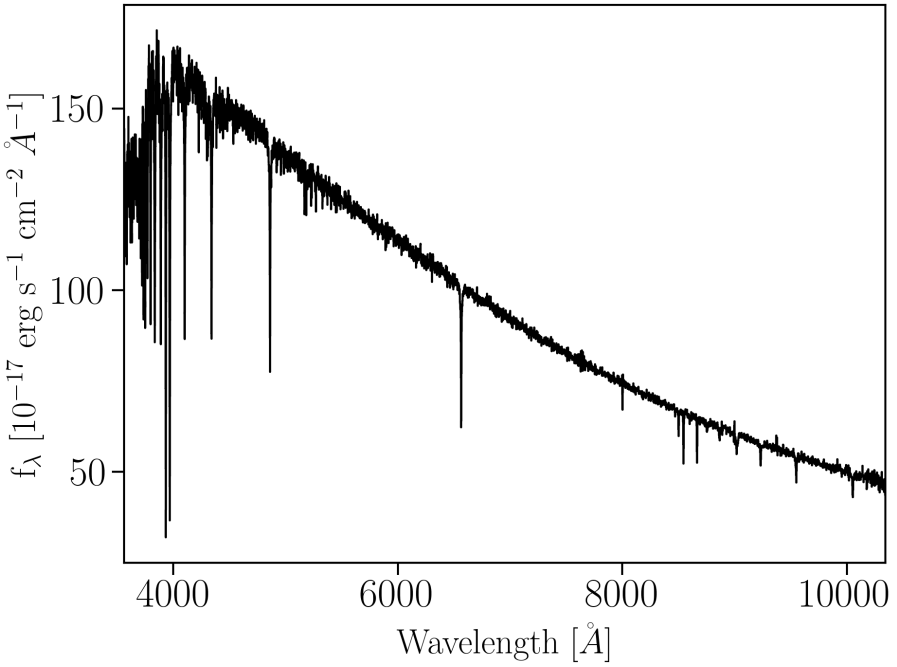
Quasar spectra from SDSS

Spectroscopy

- Spectra show electromagnetic radiation as a function of wavelength.
- They are rich in information about what emitted the continuum, emission lines, and absorption lines.



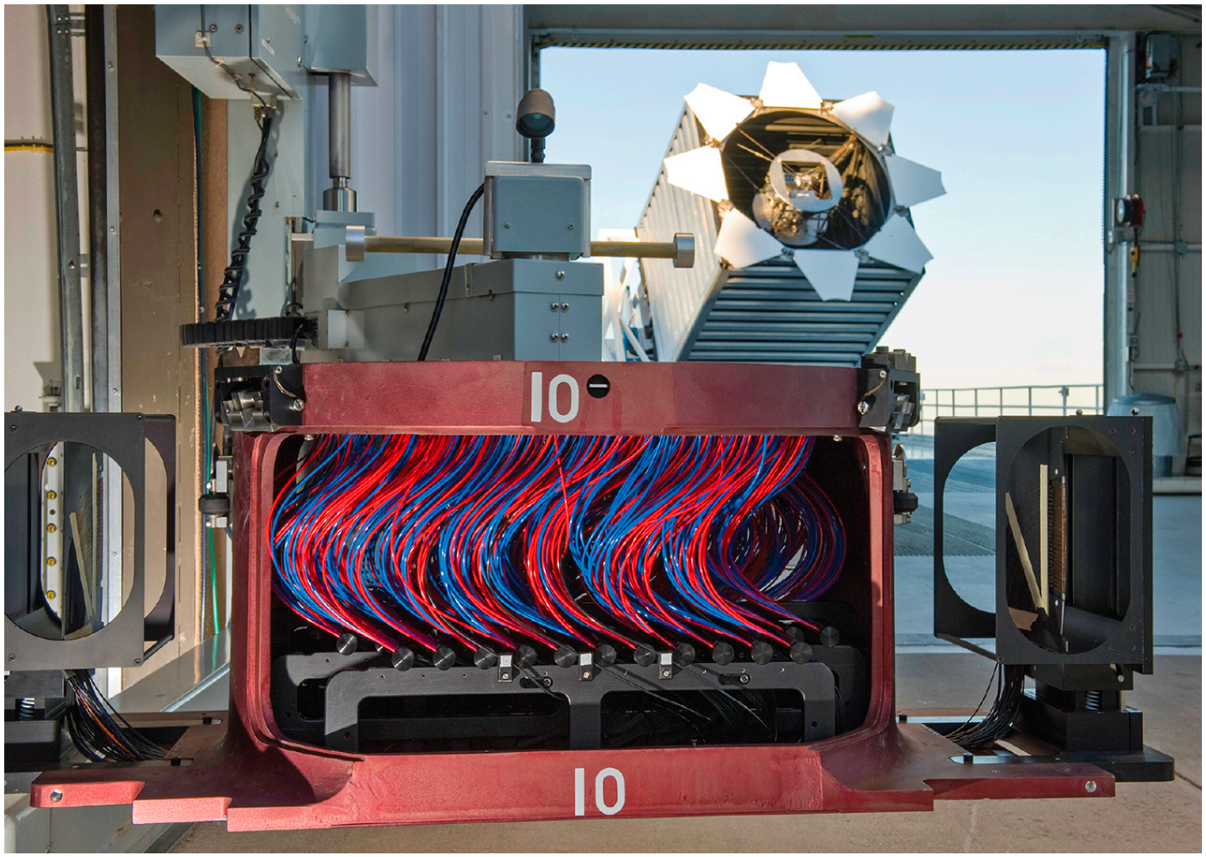
A low-redshift quasar.



A star.

Spectroscopic Follow-up Surveys

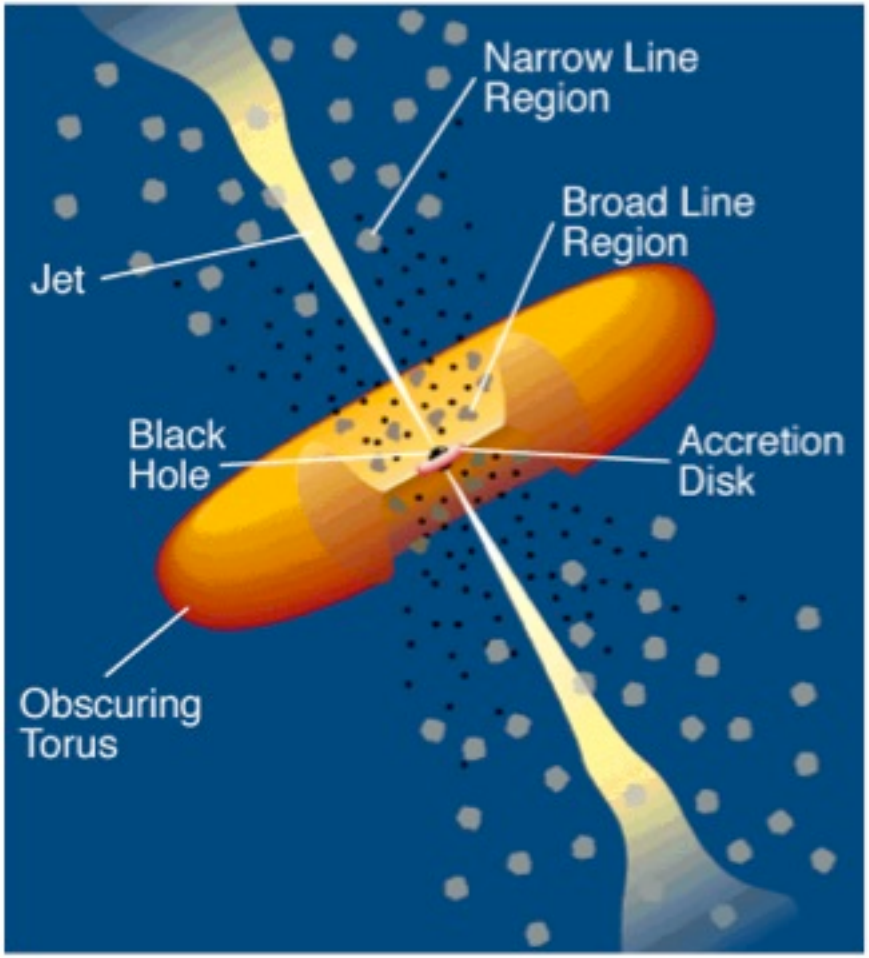
- The photometric object selection you've been doing is often used to select objects for spectroscopic follow-up.
- Photometric classification always has contamination.
- Spectroscopy is the *only* way to confirm with certainty an object's type.



Fibers from the BOSS spectrograph

Spectroscopic Follow-up Surveys

- Spectra offer much more information about objects.
- Without them, we would know nothing about the unresolved nuclear structure of quasars (for example).
- They also give precise redshift measurements using emission/absorption lines.



A cartoon of quasar structure inferred from spectroscopy and multi-wavelength studies.

Gathering SDSS Spectra

- SDSS DR16 has all the previous SDSS spectra: https://www.sdss.org/dr16/spectro/
- We'll access spectra using the SQL page: http://skyserver.sdss.org/dr16/en/tools/crossid/crossid.aspx
- Recall the SQL intro from week 7 and the tutorial in the course links.

Python tasks

1. In my week 11 directory, find the (familiar) files qsos-ra180-dec30-rad3.fits and stars-ra180-dec30-rad3.fits. These contain the RAs and DECs of known quasars and stars.
2. Write some Python code that will pull coordinates for 10 quasars and 10 stars randomly from these files (the *np.random.randint* function may be useful).
3. Output one test RA and DEC to familiarize yourself with running a query here: http://skyserver.sdss.org/dr16/en/tools/crossid/crossid.aspx
   - Select the *spectra* search, *Nearest primary,* and *RA DEC* options. Also check the *Join with images* box so we can pull photometric data.

Python tasks

- Write an SQL query to pull the spectroscopic ID (*specobjid)*, RA, Dec, spectroscopic redshift, and *mjd, plate, fiberid* of your objects. Also get *ugriz* PSF magnitudes (*psfMag_u, psfMag_g*, etc.) from the linked imaging.
- Return values as a .fits file for later use, then return your results in HTML.
- Click the "submit" button to upload your list to the Science Archive WebApp (SAW). If you do not see a button, upload it yourself at: https://dr16.sdss.org/optical/spectrum/search
- Explore the info the SAW returns. You can see an object's explorer page, look at the spectrum, etc.

Python tasks

- Download the wget script to download the fits files.

4. Write a Python function (see hints in my week 15) to take RA and DEC for your list of objects, collect their spectral and photometric information, generate a wget script, and download the fits files. Don't add fits files to Git!
   - Note different URLs for low and high plate numbers.
5. Write some code to read in the fits files and plot hardcopies of the spectra. Note the flux units of the data, which are given in the image header in extension 0.
6. Look through your spectra. What is different between the stars and spectra. If you didn't already know the classifications, could you classify them?

Things you may need to install

- The mechanize Python package. There are two options, try them in this order:
  - conda install mechanize
    pip install mechanize
- The pandas Python package. Try the same two options:
  - conda install pandas
    pip intall pandas
- The UNIX wget command. Check if you have it by typing “which wget” in the terminal. If you do not, you can install with Macports (or Homebrew):
  - https://www.macports.org/install.php
    sudo port install wget
    Add /opt/local/bin/ to your path