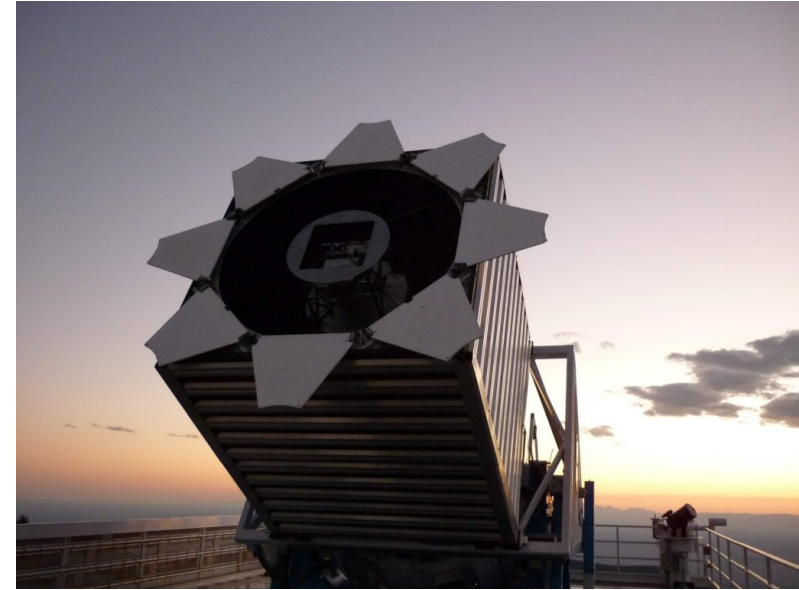


# Introduction to the SDSS

Plates for  
Education  
Scotland  
Teaching Activity

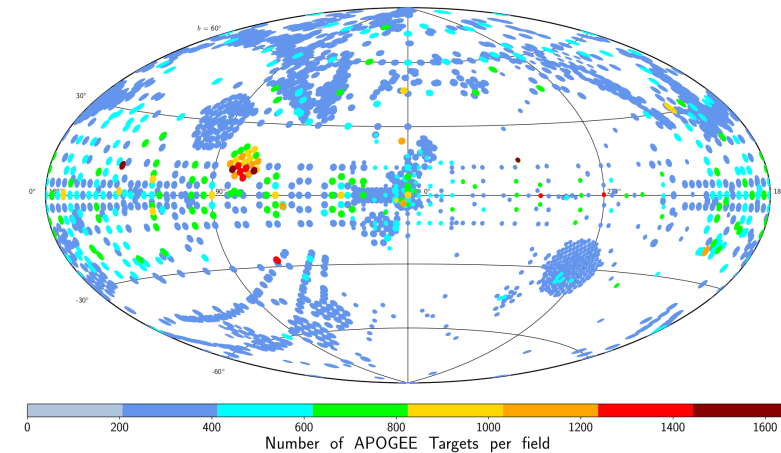
# Sloan Digital Sky Survey

- Survey to collect, store and process information from millions of astronomical objects
- Collect images and spectra using the Sloan Foundation telescope at the Apache Point Observatory
- Astronomers use this data such as images and brightness collected by the telescope to classify objects and calculate their distance to us



# SDSS Phases

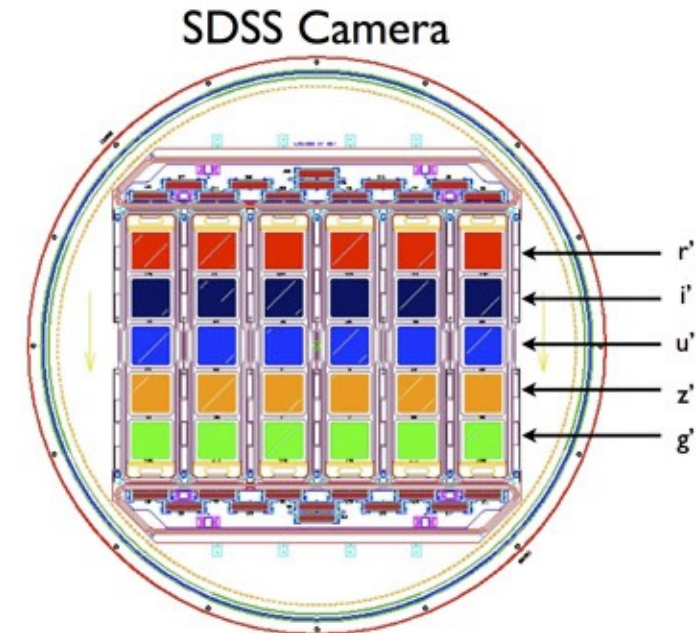
- The SDSS has gone through 5 phases from the 2000 to the present
- The most recent phase is SDDS-V which started in 2020 included 3 surveys:
- **APOGEE** (Apache Point Observatory Galactic Evolution Survey): mapped the Milky Way stars to better understand how our galaxy formed and evolved.
- **MaNGA** (Mapping Nearby Galaxies at APO): produced spectra measurements across the entire face of many nearby galaxies.
- **eBOSS** (Extended Baryon Oscillation Spectroscopic Survey): maps galaxies and quasars from when the universe was 3 to 8 billion years young!
  - This period helps scientists understand dark energy and how it affects the expansion of the universe.
- The data from all five phases amounts to mapping one third of our sky



This image shows the field coverage from APOGEE alone

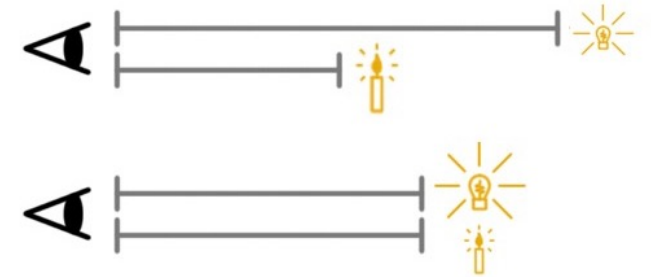
# Imaging

- Camera attached to the telescope with five filters at different wavelengths
  - Wavelength – distance between two successive crests of the light wave
  - Filter – special coloured glass that only allows light of a specific wavelength range to shine through
- Filters shown to the right are:
  - r - yellow and red visible light
  - i – infrared light
  - u – ultraviolet light
  - z – near infrared
  - g – blue and green visible light



# Imaging

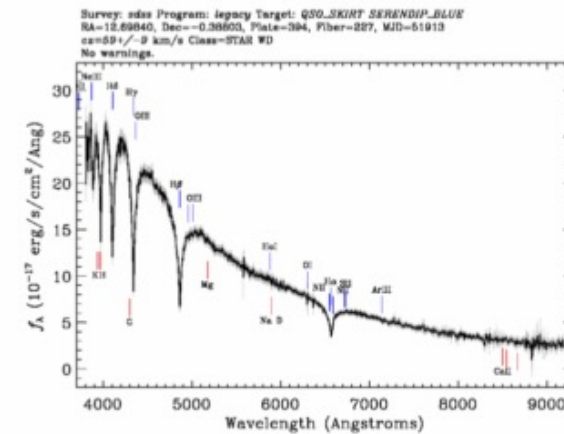
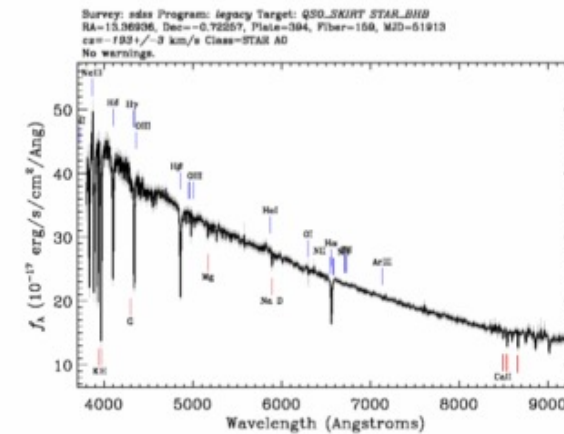
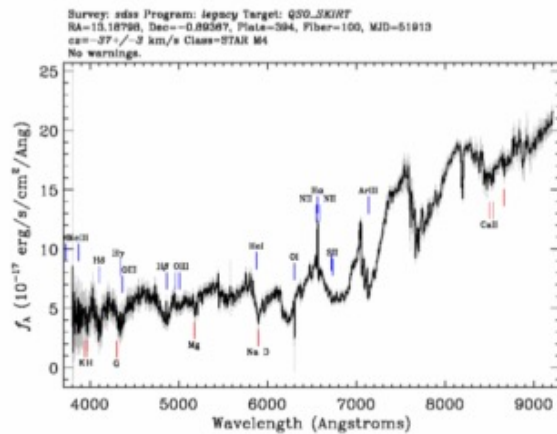
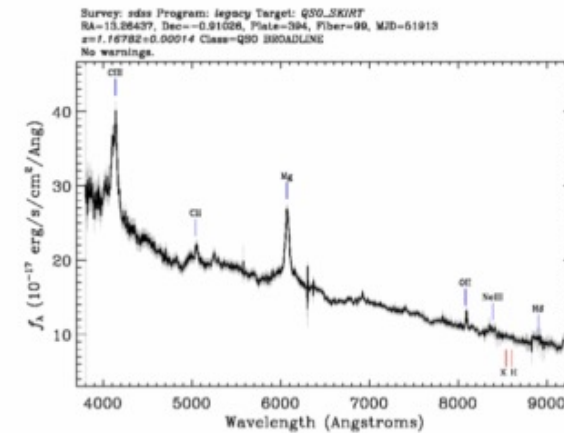
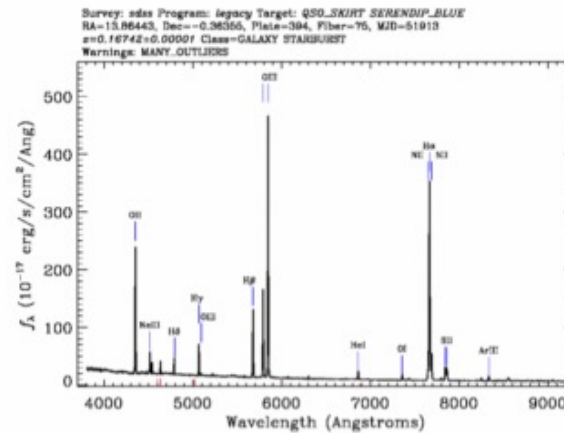
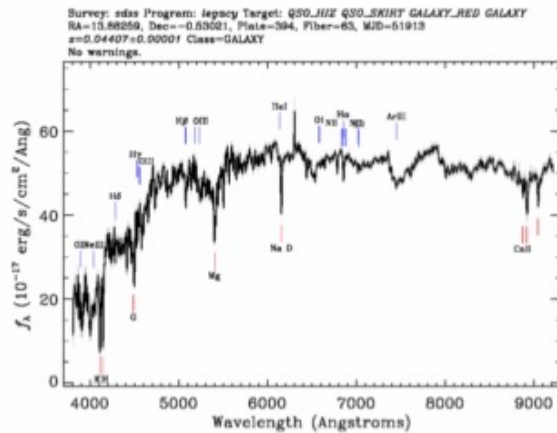
- The camera measures the amount of light passing through each filter
  - Light intensity relates to brightness of the object being observed
- Magnitude is a measure of brightness
  - **Apparent magnitude** – is a measure of how bright something appears to be from our perspective on earth
  - **Absolute magnitude** – how bright the object would be at a standard distance away from us.
- Magnitudes are measured with a reversed scale, the brighter the object the smaller the magnitude



The light bulb is **brighter** than a candle when they are seen from the **same distance**. However, the candle and bulb can appear to have the **same brightness** if the light bulb is **further away**.

# Spectroscopy

As well as taking images of objects, the camera is used to take their spectra

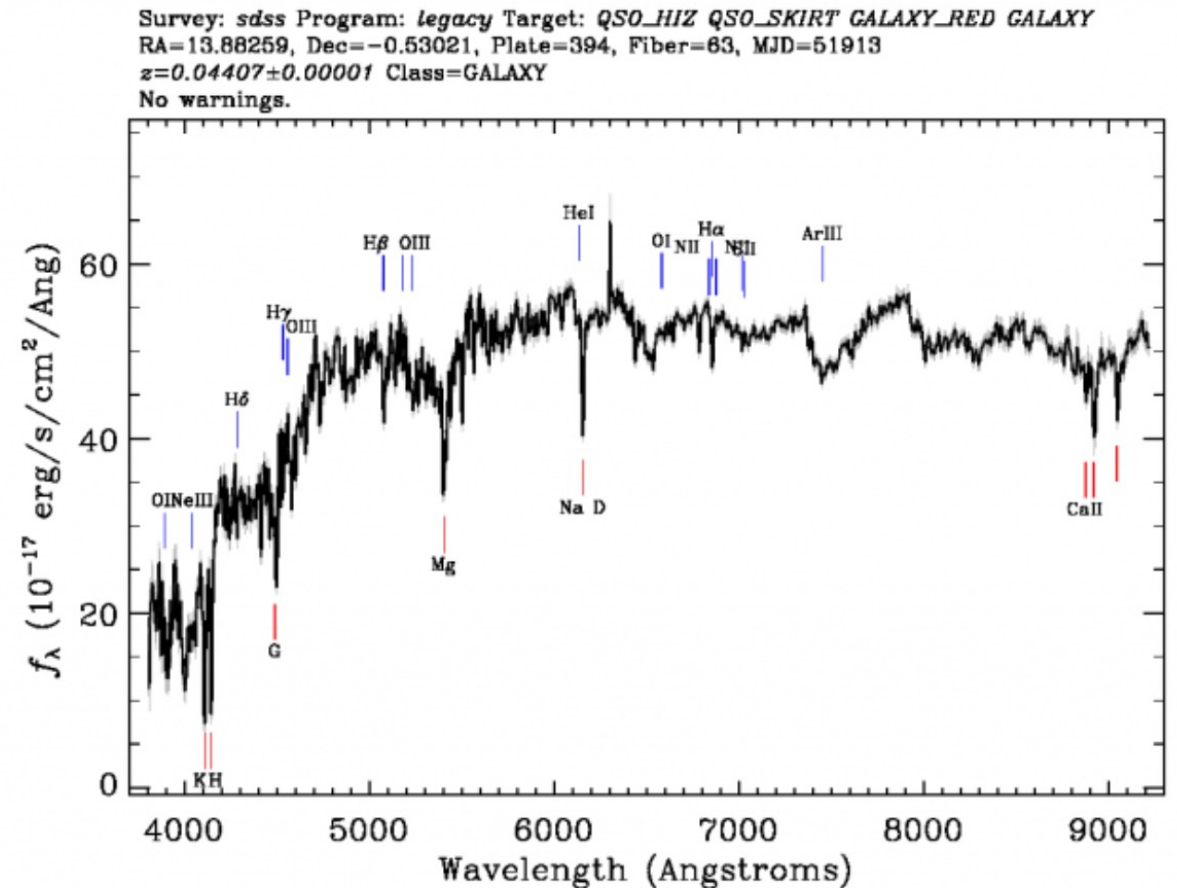
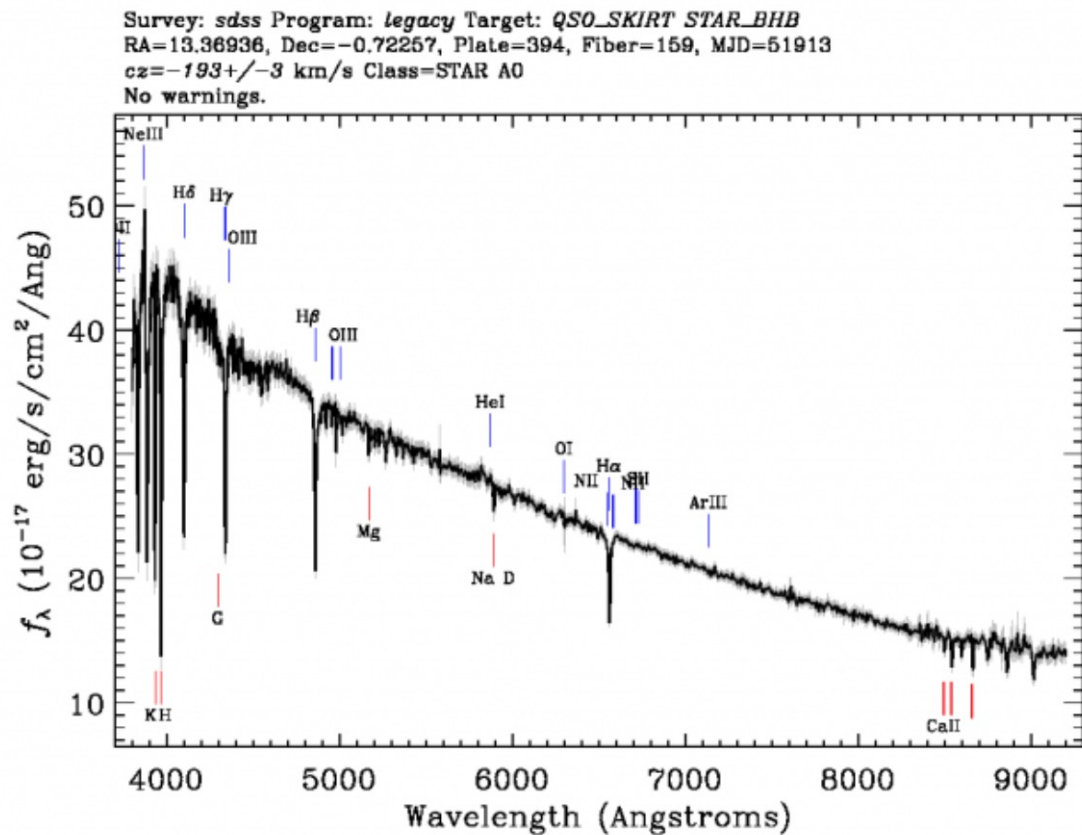


# Spectroscopy

- A Spectrum is a graph of intensity against wavelength
- It helps astronomers classify objects and learn more about their chemical composition
- Features:
  - **Continuum** – every object produces a continuous spectrum with some light emitted at every wavelength. However, no spectrum is completely smooth
  - **Absorption lines** – dips in intensity at certain wavelengths create lines that fall below the continuum. These are wavelengths where light has been absorbed by gas or dust that is between us and the source of light.
  - **Emission lines** – peaks in intensity above the continuum. These are wavelengths where light has been emitted by hot gas.

# Spectroscopy

Can you list the differences between the spectra below?





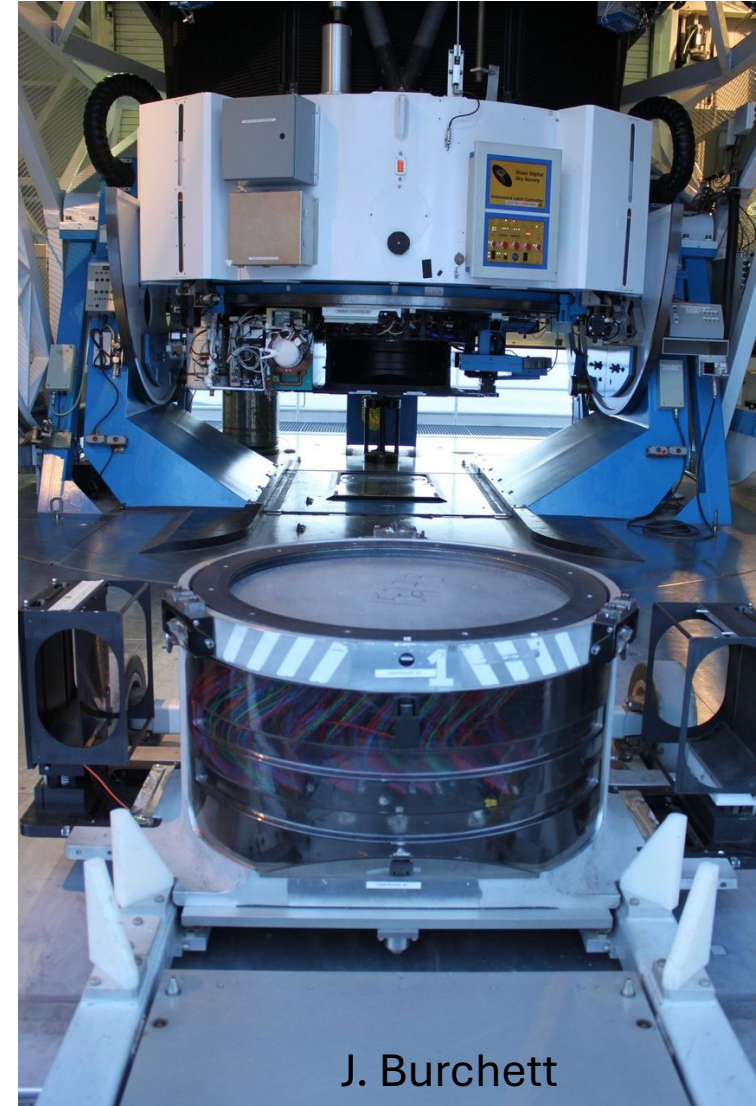
# Plates

- To obtain the spectra of many objects at once the SDSS produced specially drilled aluminium plates with 1000 holes, to capture light from 1000 objects at a time
- The plates are meticulously drilled so that the holes correspond exactly to the positions of the target object
  - The plates act as a mask to stop light from other sources



# Plates

- Each plate is placed on the focal plane of the telescope and each hole is attached to a fibre optic cable
  - The light coming from each object passes through the corresponding hole and into each cable
- After the plate is used and all the necessary data is obtained it becomes useless
  - The SDSS had to drill thousands of plates to cover 1/3 of the sky and millions of objects
- After plates are used, they are given to schools and used for educational purposes!



J. Burchett