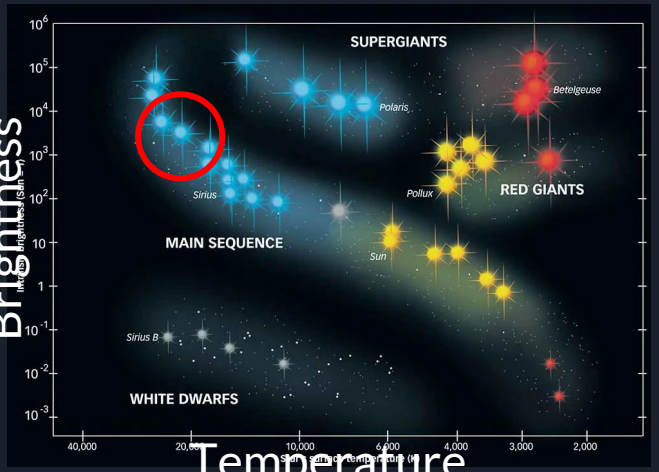
Interstellar Polarization and Be stars

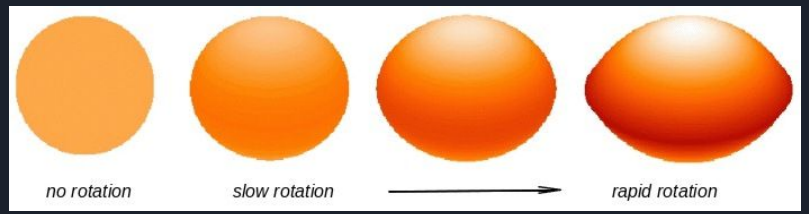
PRESENTATION: ~~ERICK POWELL~~ **Rochelle Horanzy**

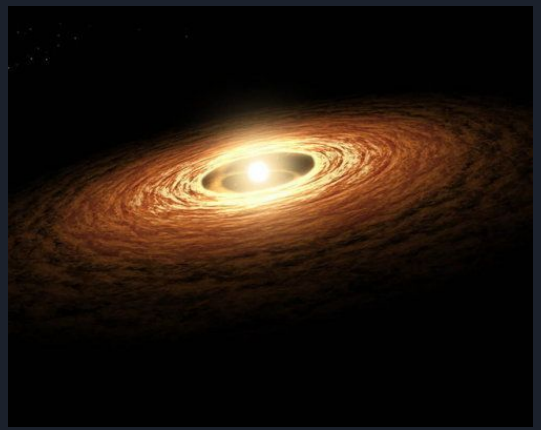
GUIDANCE: DR. WISNIEWSKI

B Stars and Be Stars



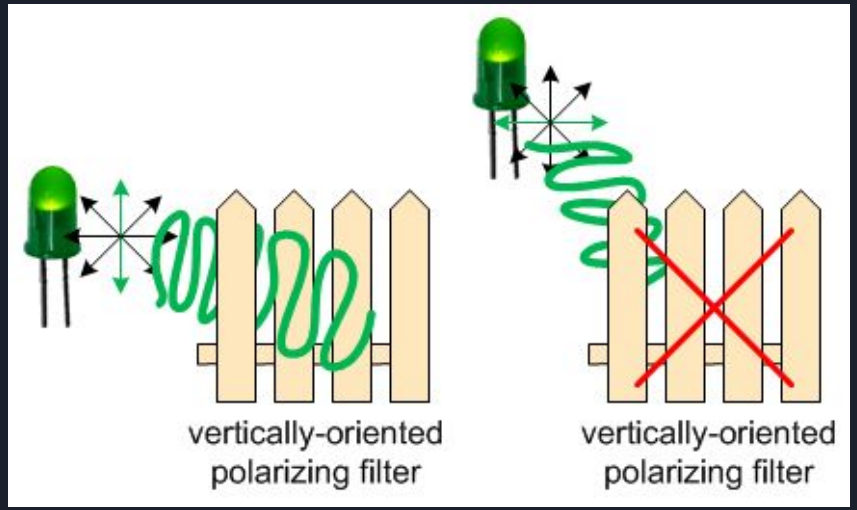
- Be Stars = B stars with H-alpha lines
  - Hydrogen Emits photons at 656 nm
- Very rapid rotation (fastest = 1000+ rev/sec)
- Surrounding disk made of dust, gas, etc.
  - Unstable, “decretion” disks
  - Formation process unclear





Polarization

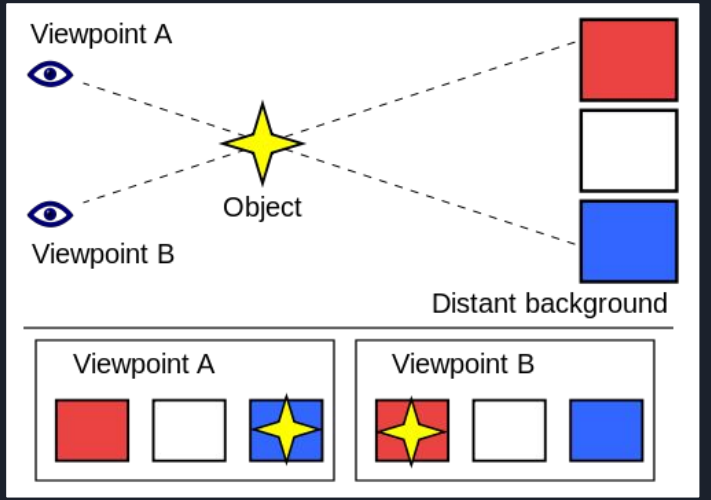
- Unpolarized light = light that oscillates in all directions
- 4 Stokes Parameters (polarizing filters)
  - 1 for unpolarized light, approx. half of the light
  - 2 for linearly polarized light
  - 1 for circularly polarized light



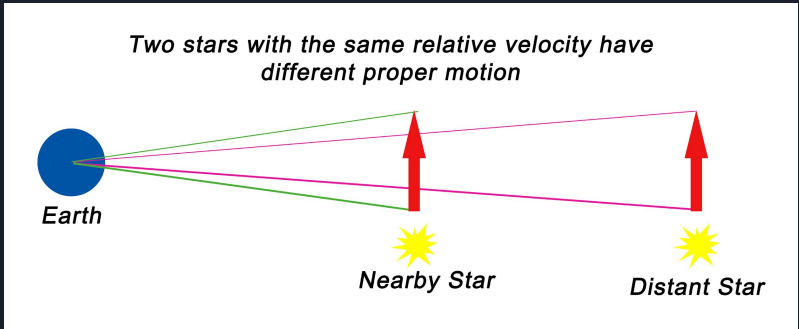
- Polarized light -> object surrounded by space materials
  - Tells us about materials of circumstellar disks
  - Compute interstellar magnetic fields
  - Measure cosmic microwave background

Parallax and Proper Motion

Parallax: The effect that happens when an object in space is viewed from different angles



Proper motion: The “actual” motion of an object in space, relative to the sun



Together, these two measurements tell us if stars are in the *same* cluster

What's the Point?

- Gather data on clusters with Be star candidates
- Allows us to see how circumstellar disks evolve
- Physics applicable to other astronomical phenomena:
  - Star formation
  - Accretion disks and quasars
  - Protoplanetary disks

How Was This Done?

1. Take ground-based imagery of a cluster
    a. 17 clusters + 1 double cluster
    b. Each cluster observed over multiple dates
    c. Each date has 4 filters: B, I, R, V - correspond to colors
2. Convert the x- and y-coordinates, in each file, to right ascension and declination using IRAF
    a. ra~~x-coordinate, dec~~y-coordinate
3. Cross-match to GAIA catalog to get proper motions and parallaxes
4. Create q vs. u scatter plots to determine the interstellar polarization

What Was I Working With?

NGC663

NGC6530

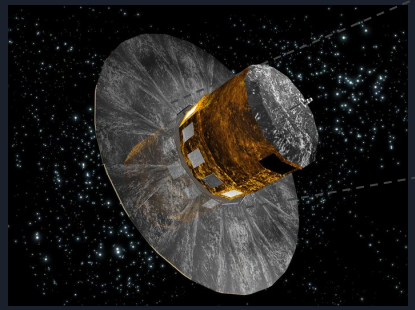
Observation files with x- and y-coordinates, 2 Stokes' parameters ('q' and 'u'), other information

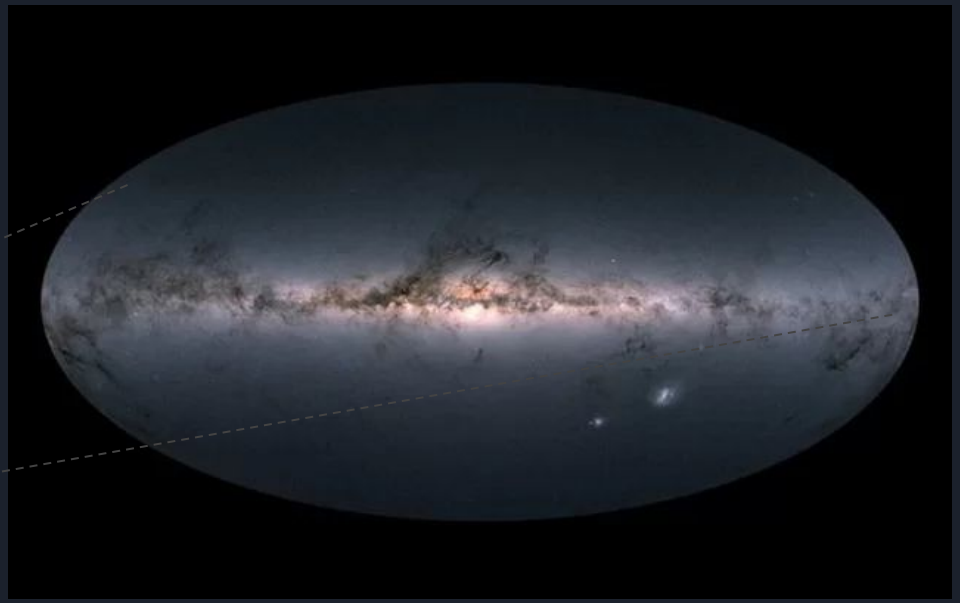
IRAF

IRAF is a software system used to reduce and analyze astronomical data

Convert the x- and y-coordinates to right ascensions and declinations

GAIA

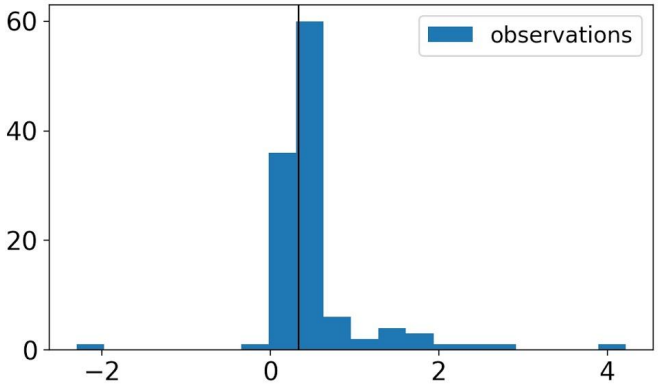


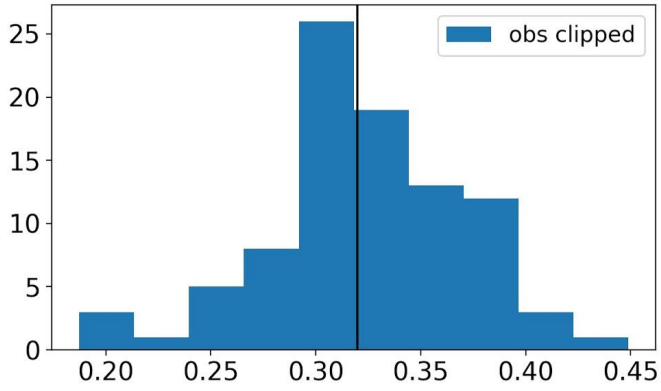


- A satellite used to create a precise 3D map of about 1 billion stars throughout our galaxy and beyond
- Plug files with ra and dec into GAIA
- GAIA gives corresponding parallax, proper motion, photometry, and much more

Parallax Cuts

- Cut outliers to get a better range of parallaxes/find out which stars are within the cluster
- Use sigma_clip to cut out points more than 2.5 sigma from median





Measure Interstellar Polarization

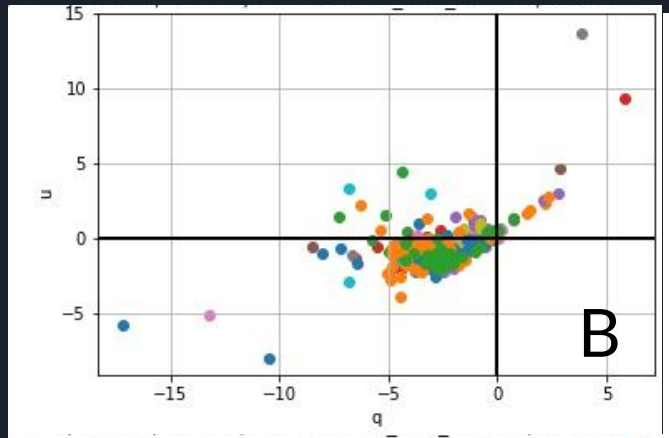
Ideally:

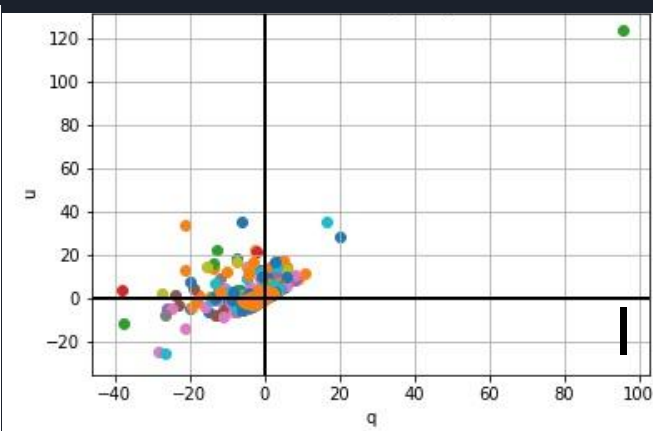
Generate a vector that would point from the origin to the center of the cluster

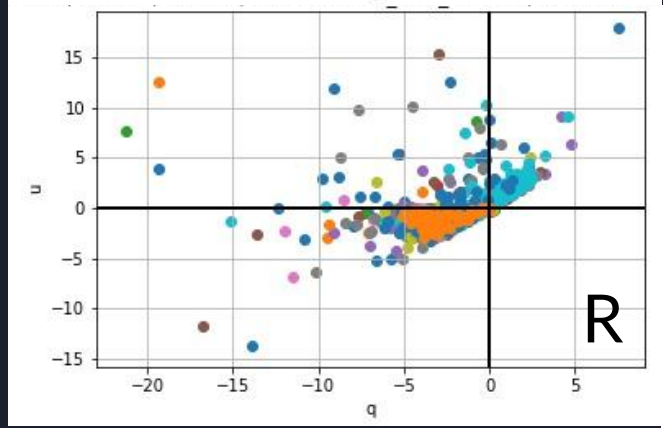
- V filter shows ideal

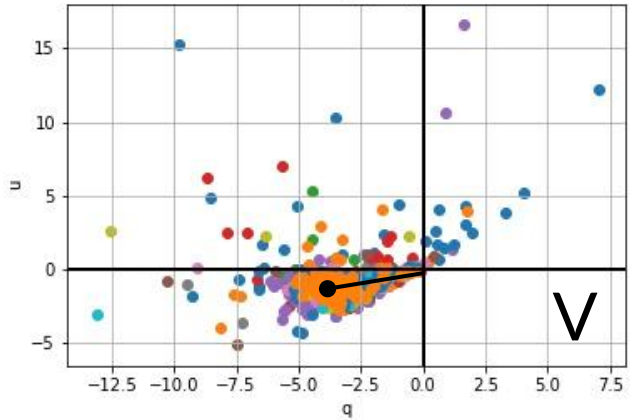
Reality:

Points are everywhere





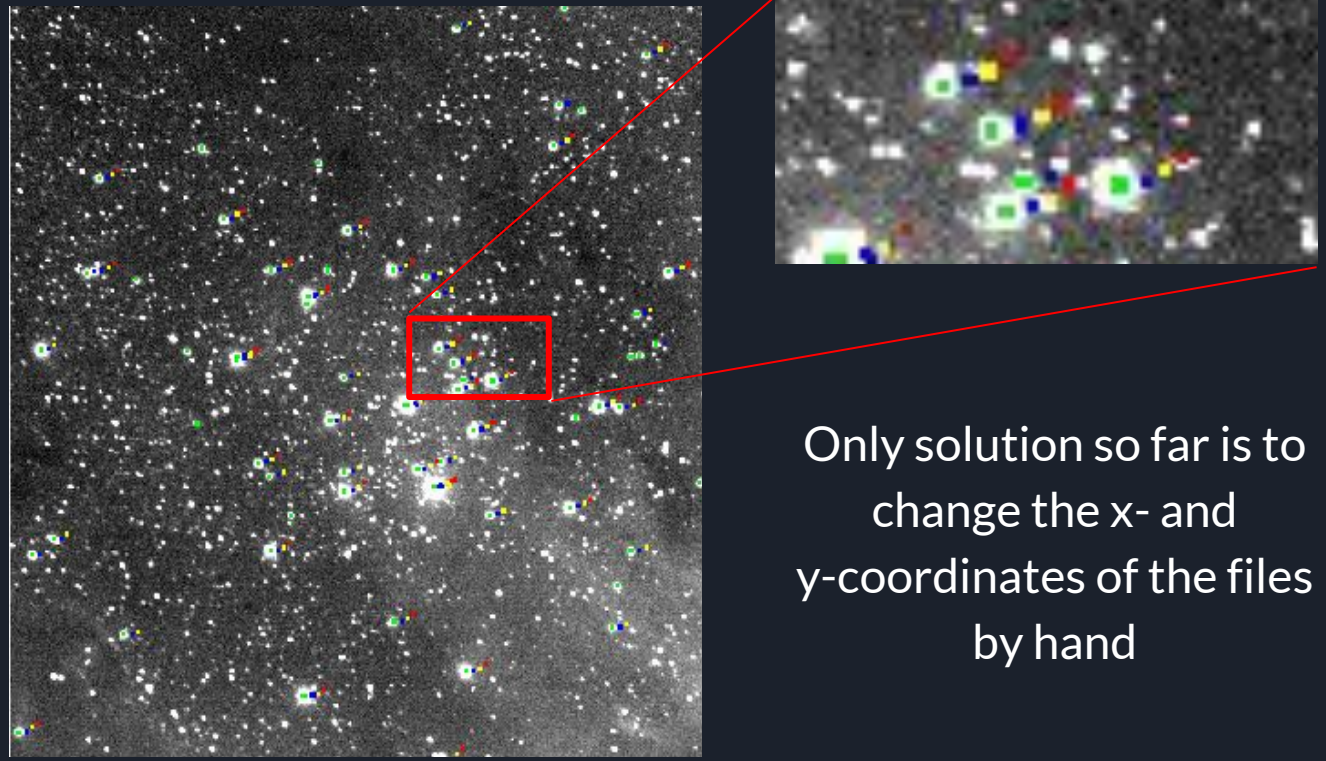




A Big Pain in my Astrometry

Only one filter overlays properly

This creates errors that propagate into everything we do



Only solution so far is to change the x- and y-coordinates of the files by hand

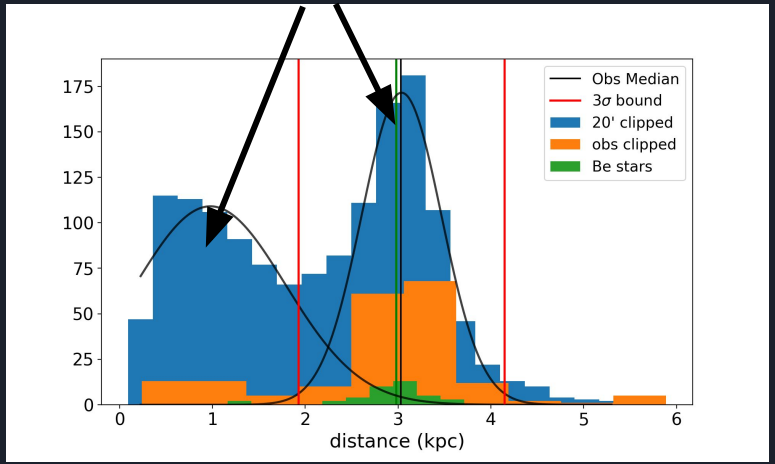
Compare Distances (Not Parallaxes) With Other Data

Distance more helpful than parallax because we can use that to be certain the stars are in the same cluster

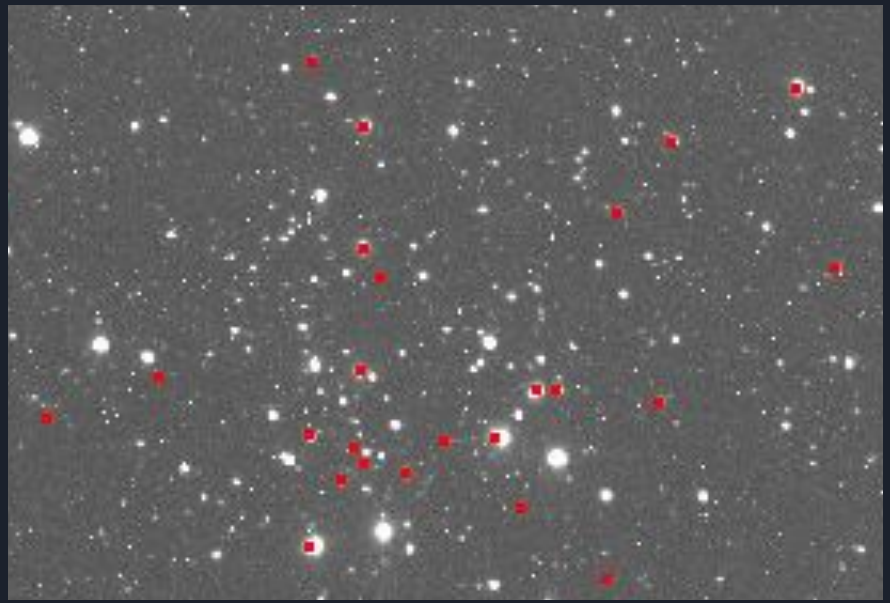
1. Gaia - ra: 26.5, dec: 61.25, 20 arcminute radius
2. 1 date from NGC663
3. Paper by Yu et al with Be star candidates in NGC663

Histograms show that there could be numerous stars not within cluster

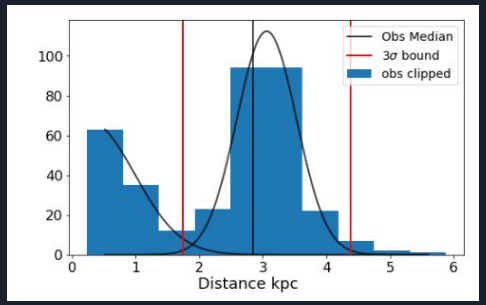
Bimodal Distribution

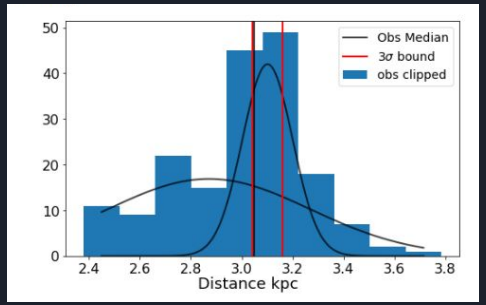


Work on the Side



- Compare NGC663 with more coordinates found in literature
  - Close matches!
- Work with other Be star candidates near NGC663 identified by photometry
  - Half of the sources in files did not match to Gaia -> half within cluster, half coincidentally located



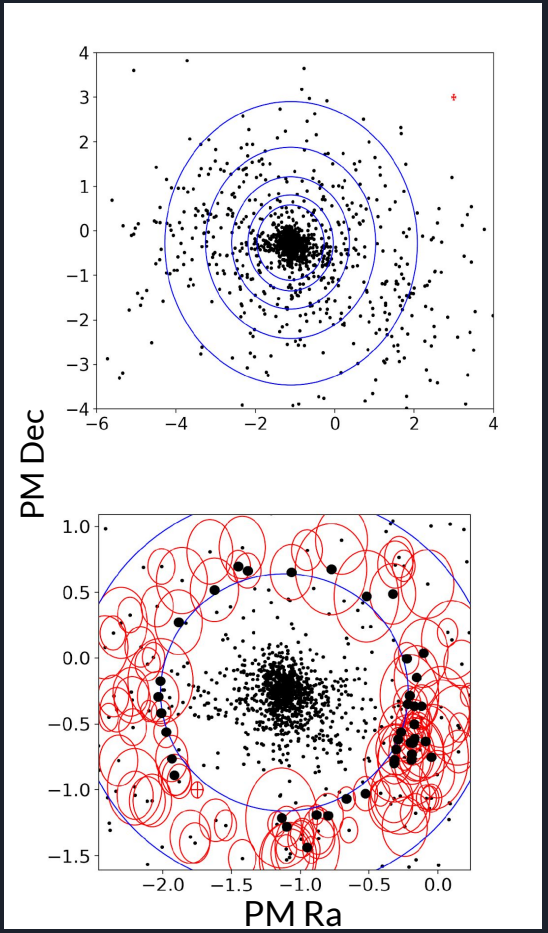


Future Plans

Need proper motion cuts as well as parallax cuts to fully determine which stars are within the clusters

- Top: circles around median values, sigma clip
- Bottom: red circles=error bars, if within inner circle then could be within cluster

15 other clusters that will need to be analyzed



Summary

The goal of the research:

- Get interstellar polarization of different clusters to see how circumstellar disks change over time

Challenges:

- The coordinate lists need to be offset
- Distances and proper motions of our cluster need to be properly calculated


Any questions?