

The Stellar Content in Bulges of Spiral Galaxies

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Outline

- Overview of Spiral Galaxies
- Objectives of this Project
- Results
- Summary and Future Work

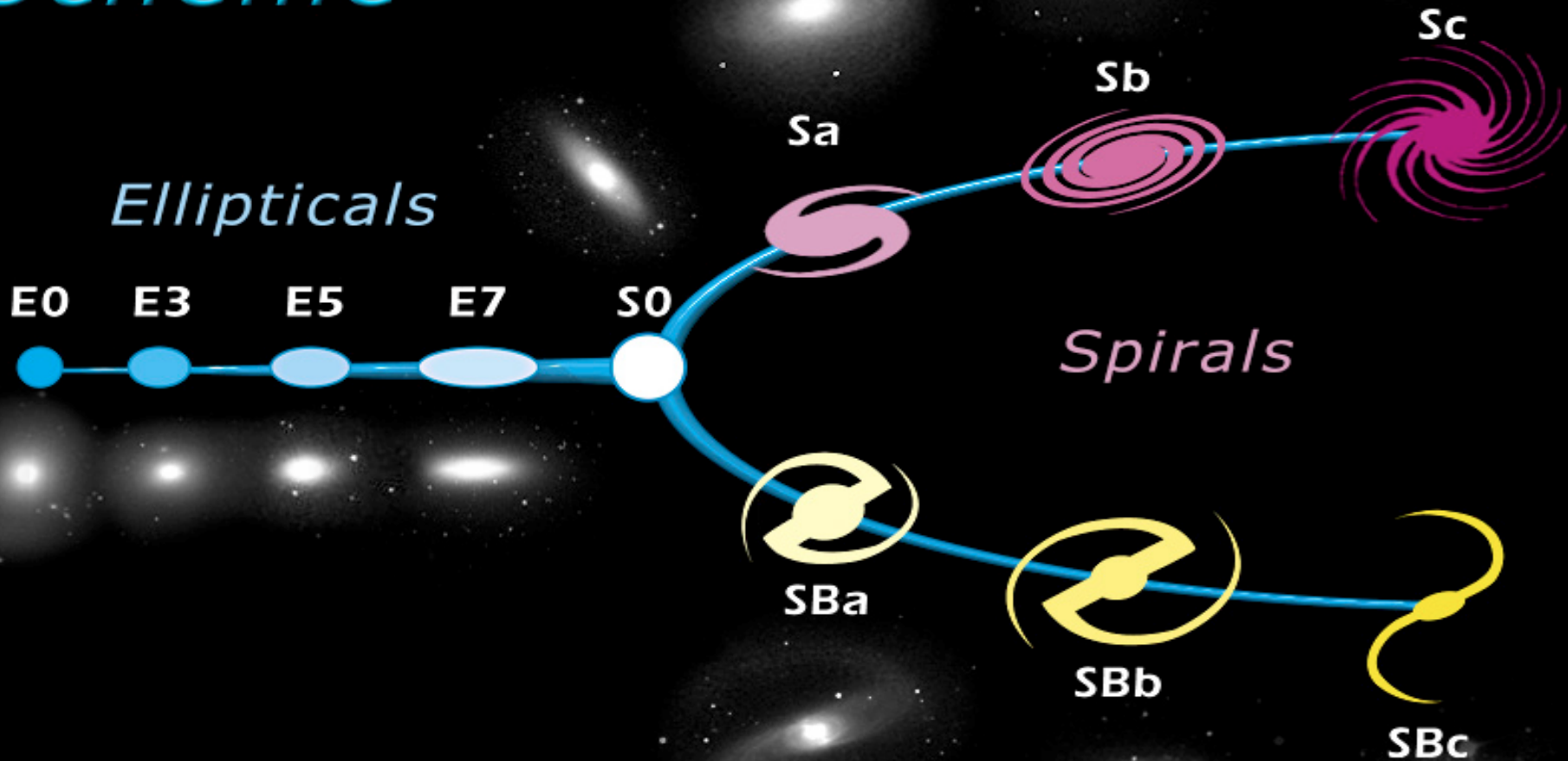


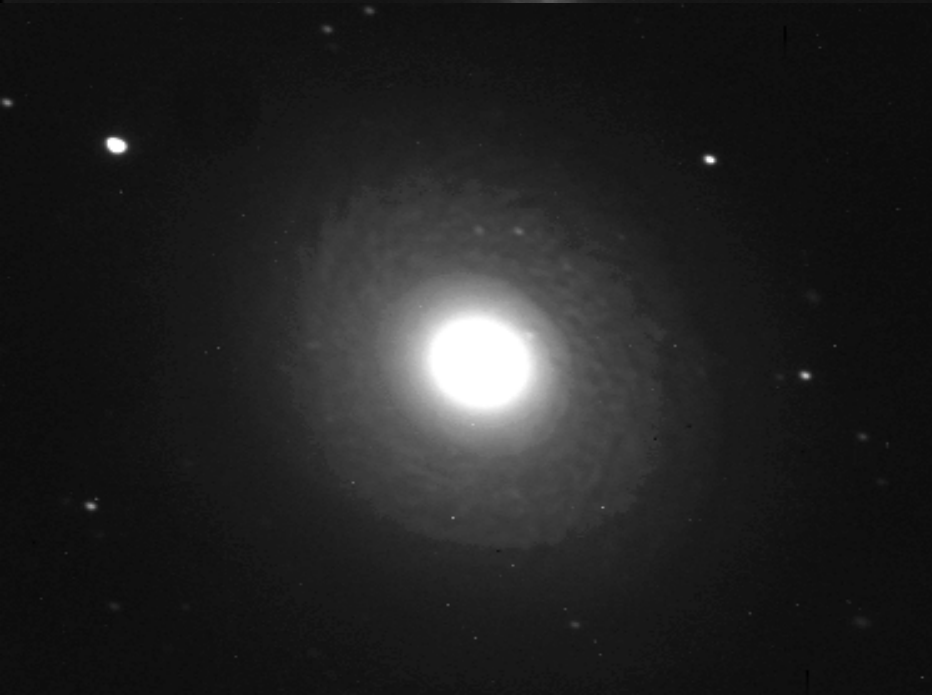
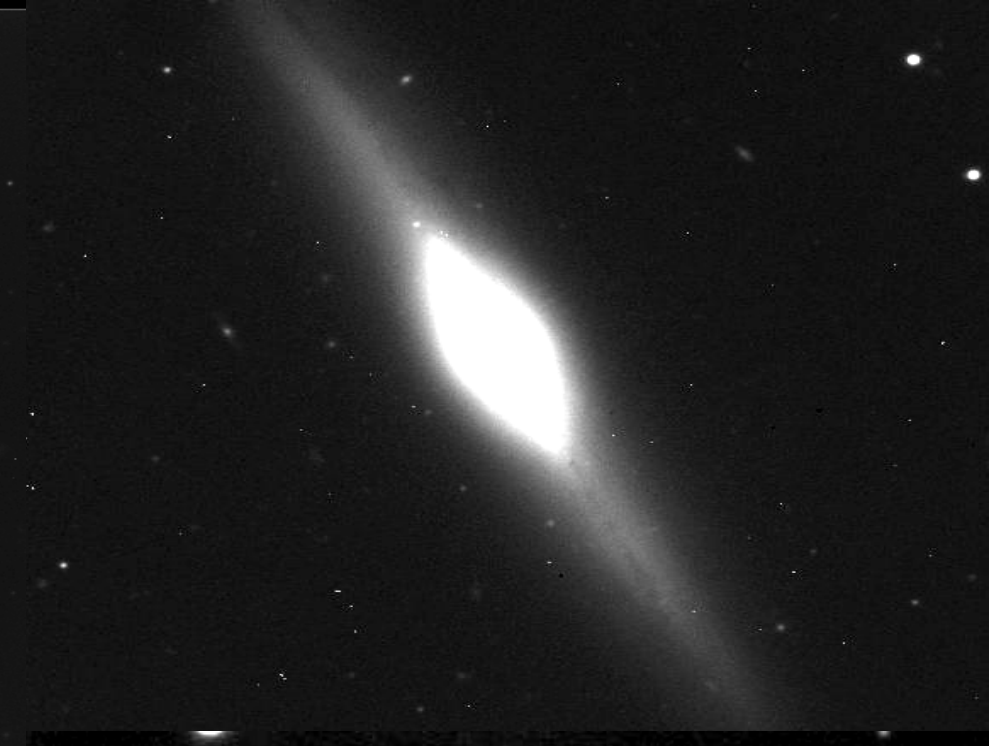
Spiral Galaxies

- One of three galaxy types, along with Ellipticals and Irregulars
- Contain a disk, a central bulge and spherical halo
 - The size of the bulge decreases along the “Hubble Sequence”
- Disks are “young” (5 Gyr) and halos are old (10-13 Gyr)
 - There is ongoing star formation in disks but not in halos
- But we’re not sure about bulges
 - Traditionally believed to be old due to redness
 - Reddening could be due to other factors such as dust and metal abundance
- Understanding the nature of bulges is essential in order to figure out how galaxies form and evolve



Edwin Hubble's Classification Scheme





Project Objectives

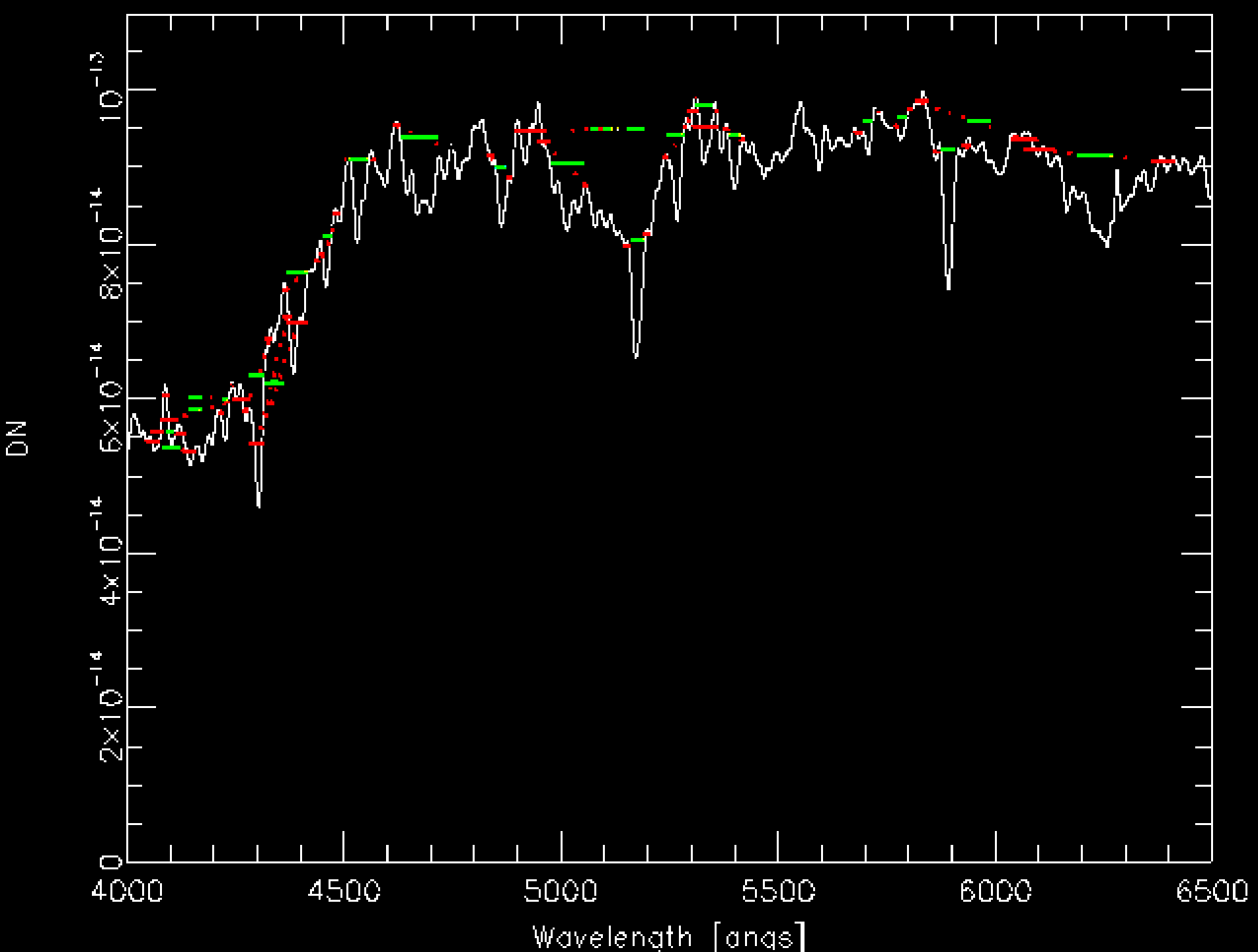
- Understand the nature of the stellar content in bulges
 - Measure the strengths of absorption lines in bulge spectra
 - Translate the line strengths into ages and abundances using spectral synthesis models
- Determine the relationship between the stellar content and other galaxy properties (size, shape, rotational and random motions)
- Constrain formation mechanisms for bulges and galaxies in general

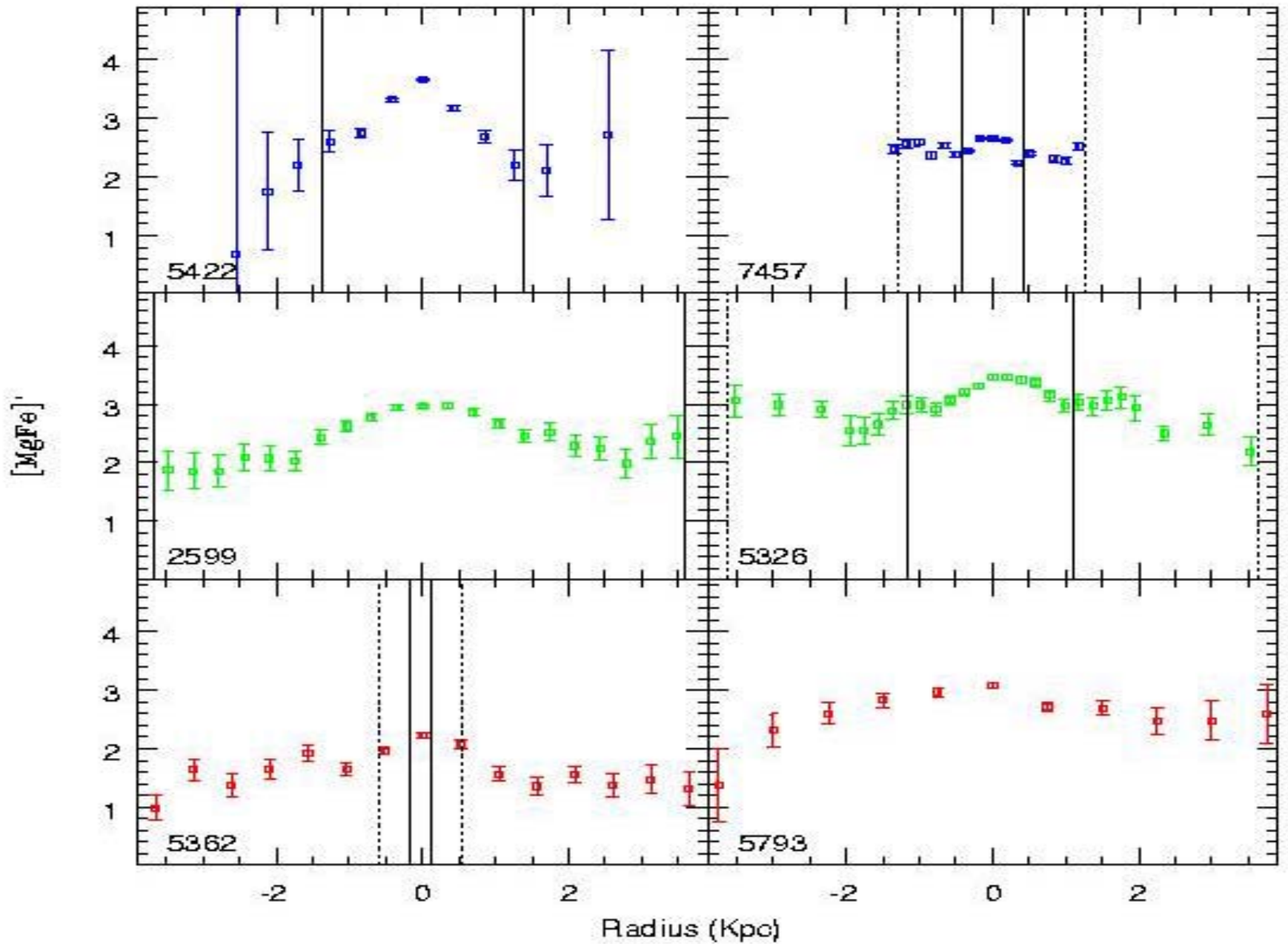


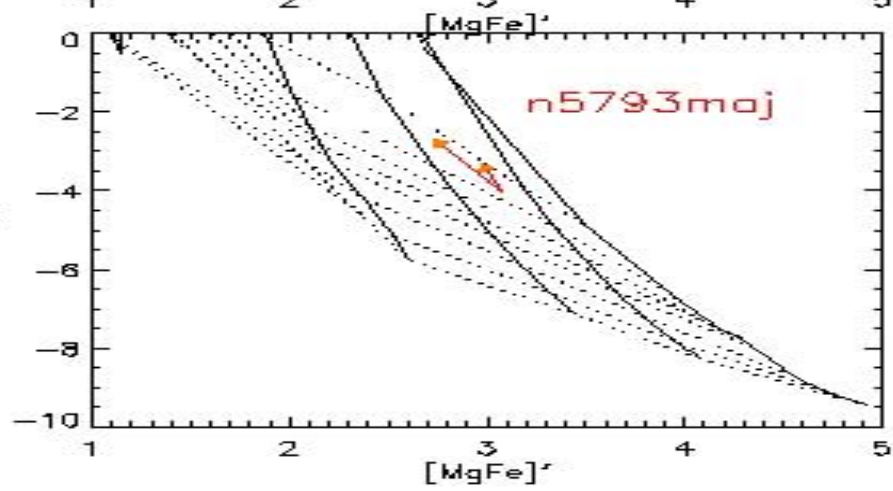
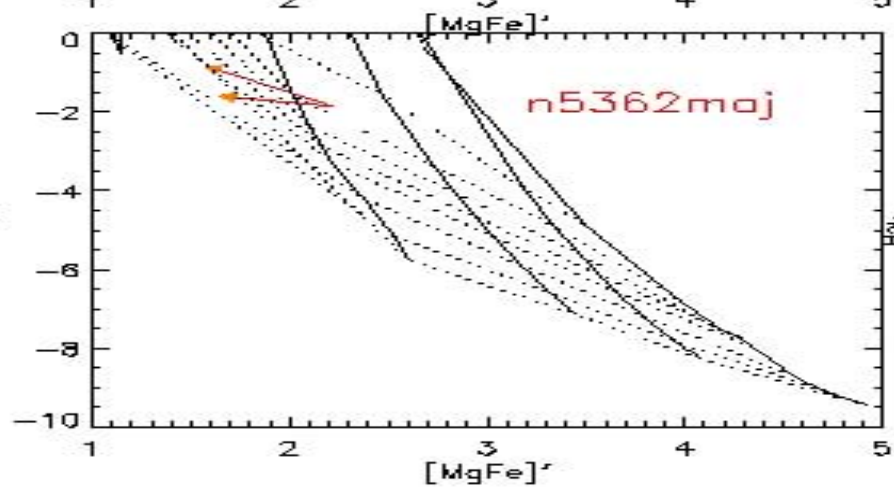
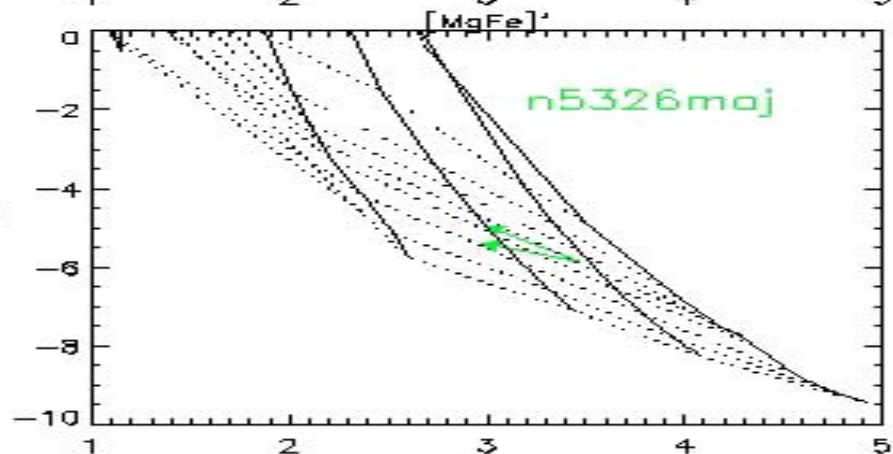
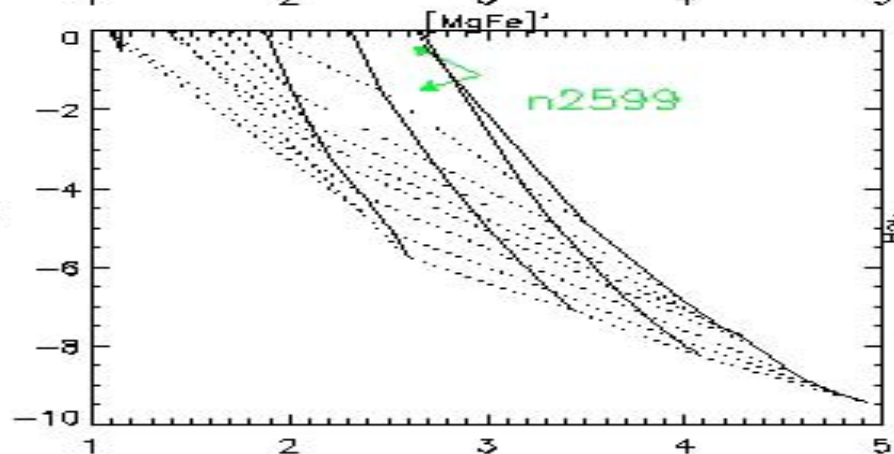
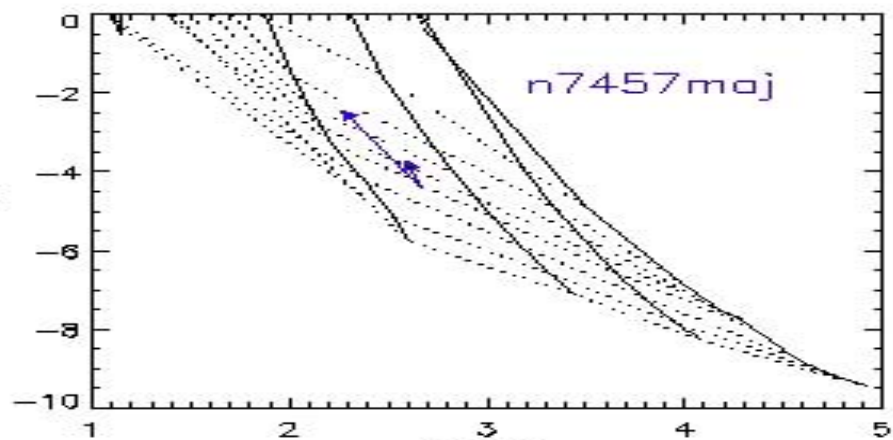
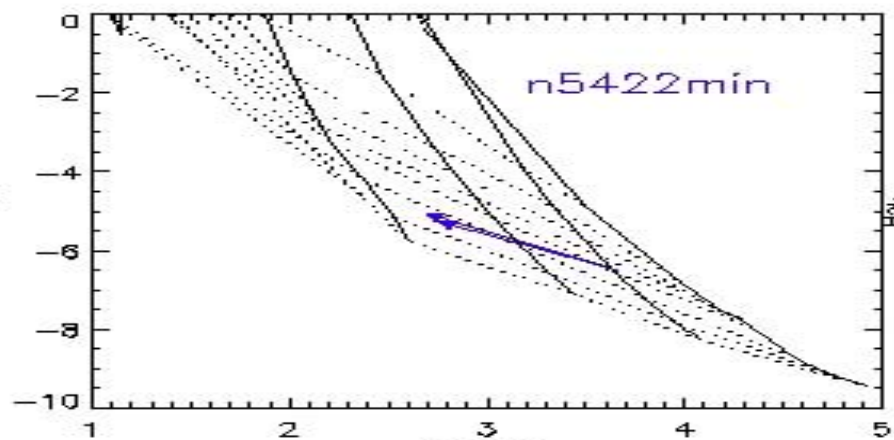
Bulge Formation Models

- Formed in the early universe through a massive starburst
 - Could be due to the collapse of a gas cloud or mergers of disk fragments
 - Bulge stars should be old, metal-rich, and have metallicity gradients
- Form gradually from instabilities in the inner disk
 - A bar forms in the inner disk which then disintegrates into a bulge
 - Bulge stars should be similar in age and metallicity to disk stars









Summary

- Most large (“early-type”) bulges are old, metal-rich, and have strong metallicity gradients
 - Consistent with primordial formation
 - Of the three exceptions, two show kinematical evidence of bar-induced formation
- As we move to later types, the age and metallicity decreases
 - Likely to have been formed through bar instability
 - Here also there are exceptions! Need to study kinematics in more detail
- Overall, results consistent with all bulges having a primordial component with some late types having an additional young component
- Future Work: Conduct a less detailed study on several hundred thousand bulges using data from the Sloan Digital Sky Survey

