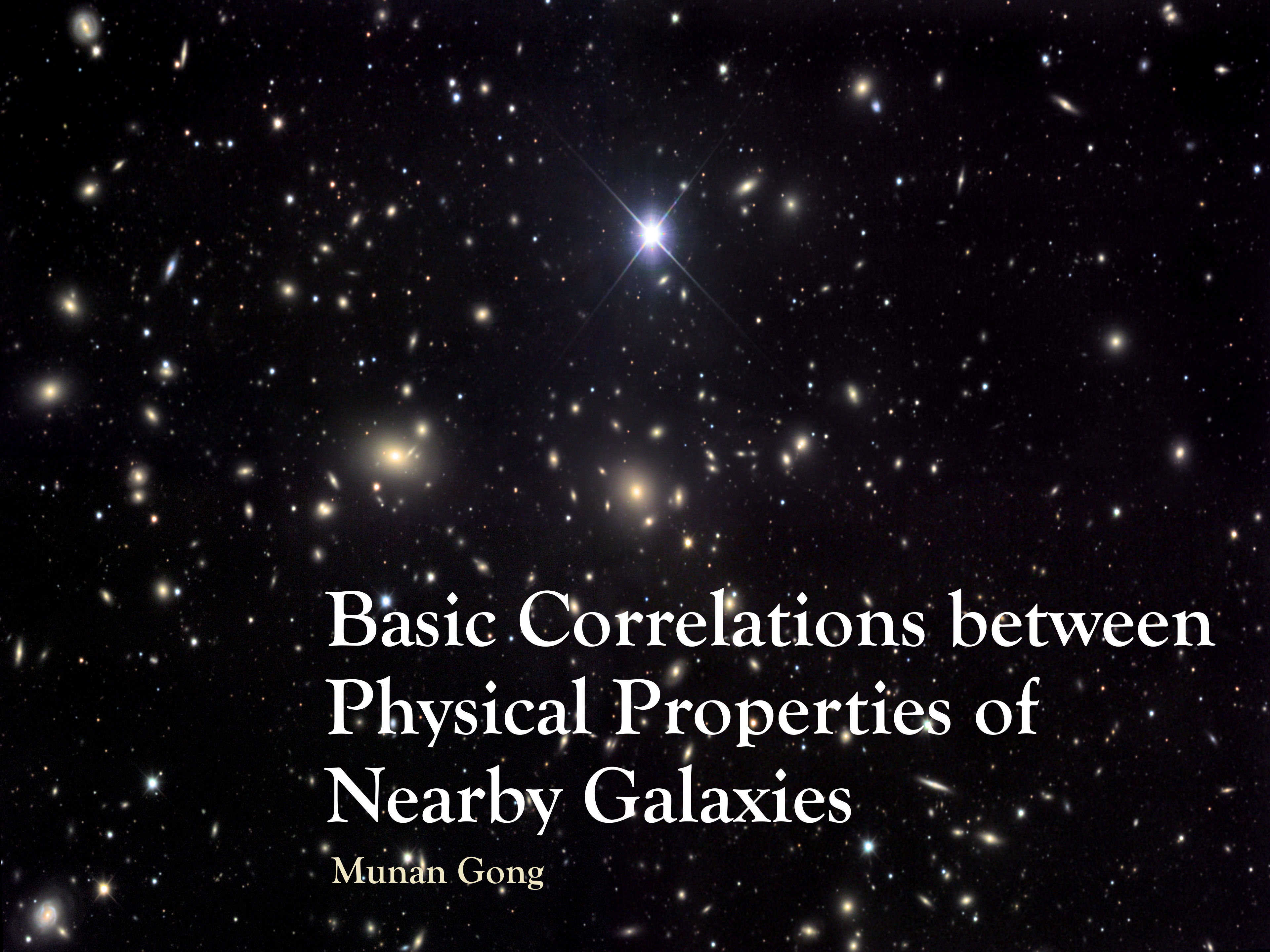


Basic Correlations between Physical Properties of Nearby Galaxies

Munan Gong

Take home points

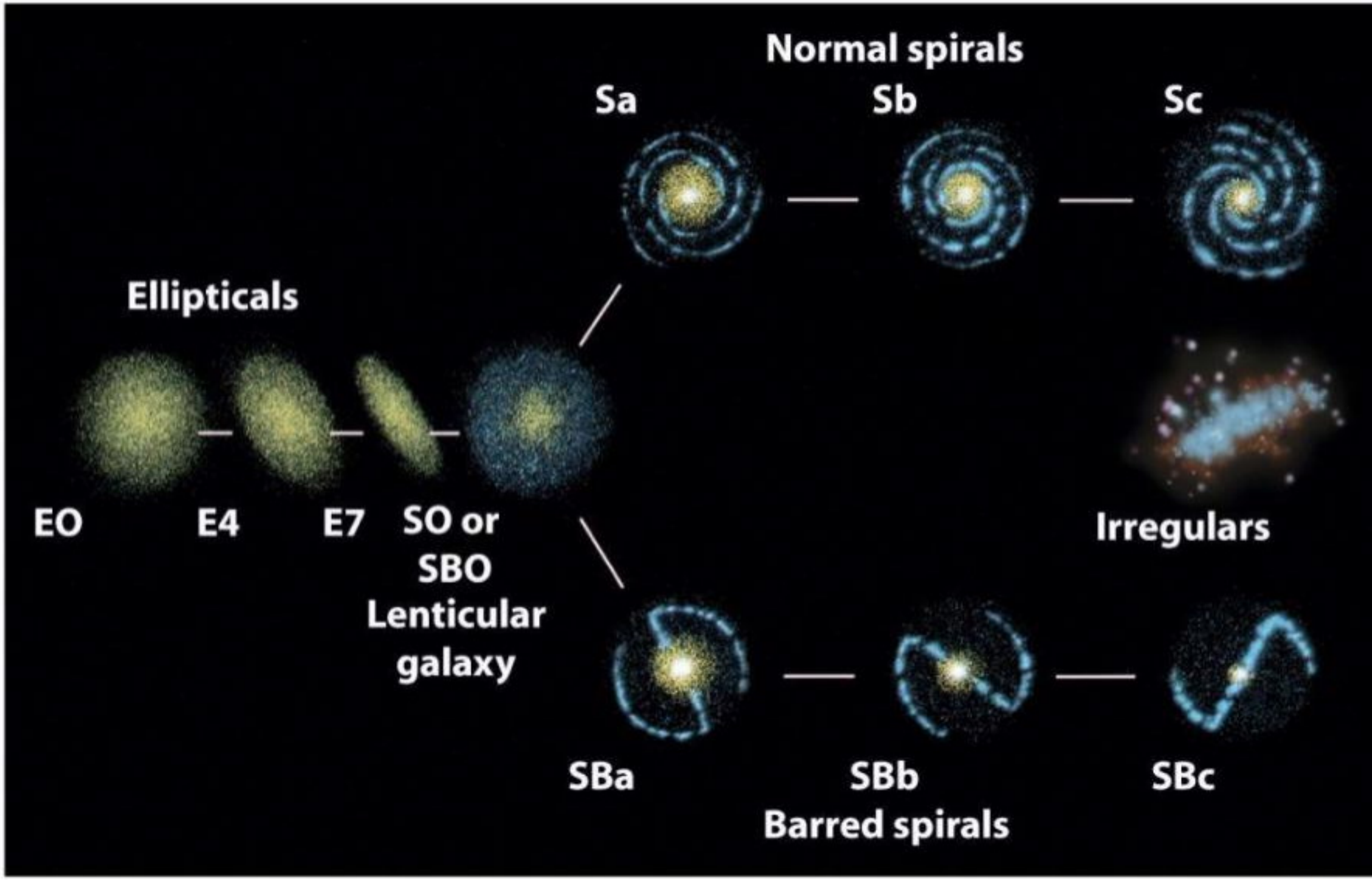
- Spirals
  - Blue
  - Lots of emission lines in spectrum
  - Late-type morphology (disky, spiral arms, less concentrated)
  - Young
  - $\sim 10^8 - 10^{10}\ M_\odot$
  - Ongoing star formation
  - Lots of gas

- Ellipticals
  - Red
  - Lack of emission lines in spectrum
  - Early-type morphology (round, bulgy, more concentrated)
  - Old
  - $\sim 10^{10} - 10^{13}\ M_\odot$
  - Post star formation
  - Lack of gas

Outline

- History of galaxy type classification: Hubble sequence
- Sloan Digital Sky Survey (SDSS)
- Color-magnitude, color-morphology correlation
- Star formation history-stellar mass correlation
- Metallicity-stellar mass correlation

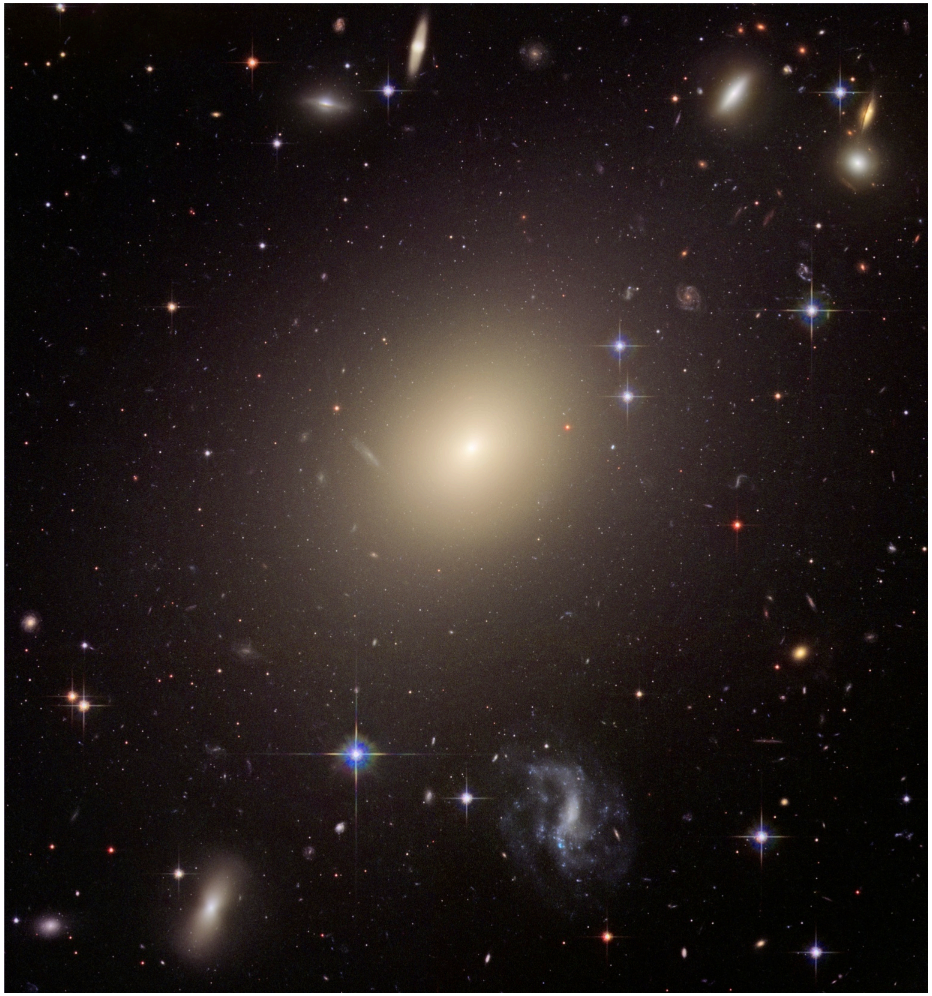
History: Hubble sequence



- In the 1920s
- ‘early type’ and ‘late type’

Elliptical VS. Spiral

- The giant elliptical galaxy ESO 325-G004



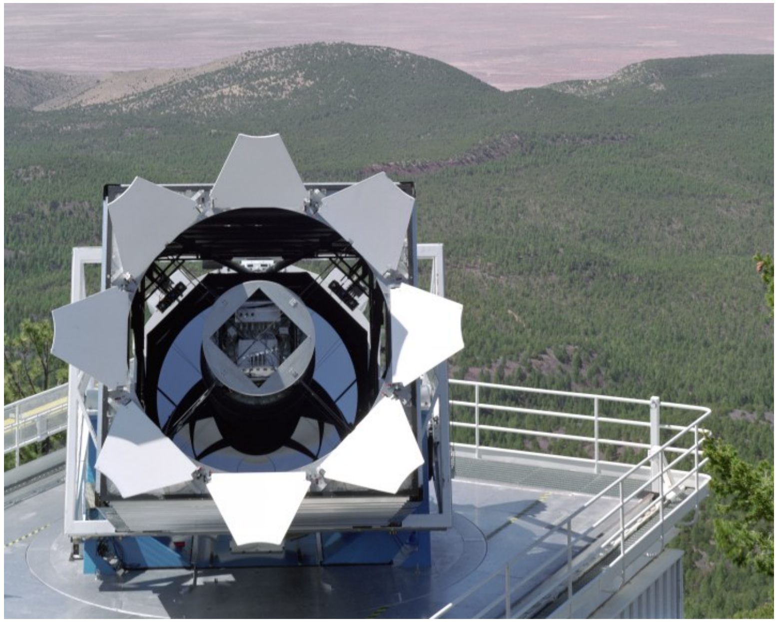
- ...What's this?

Round, bulgy, red

Disky, spirals, blue

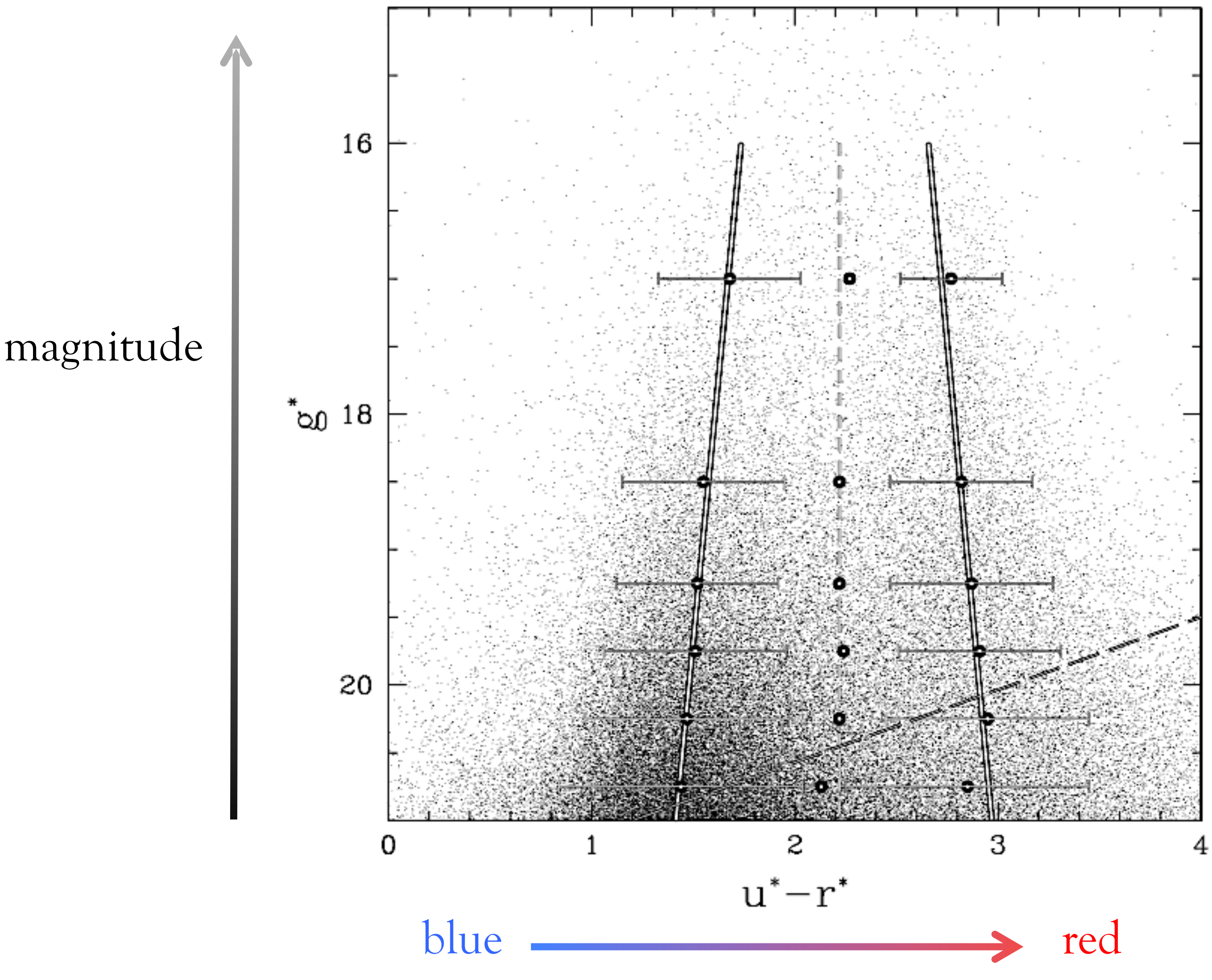
Sloan Digital Sky Survey (SDSS)

- 2.5m optical telescope, 5 bands photometry, spectroscopy
- Deep, multi-color images covering more than 1/4 sky
- 3-dimensional maps containing more than 930,000 galaxies
- Our department is heavily involved!



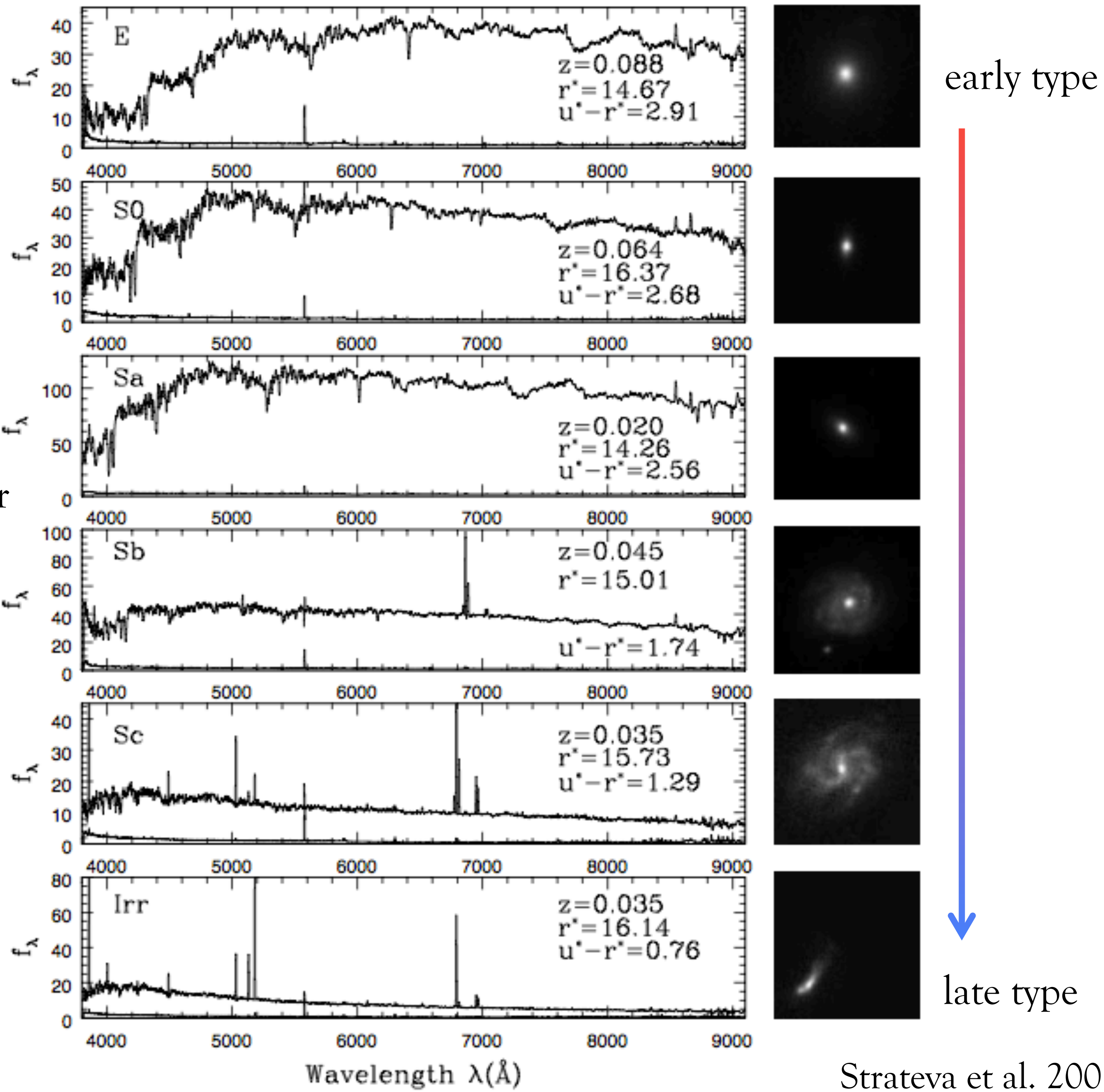
Early work: color–magnitude correlation

- Two distinctive population, separating at u-r=2.2



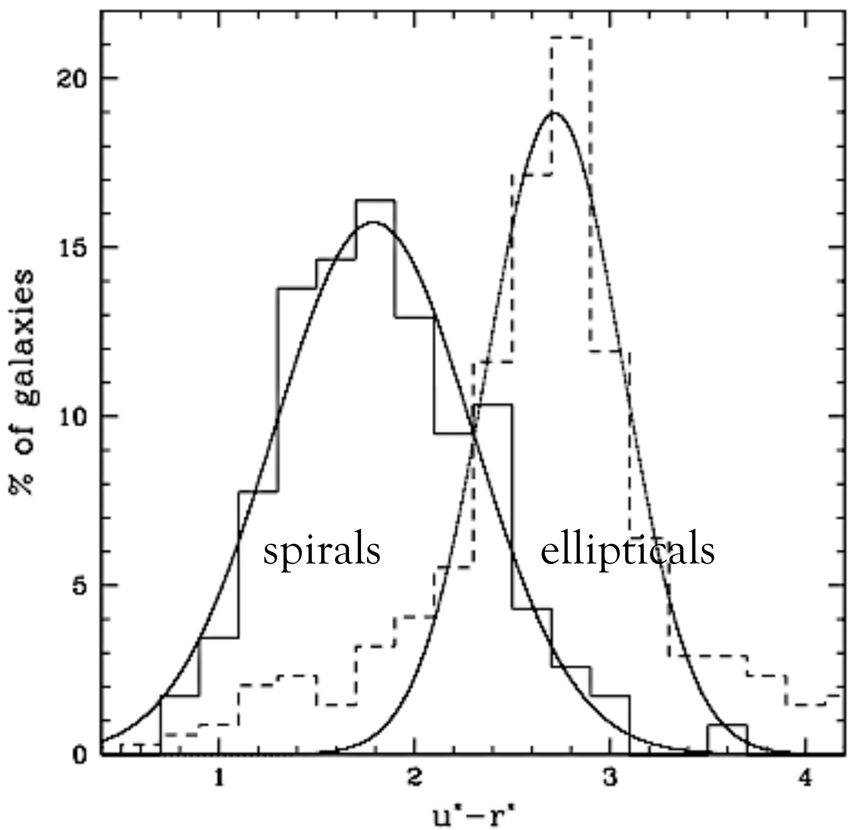
Strateva et al. 2001

- Red->blue continuum
- The 4000 Å break in old star populations
- Spectral lines, eg. H α line from hot HII region indicates on-going star formation

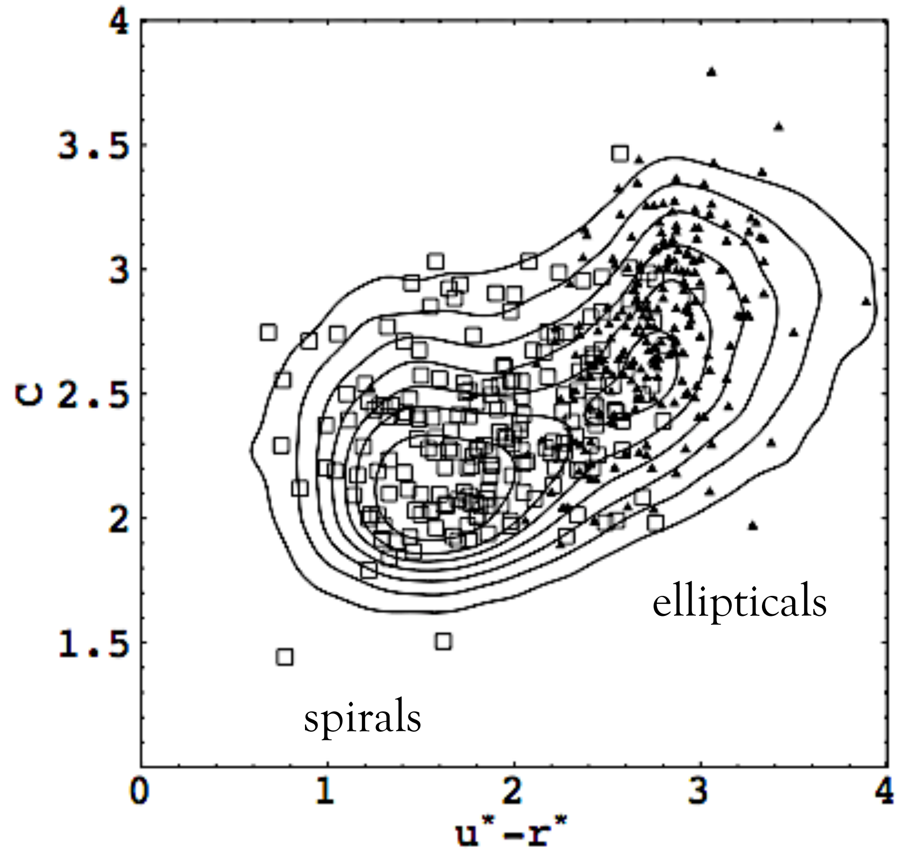


Strateva et al. 2001

Color–morphology correlation



blue → red



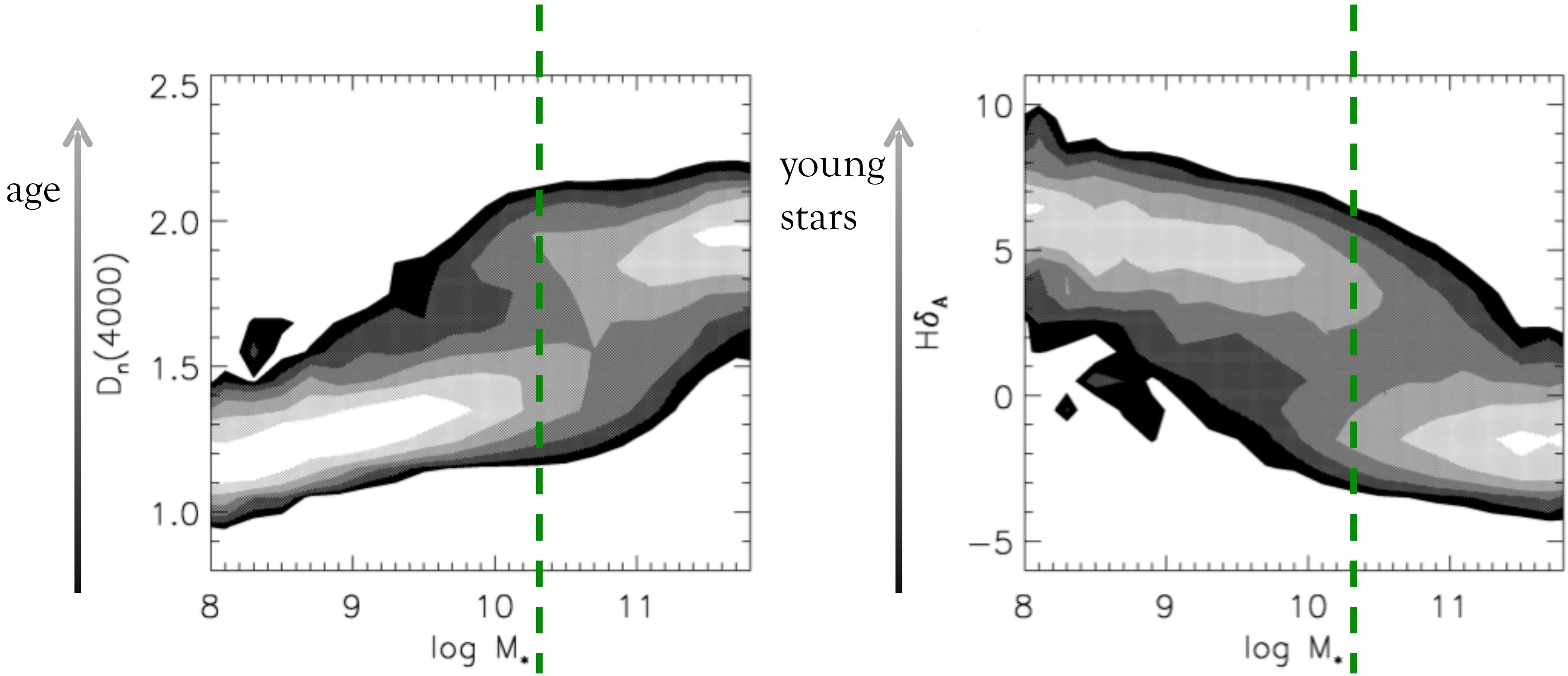
- Concentration index C=r90/r50, disky →bulgy
- Two distinctive populations

Strateva et al. 2001

Star formation history-stellar mass correlation

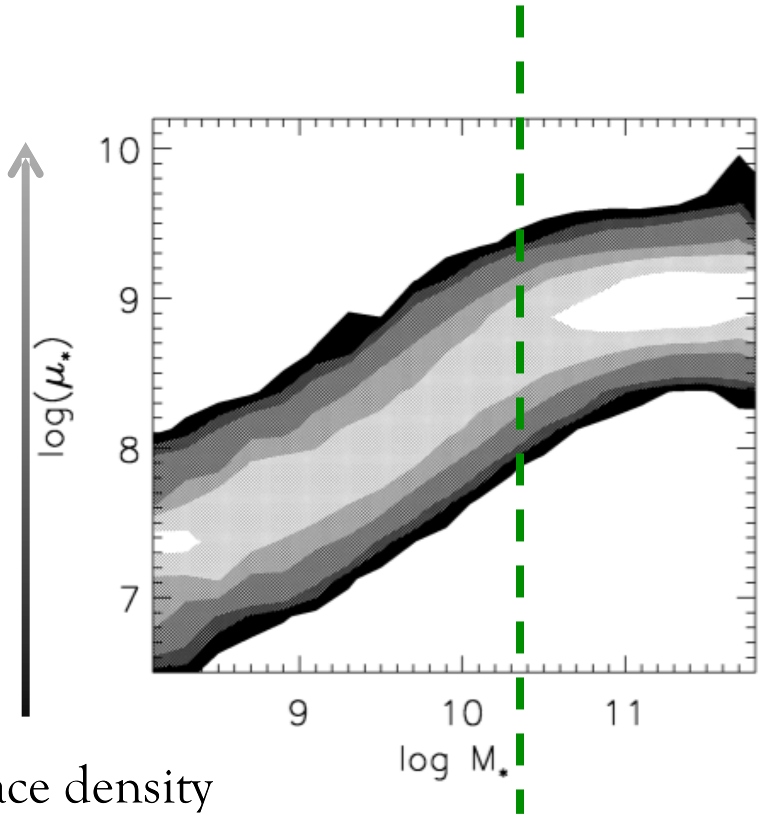
- Total stellar mass of galaxies M_* derived from models that fit the spectra
- Stellar spectral indices
  - The 4000 Å break $D_n(4000)$: age
  - The Balmer absorption index $H\delta_A$: recent star burst (young A,B stars)

The magic mass transition at $M_* = 3\times10^{10}\ M_\odot$

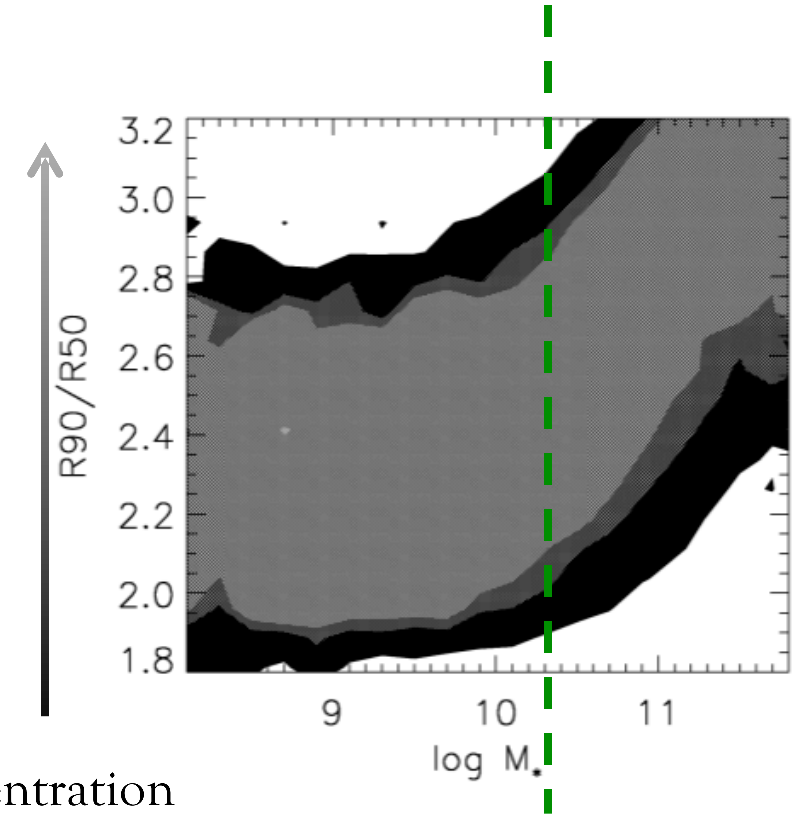


Kauffmann et al. 2003

Correlation with stellar surface density and shape



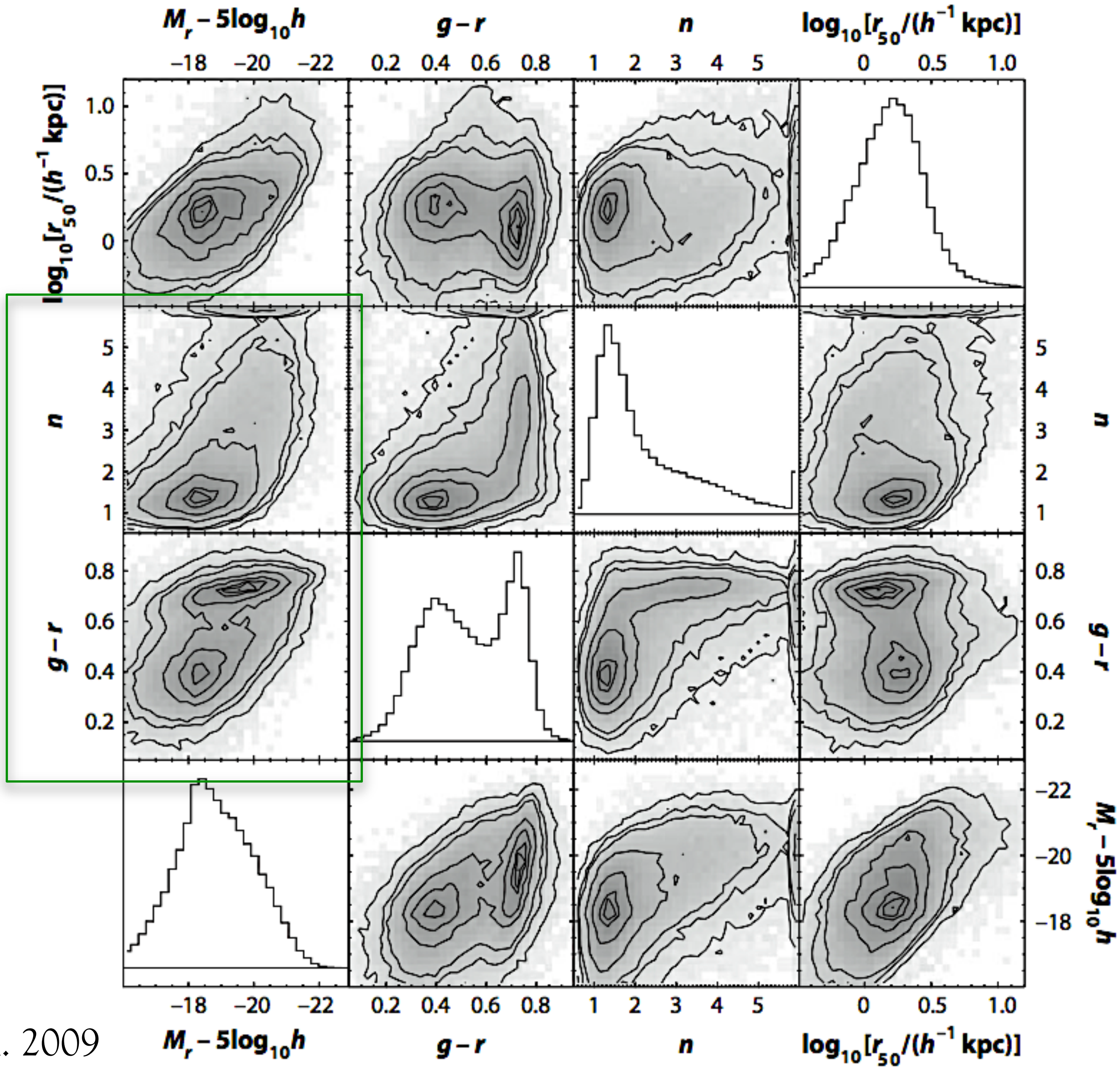
surface density
of stellar mass



concentration

Kauffmann et al. 2003

To sum it up...

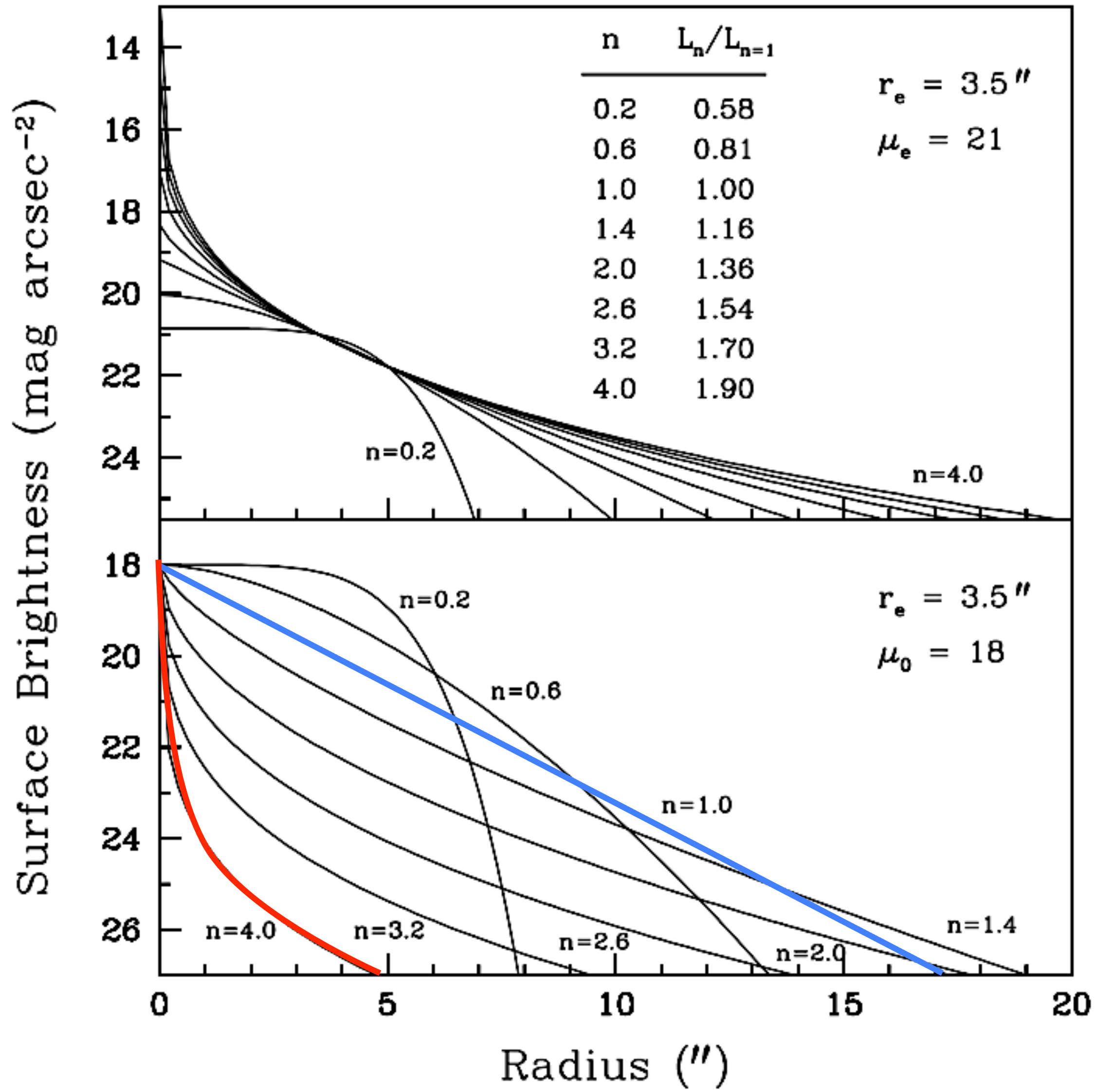


Blanton et al. 2009

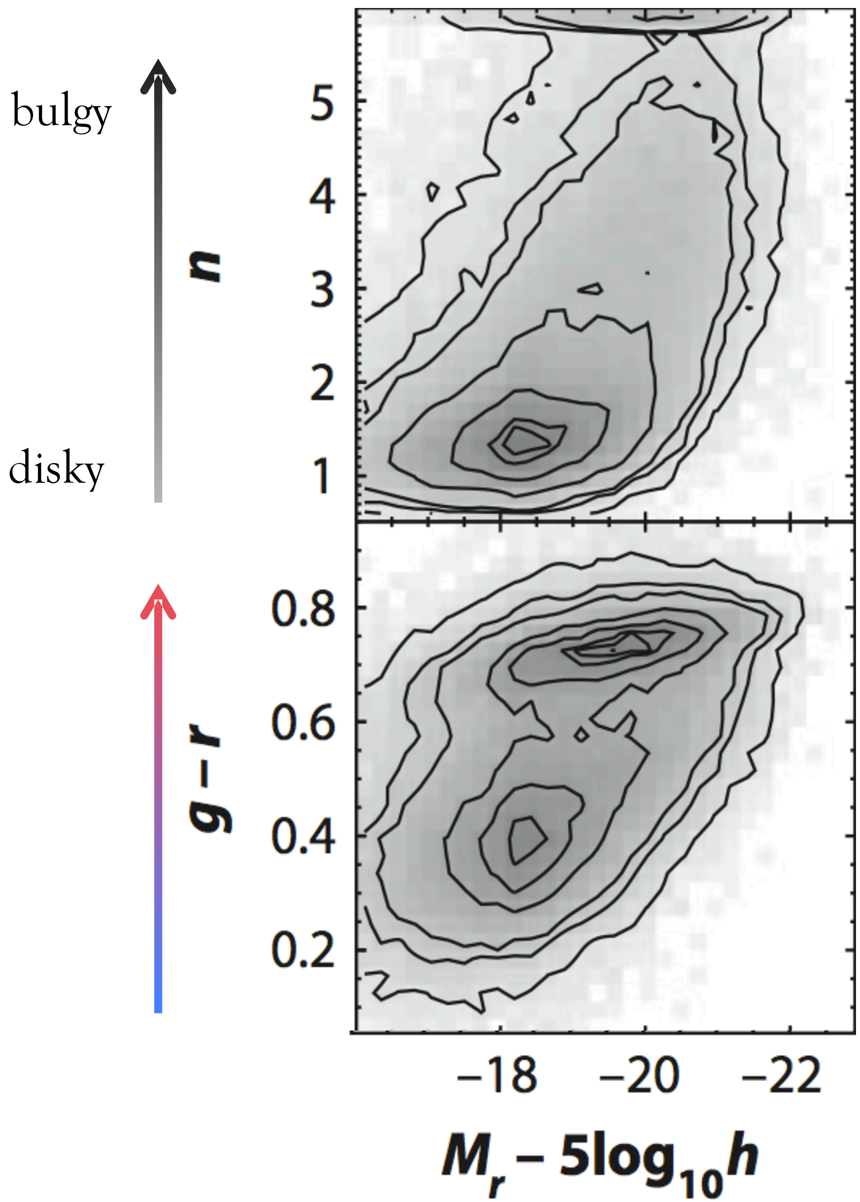
The Sérsic index n

$$I(r) = I_0 \exp\left[-\left(\frac{r}{r_0}\right)^{1/n}\right]$$

- n=0, uniform disk
- n=0.5, Gaussian
- n=1, exponential, typical for spiral galaxies
- n=4, de Vaucouleurs profile for elliptical galaxies



MacArthur et al. 2003

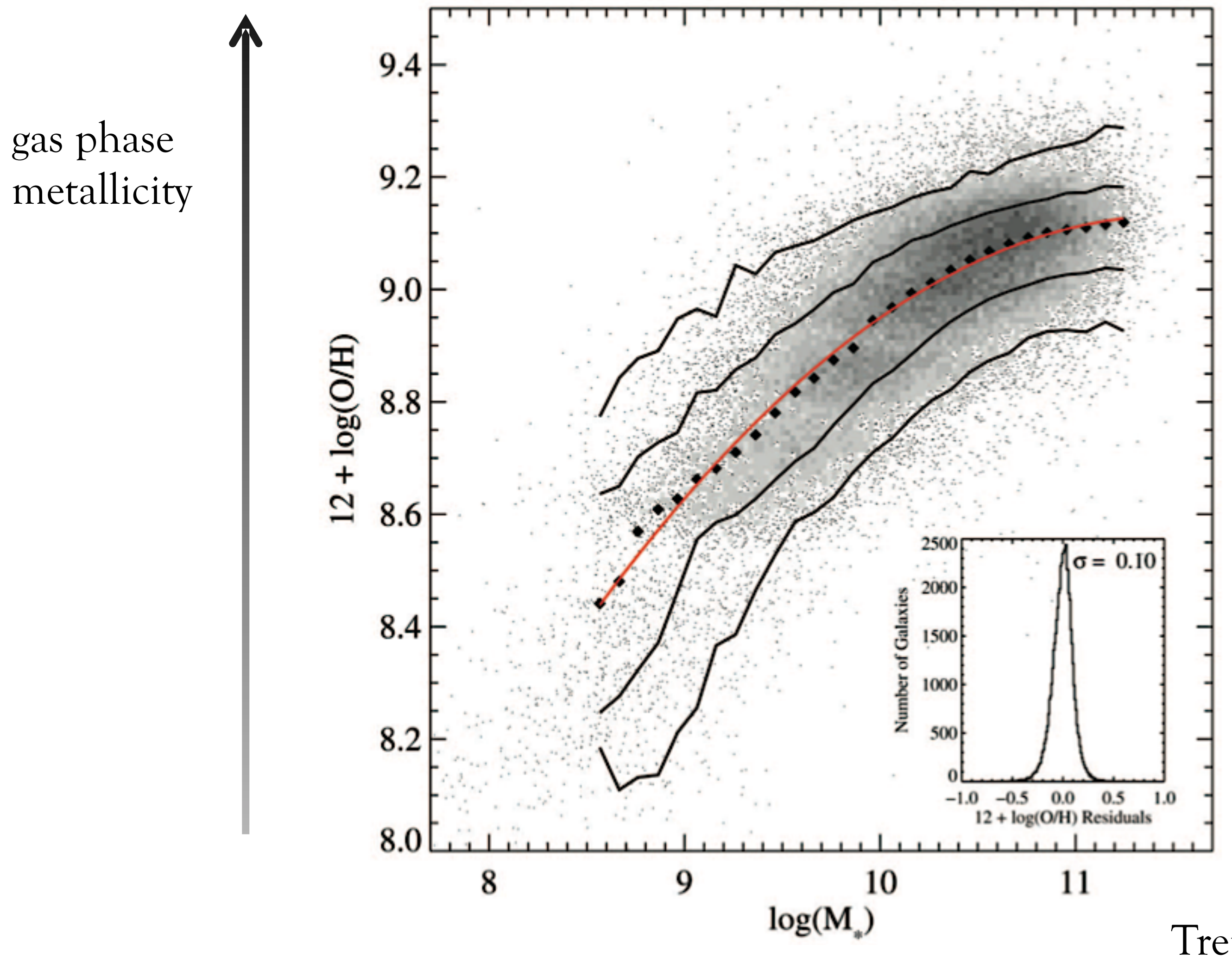


Blanton et al. 2009

- n increases with mass
- The color-magnitude diagram
  - The 'green valley'

Metallicity-stellar mass correlation

- Metallicity increases with the stellar mass of galaxy



Tremonti et al. 2004

Outline

- History of galaxy type classification: Hubble sequence
- Sloan Digital Sky Survey (SDSS)
- Color-magnitude, color-morphology correlation
  - Color transition: u-r=2.2
- Star formation history-stellar mass correlation
  - Mass transition: $M_* = 3\times10^{10}\ M_\odot$
- Metallicity-stellar mass correlation
  - Metallicity increases with mass

Take home points

- Spirals
  - Blue
  - Lots of emission lines in spectrum
  - Late-type morphology (disky, spiral arms, less concentrated)
  - Young
  - $\sim 10^8$ - 10^{10} $M_\odot$
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  - Post star formation
  - Lack of gas

- What's the physics made them divided into two distinctive groups?
- Why is there a magic mass transition at $M_* = 3\times10^{10}\ M_\odot$?
- What made the galaxies evolve - remove the gas, shut down star formation, and made them round and bulgy?

References

- Kauffmann, G., Heckman, T. M., White, S. D. M., et al. 2003, MNRAS, 341, 54
- Strateva, I., Ivezicv, Z., Knapp, G. R., et al. 2001, ApJ, 122, 1861
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