Moving away from galaxy morphology

It would be good to be able to relate measurements of physical properties such as mass, luminosity to galaxy formation theories

[Q] Why didnt Hubble start with these properties? Why morphology?

The SDSS transformed the study of galaxies

→ uniform set of colors & magnitudes in 5 bands (ugriz) over 1/4 of the sky .... digital detectors

→ redshifts and spectra for hundreds of thousands of galaxies

[Q] Why were the spectra so important?

→ distances for galaxies in Hubble flow
  → luminosities

77,153 galaxies with z < .05

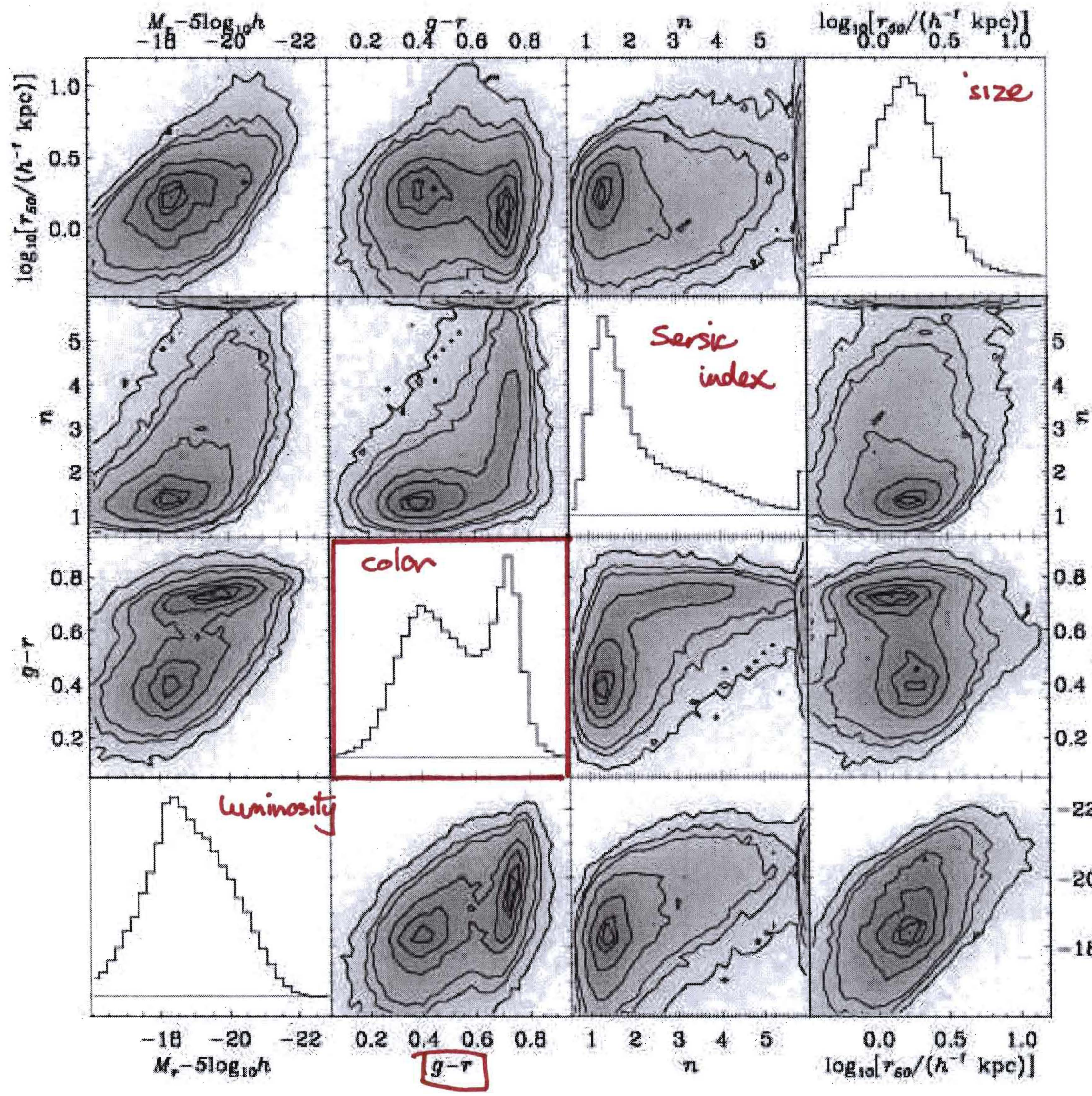


Fig. 1.— Distribution of broad-band galaxy properties in the SDSS. The diagonal panels show the distribution of four properties independently: absolute magnitude M_r, $g - r$ color, Sérsic index n, and half-light radius r_{50}. A bimodal distribution in $g - r$ is apparent. The off-diagonal panels show the bivariate distribution of each pair of properties, revealing the complex relationships among them. The greyscale and contours reflect the number of galaxies in each bin (darker means larger number).

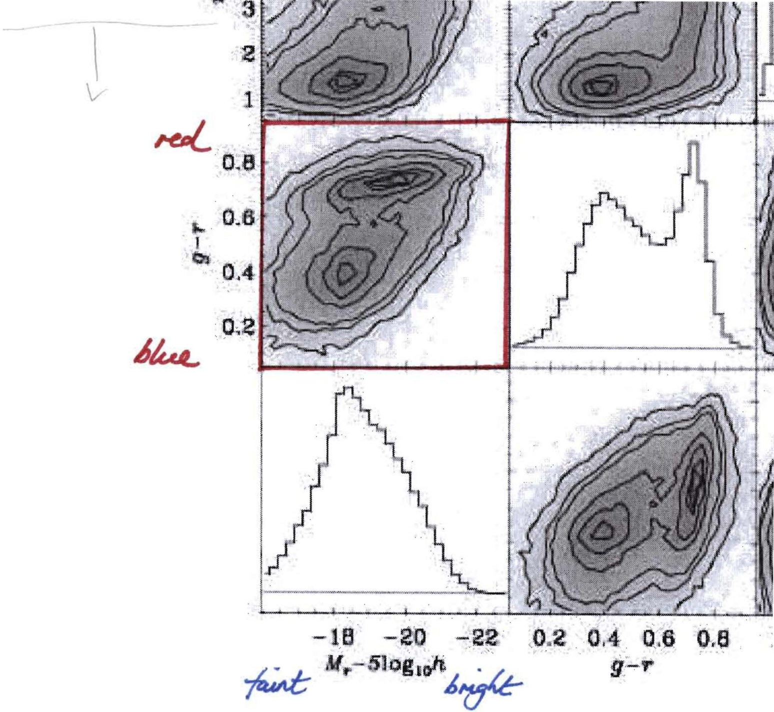
Blanton & Moustakas 2009
ARAA

SDSS (eg Blanton & collaborators) compared the properties of galaxies using 4 major measurements:

- Luminosity ($M_r - 5\log_{10} h$) → correlates with mass
  - (h ← distance scale)
- Color ($g-r$)
- Concentration (Sersic index n)
- Size (half-light radius r_{50})

[Q] Color ($g-r$) is clearly bimodal. What types of galaxies would you expect to find populating the two peaks?

[Q] What can we conclude from the relationship between color and galaxy luminosity?



3
2
1
red
0.8
0.6
0.4
0.2
blue
g−r
−18
−20
−22
$M_r - 5\log_{10}h$
0.2
0.4
0.6
0.8
g−r
faint
bright

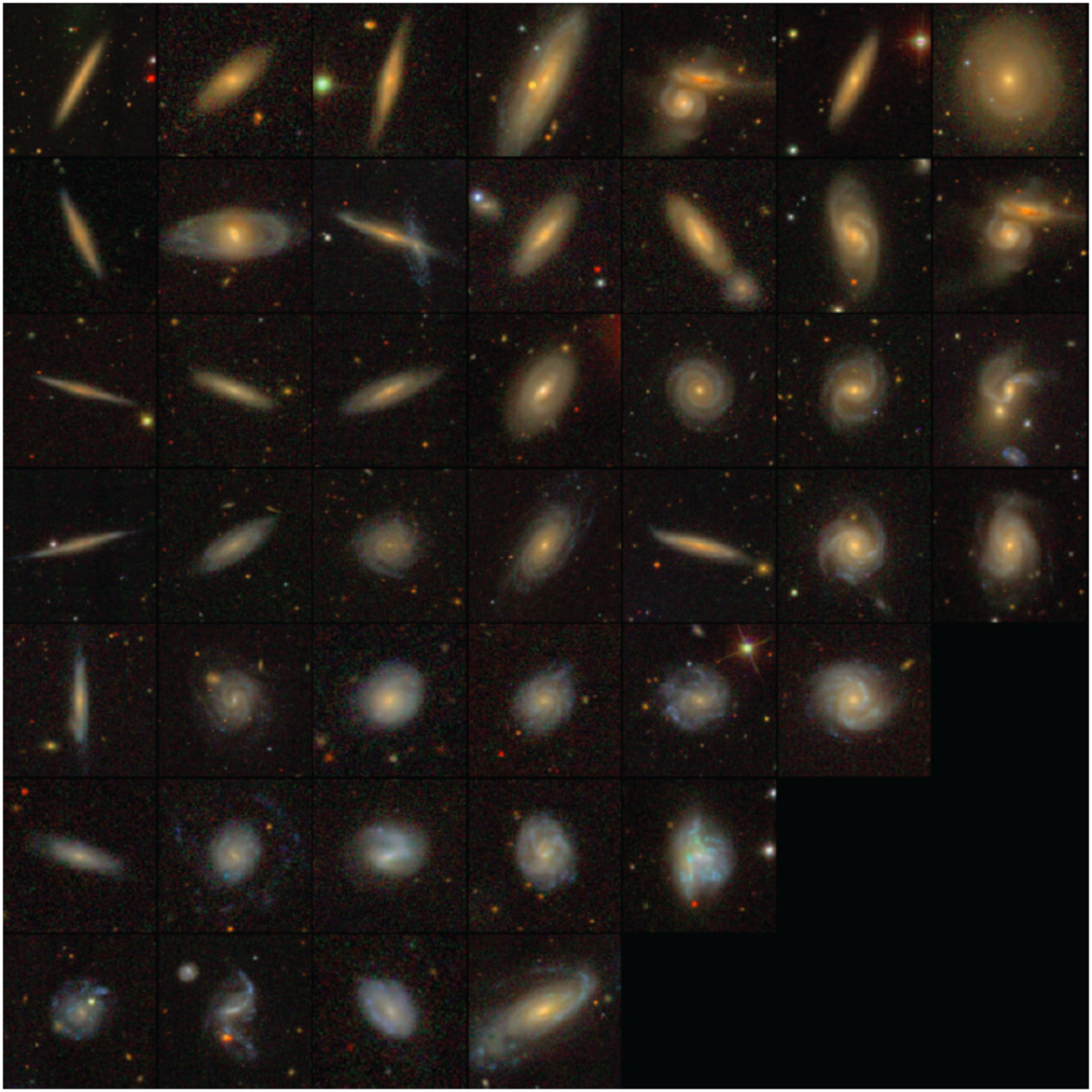
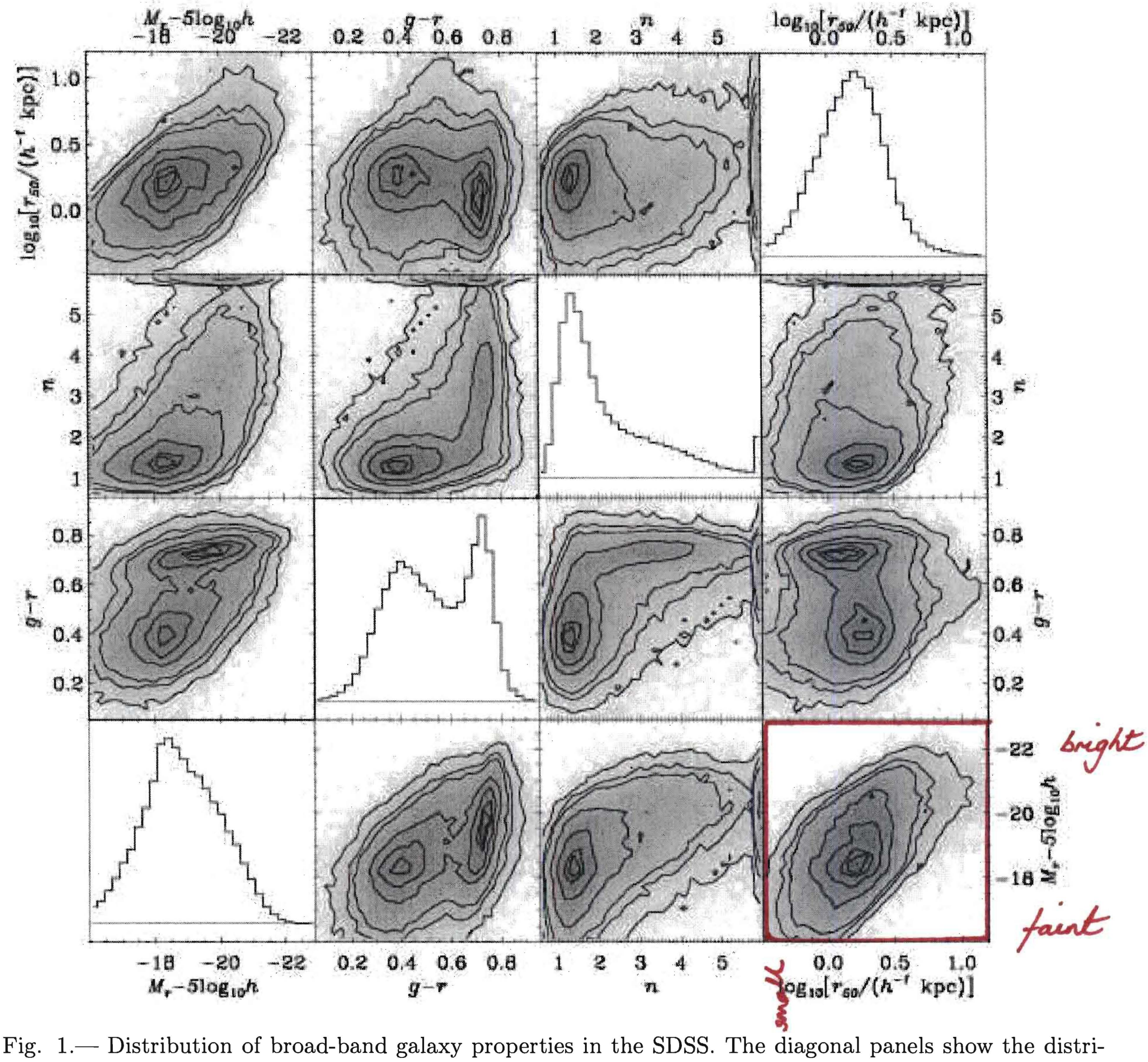


Figure 7

SDSS images of spiral galaxies, selected according to classifications in NED to be Sa–Sd (including barred types). The images are sorted by absolute magnitude in the horizontal direction, ranging between $M_r - 5\log_{10} h \sim -18.5$ and -22 from left to right, and $g - r$ color in the vertical direction, ranging between 0.2 and 0.9 mag from the bottom to the top. Thus, the brightest, reddest spirals are in the upper-right. The galaxies shown were selected randomly, except we excluded two cases from the original set owing to image



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We refer to the red & blue sequences.

Blue sequence : mostly spiral galaxies with ongoing star formation

Red sequence : several morphological types contribute :

dE @ faint end

early-type spirals, S0s, dust-reddened spirals

giant ellipticals

cD galaxies @ center of galaxy clusters

(increasing luminosity ↓)

Also note correlation between luminosity & size (half light radius) :

the biggest galaxies are also the most luminous

(BUT remember LSB galaxies .... disk galaxies can extend to many r_{50} .)

Concentration of luminosity

Of Blanton's 4 quantities (luminosity, color, size, conc) this is the most directly related to morphology.

Sersic index provides a general measure

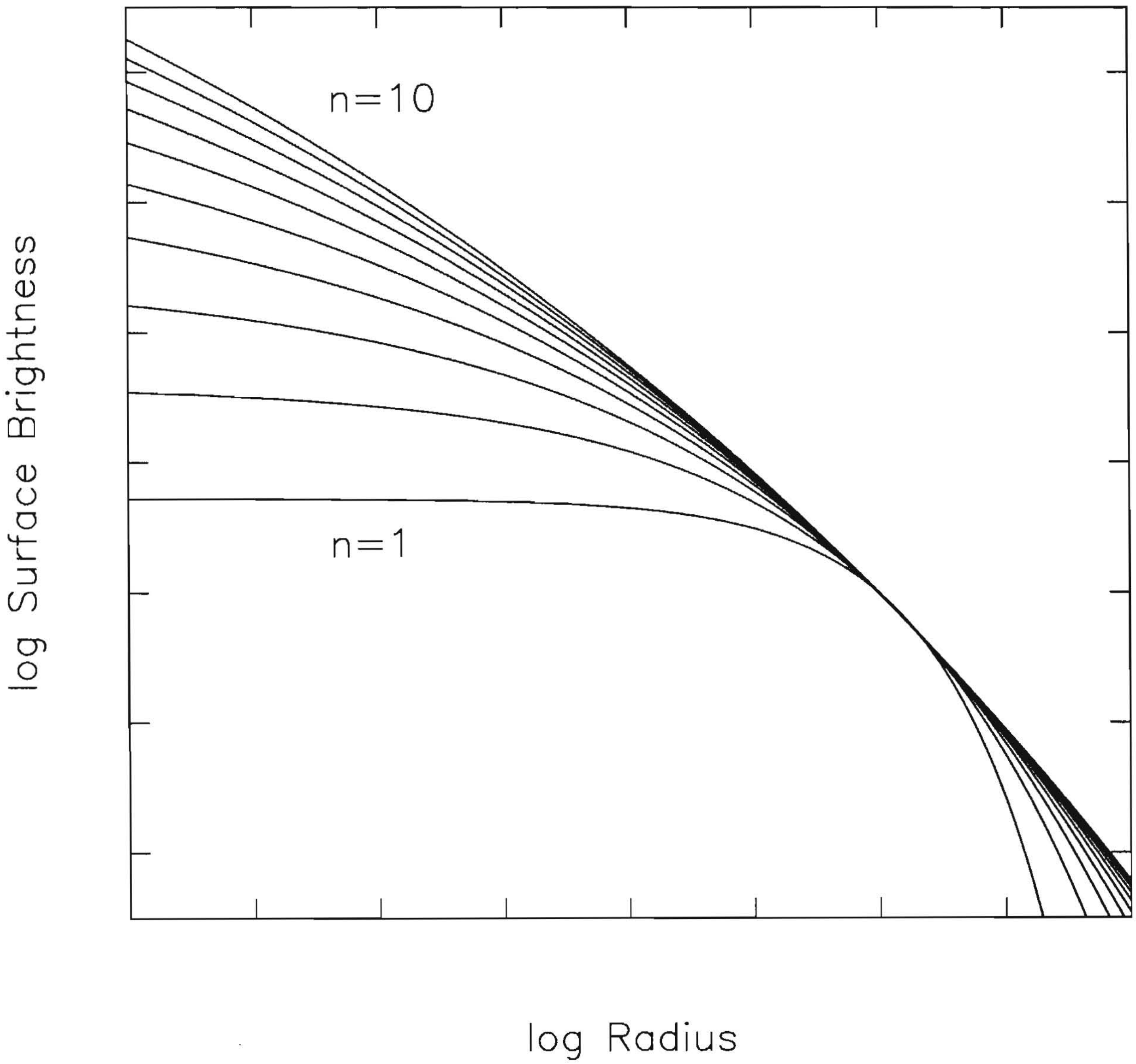
$n = 1$ low conc, exponential disk
$n = 4$ high conc, $R^{1/4}$ law

| special cases

Note that low concentration galaxies have a large range in color

red dE ← color → blue Sc

Red galaxies can have both high & low concentration


n=10
n=1
log Surface Brightness
log Radius

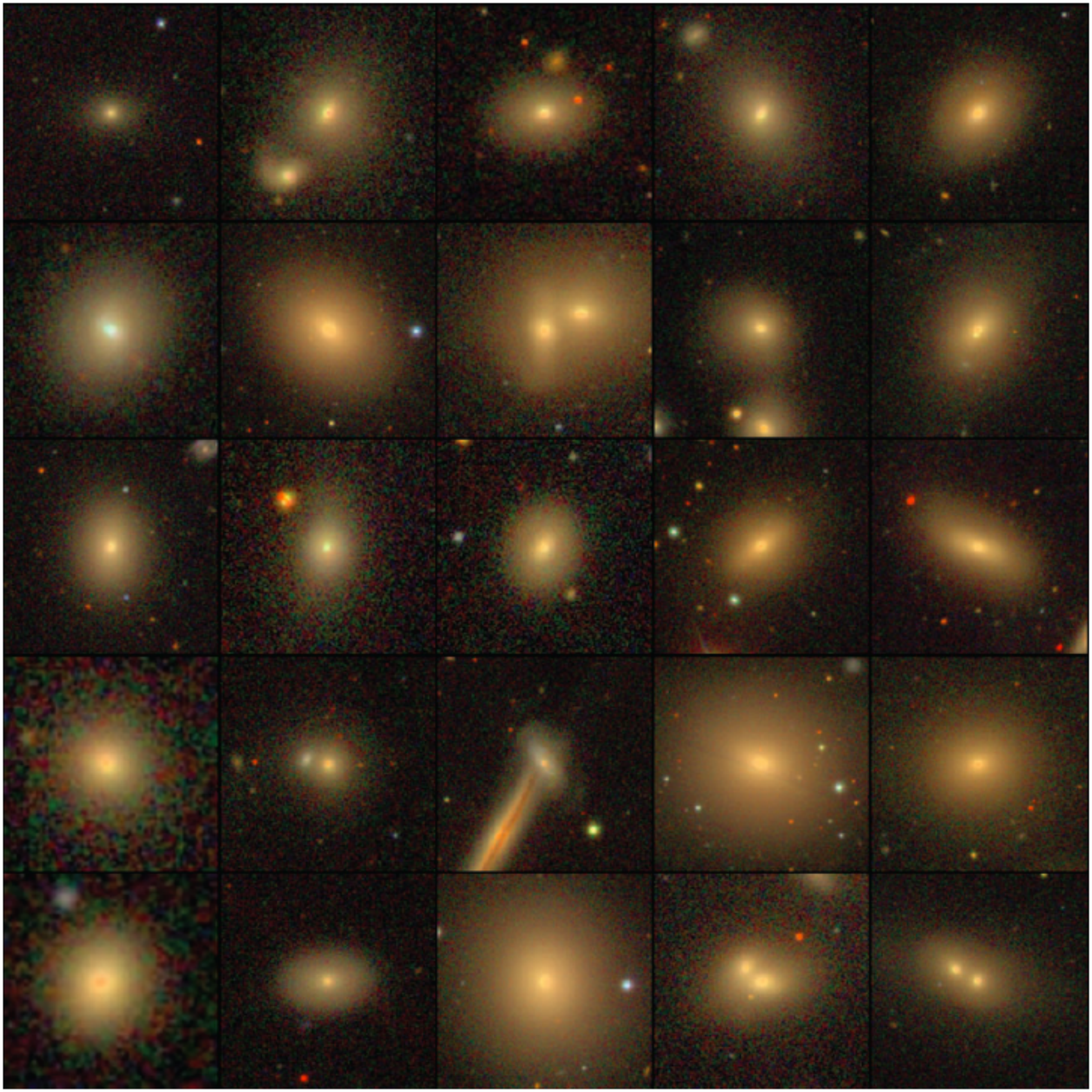


Figure 13

Sloan Digital Sky Survey images of elliptical galaxies, selected according to classifications in the NASA Extragalactic Database (NED). The images are sorted by absolute magnitude in the horizontal direction, ranging between $M_r - 5\log_{10} h \sim -18.5$ and -22 from left to right, and concentration (r_{90}/r_{50}) in the vertical direction, ranging between 2.2 and 3.8 from the bottom to the top. Thus, the brightest, most concentrated ellipticals are in the upper right. The galaxies shown were selected randomly, but roughly one-third were

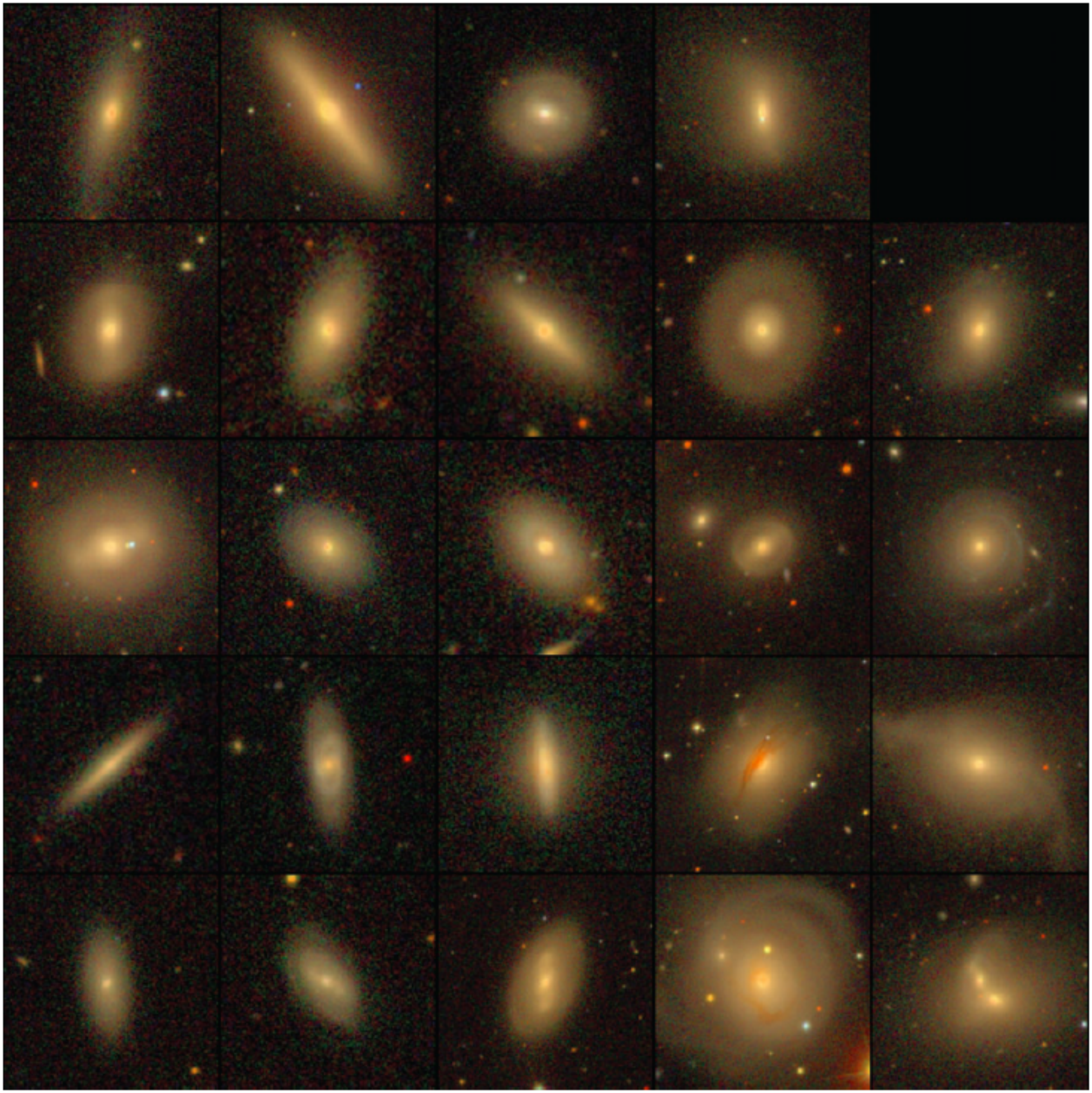
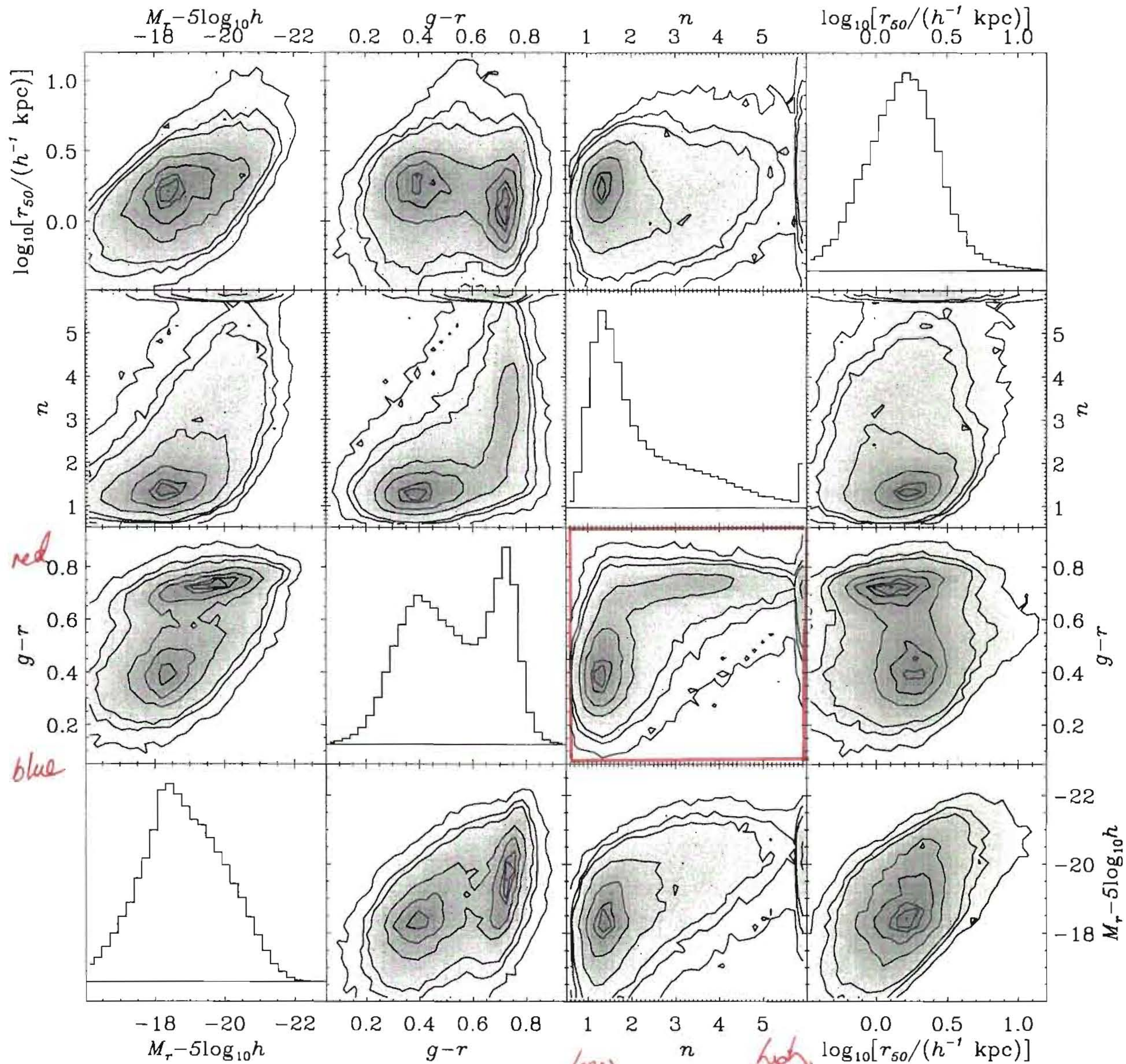


Figure 11

Sloan Digital Sky Survey images of lenticular (S0) galaxies, selected according to classifications in the NASA Extragalactic Database (NED). The images are sorted by absolute magnitude in the horizontal direction, ranging between $M_r - 5\log_{10} h \sim -18.5$ and -22 from left to right, and concentration (r_{90}/r_{50}) in the vertical direction, ranging between 2.2 and 3.8 from the bottom to the top. Thus, the brightest, most concentrated S0s are in the upper right. The galaxies shown were selected randomly, but roughly one-quarter were



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