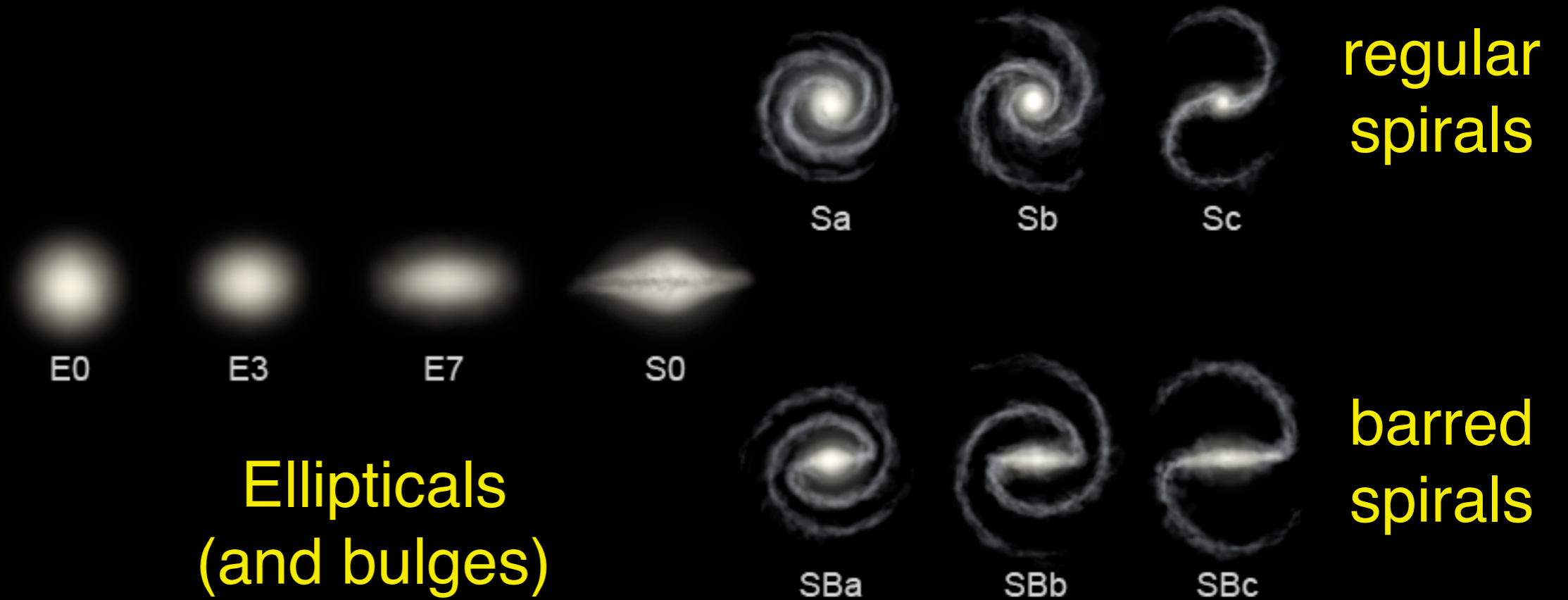Enough with the crazy ideas
Back to observations

Dark Matter has always been driven by data - specifically, astronomical observations of large structures like galaxies, clusters of galaxies, and the universe as a whole.

Galaxy Morphology
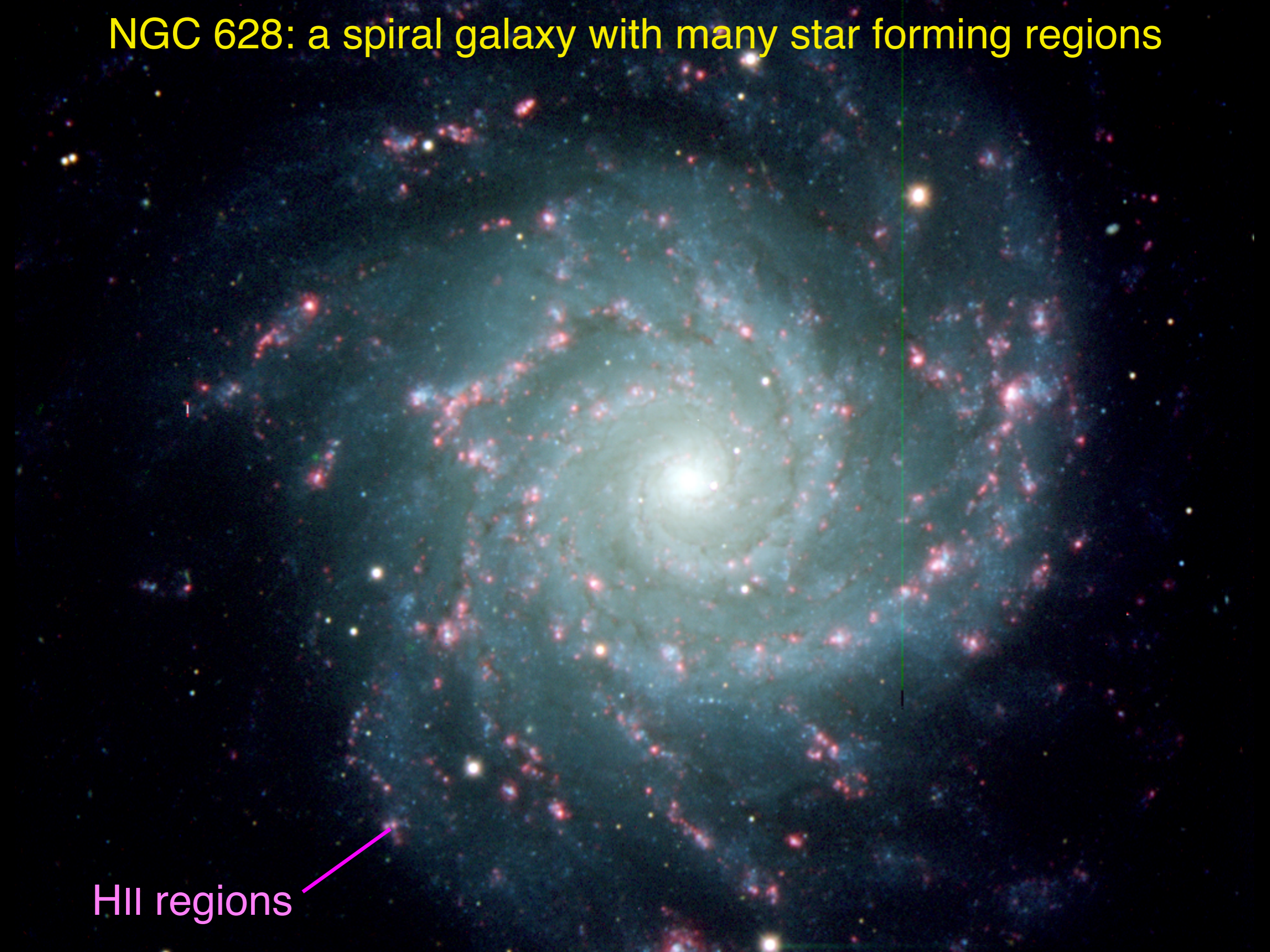The Hubble Tuning-fork sequence

increasing disk

increasing bulge

regular spirals

Sa   Sb   Sc

E0   E3   E7   S0

Ellipticals
(and bulges)
3D ellipsoids
pressure support
V/σ small

barred spirals

SBa   SBb   SBc

Spirals
2D disks
rotational support
V/σ large

NGC 6946: a spiral galaxy

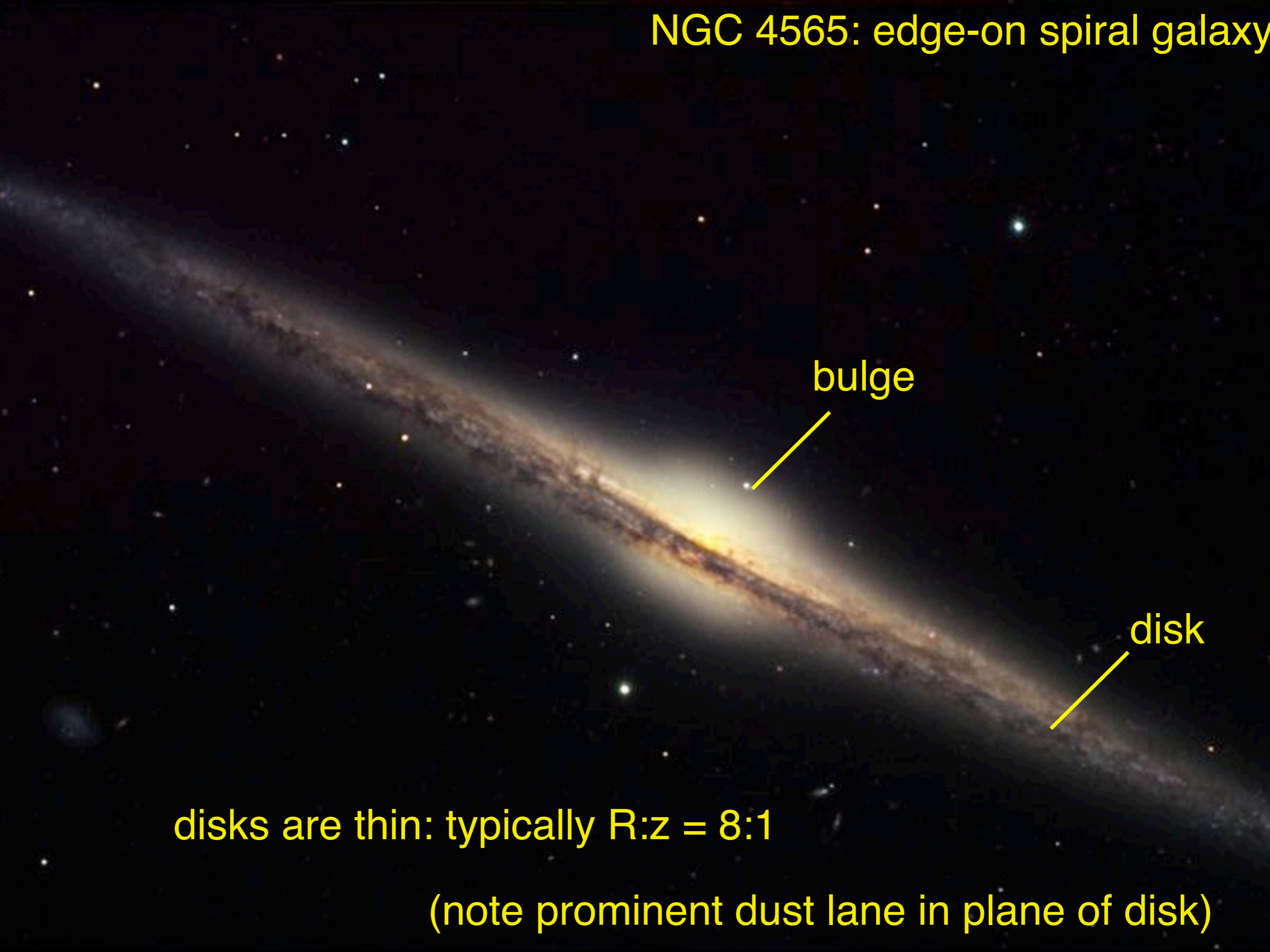NGC 628: a spiral galaxy with many star forming regions

HII regions

NGC 1300: a barred spiral galaxy

NGC 4565: edge-on spiral galaxy
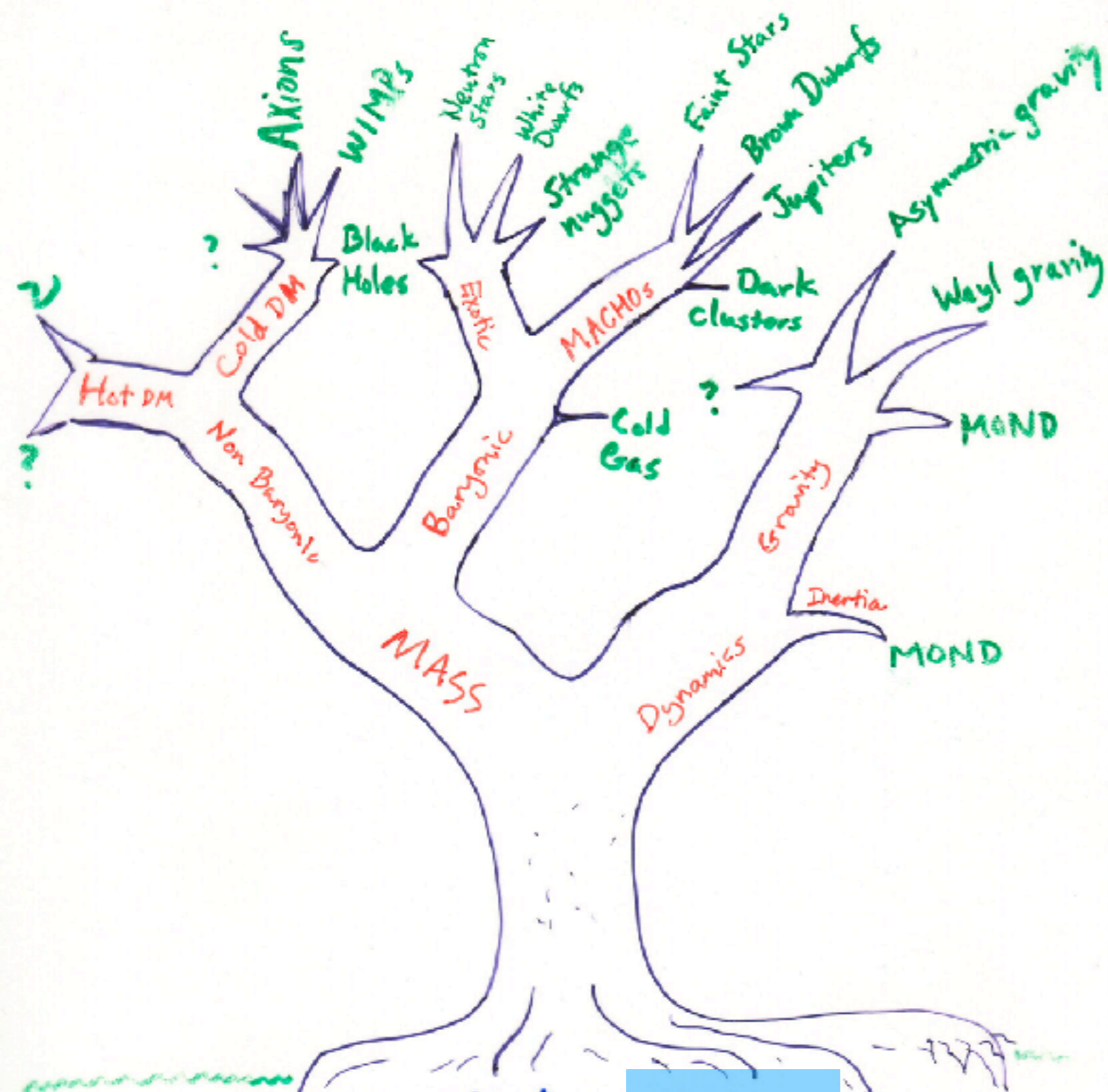
bulge

disk

disks are thin: typically R:z = 8:1

(note prominent dust lane in plane of disk)

M87: a giant Elliptical galaxy

M87   © Anglo-Australian Observatory
Photo by David Malin

Ellipticals are fat: 3D blobs rather than thin disk

Clusters of galaxies

the Zwicky problem
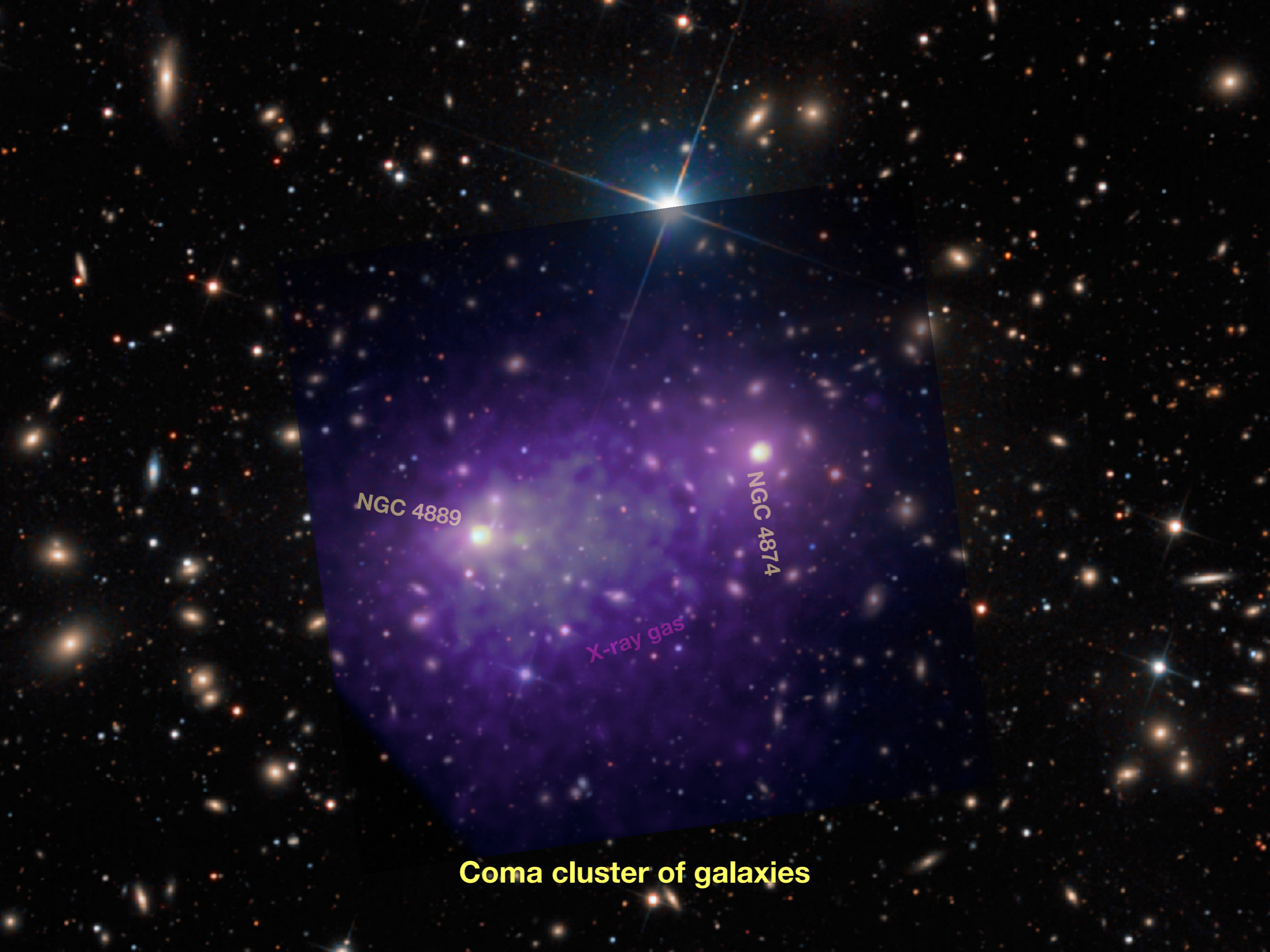
NGC 4889

NGC 4874

X-ray gas

Coma cluster of galaxies
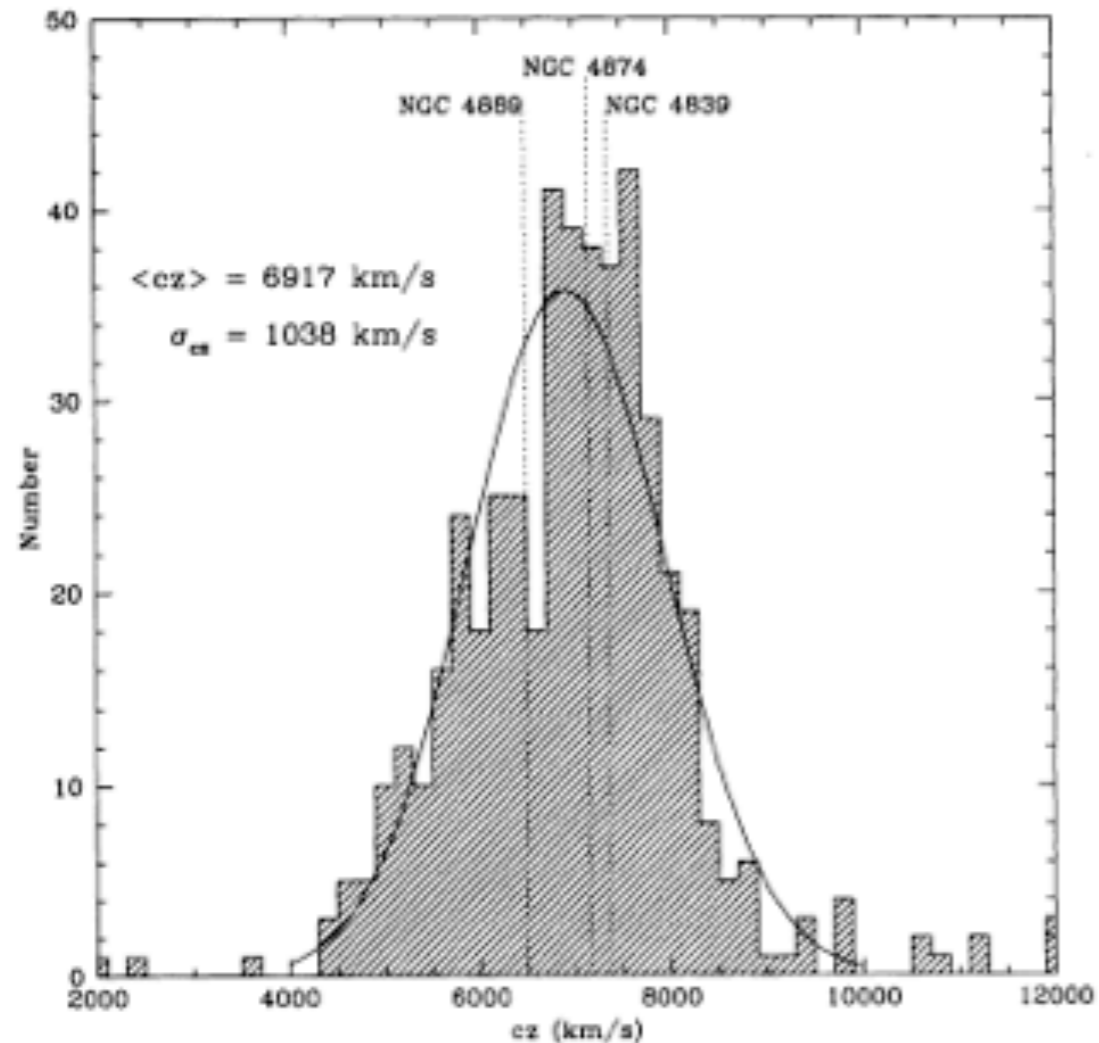
Coma cluster velocity dispersion

FIG. 5.—Distribution of radial velocities for galaxies in the Coma cluster. The curve is a Gaussian with mean 6917 km s^{-1} and standard deviation 1038 km s^{-1}. The velocities of the three dominant cluster galaxies are indicated.

Colless & Dunn 1996

See also the "Review literature" course web page
http://astroweb.case.edu/ssm/ASTR333/revlit.html

An alternative visualization of the subclustering is provided by Figure 10, which shows the smoothed density of galaxies as a function of velocity and distance from the cluster center along the NE–SW diagonal [i.e., $(X + Y)/2^{1/2}$, with NE

NGC 4874 and NGC 4889, it is no surprise to see that these two dominant galaxies are projected in the spatial dimension onto the primary and secondary peaks, respectively, in the core galaxy distribution. Contrary to naive expectation, however,
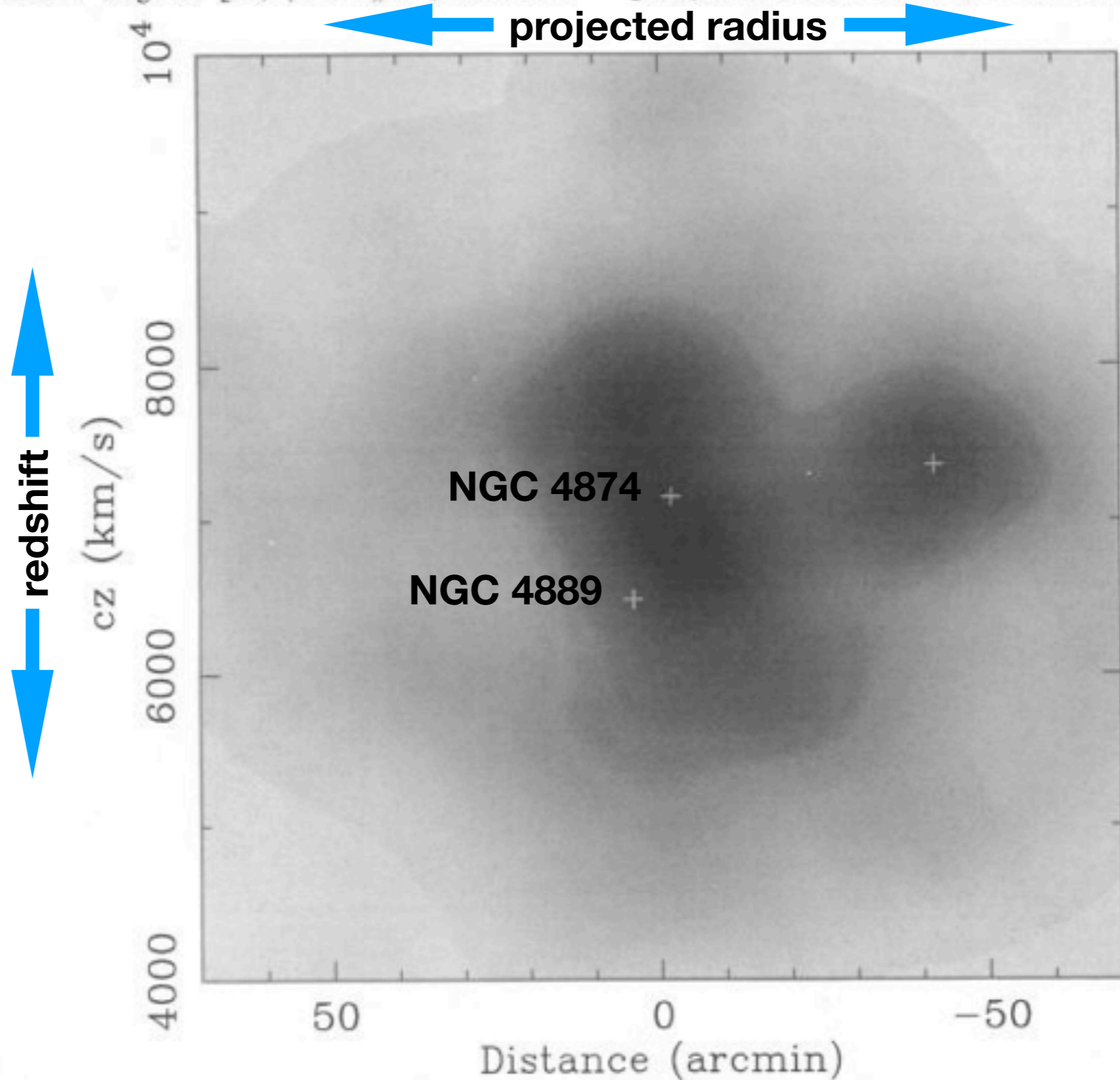

FIG. 10.—Galaxy density distribution projected onto the plane of radial velocity versus projected distance from the cluster center along the NE–SW diagonal (NE positive). The density is smoothed with a Gaussian of dispersion 8' in the spatial dimension and 300 km s^{-1} in the velocity dimension. The positions of the three dominant galaxies are marked by crosses (left to right: NGC 4889, NGC 4874, NGC 4839). The gray scale is linear with density and runs from zero to the maximum.