Galaxy evolution with big surveys

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Blanton, Eisenstein, Finkbeiner, Gunn, Quintero, Padmanabhan, Schlegel

and members of the *Sloan Digital Sky Survey*

Think of data as a source of *information*.

(*e.g.,* Shannon, *The Mathematical Theory of Communication*.)

Try to measure things that are at least *plausibly amenable* to prediction.

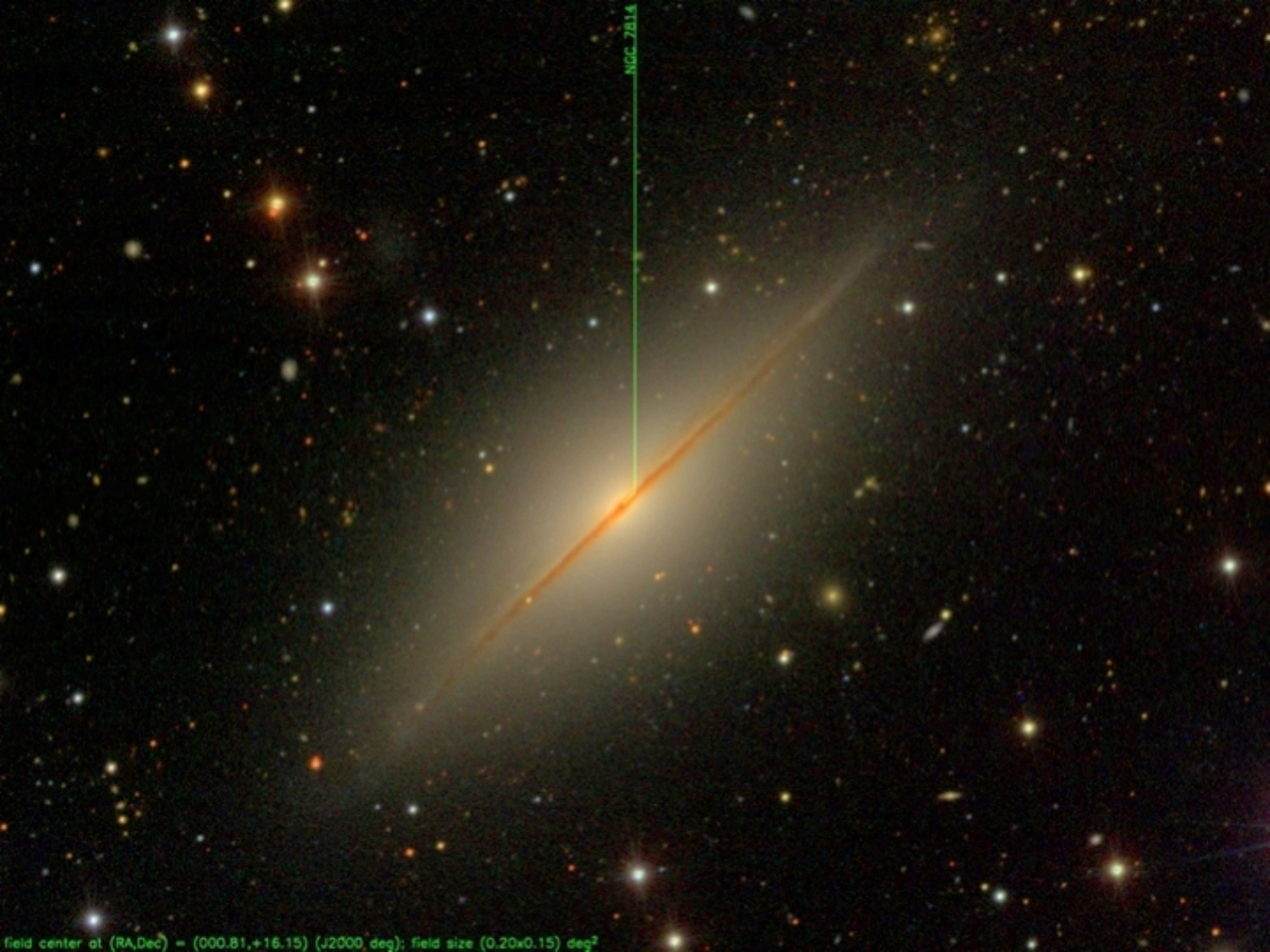
I want

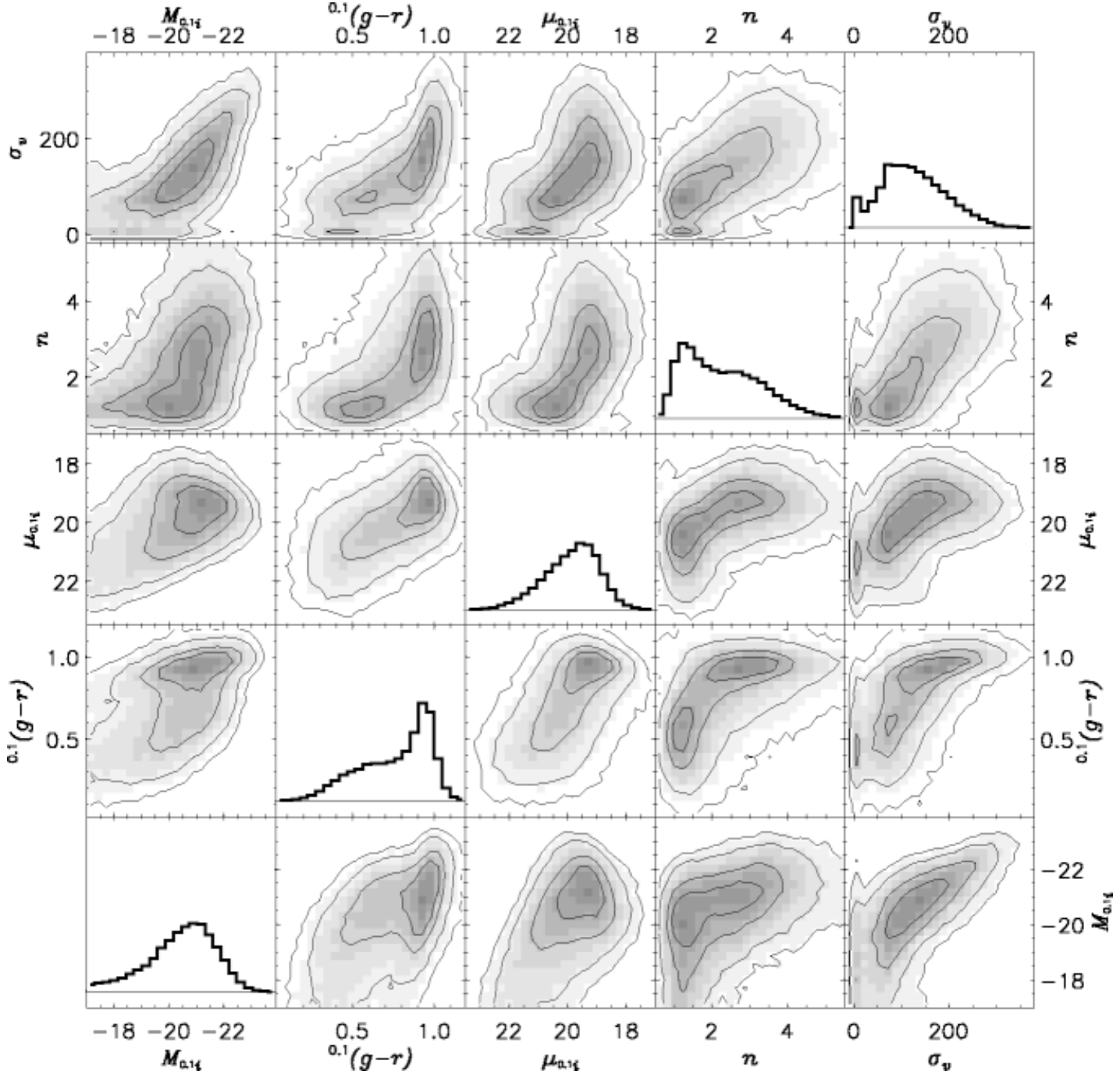
- large solid angle (with large area/boundary ratio),
- multi-band imaging,
- high *S/N* and high resolution imaging, and
- spectroscopy

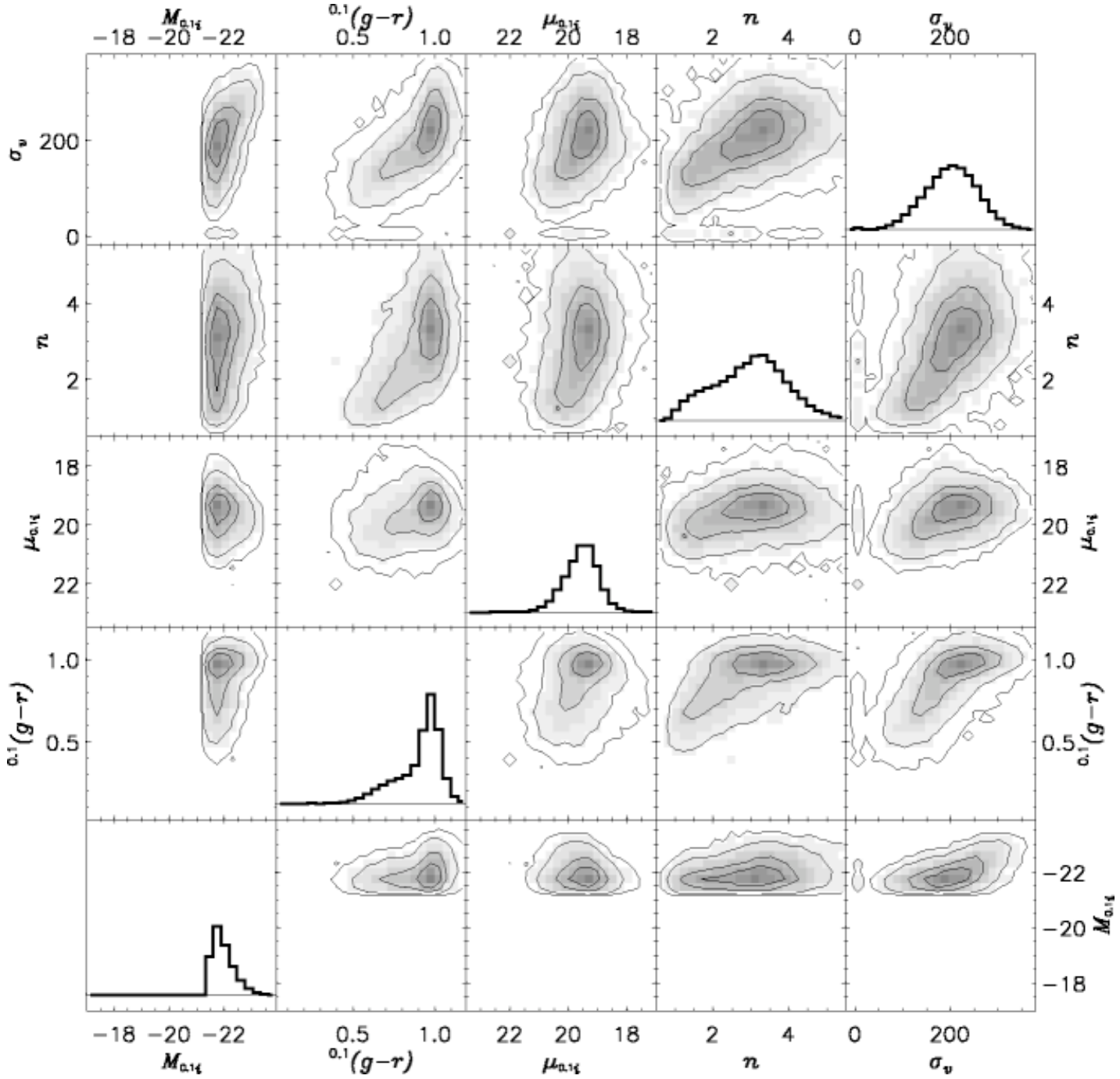
to study the evolution of

- galaxy property relationships,
- environmental dependencies, and
- the merger rate.


NGC 2805
field center at (RA,Dec) = (140.09,+64.10) (J2000 deg); field size (0.20x0.15) deg²


NGC 7814
field center at (RA,Dec) = (000.81,+16.15) (J2000 deg); field size (0.20x0.15) deg²


$M_{0.1i}$
$^{0.1}(g-r)$
$\mu_{0.1i}$
n
σ_v
−18 −20 −22
0.5 1.0
22 20 18
2 4
0 200

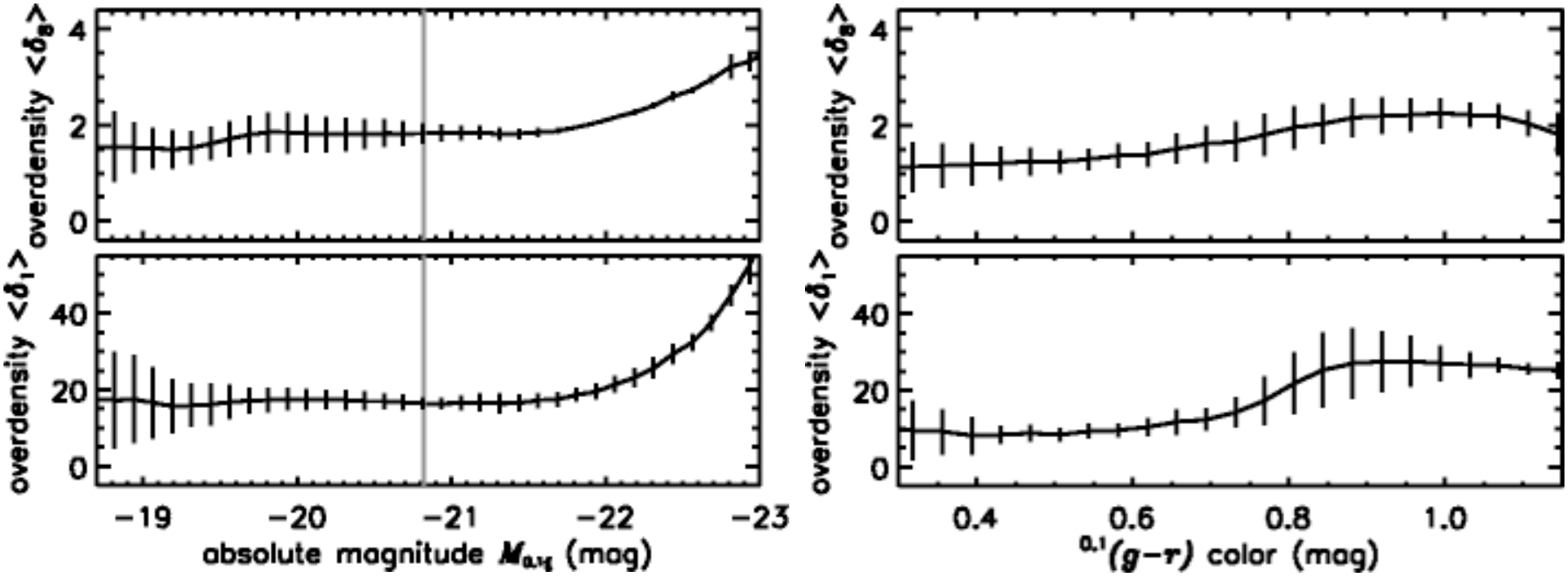

$M_{0.1i}$
$^{0.1}(g-r)$
$\mu_{0.1i}$
n
σ_v
−18 −20 −22
0.5 1.0
22 20 18
2 4
0 200

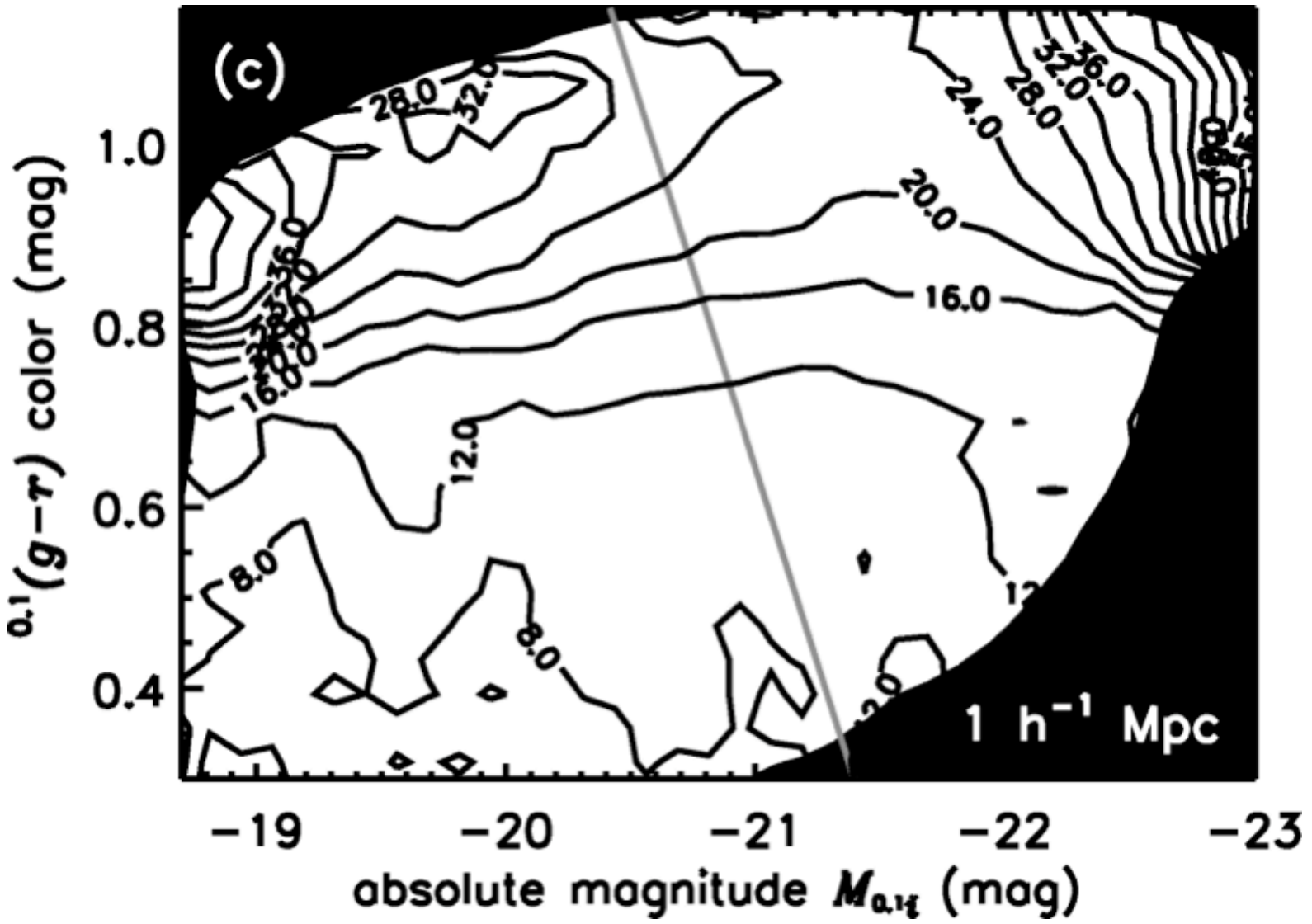
the study of galaxy property relationships requires

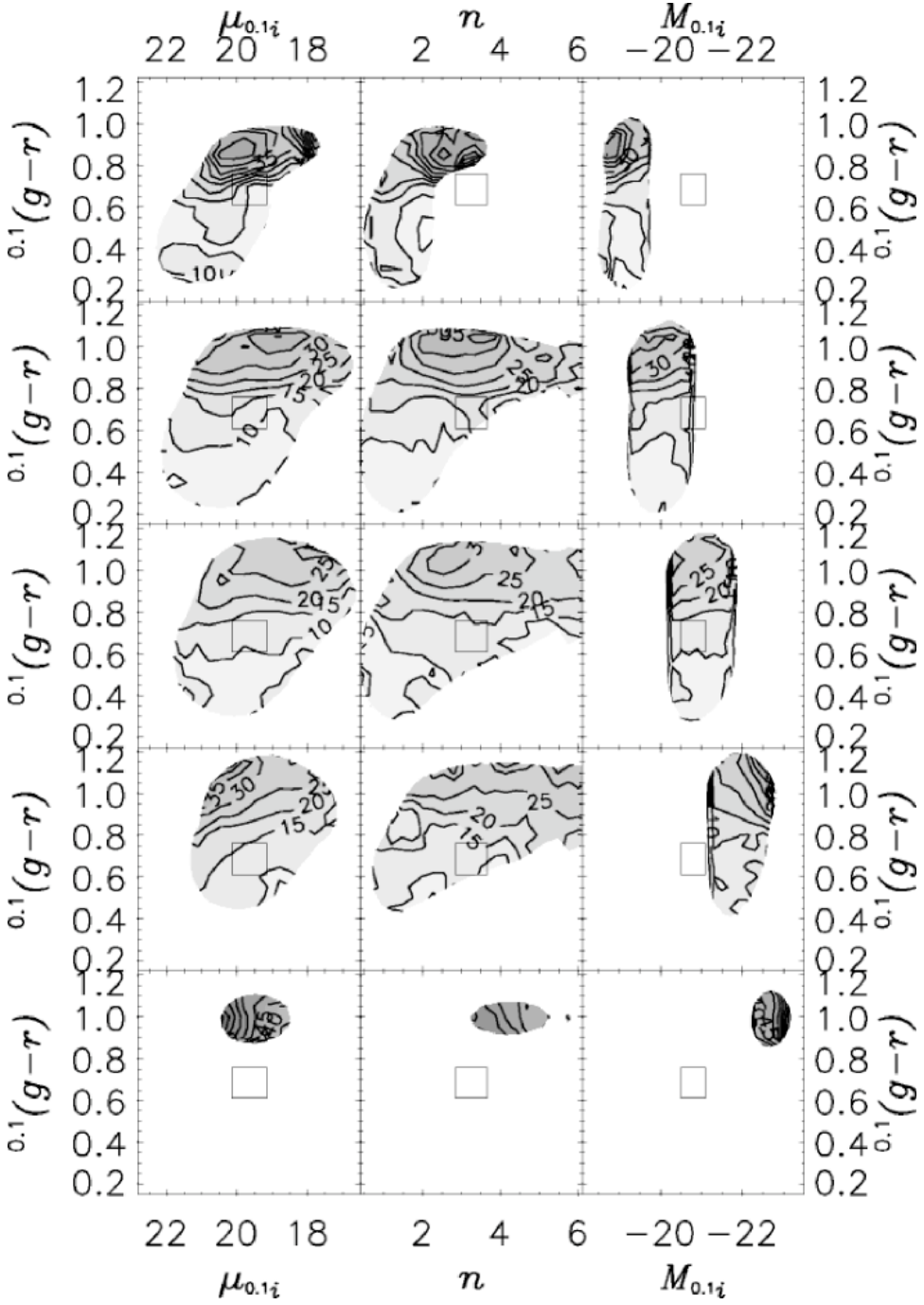
- numbers (10^5 or, better, 10^6)
- high resolution and high *S/N* imaging
- spectroscopy

galaxy environments

- environmental density estimators *never* have high *S/N* (especially if the physical scale is fixed)
- so look at environment *vs* properties, *not* properties *vs* environment
- *information!*
- Eisenstein densities are *spherical* in real space and *unbiased in the mean*.


overdensity <δ8>
overdensity <δ1>
4
2
0
40
20
0
−19
−20
−21
−22
−23
absolute magnitude M0.1i (mag)
0.4
0.6
0.8
1.0
0.1(g−r) color (mag)


(c)
1.0
0.8
0.6
0.4
$^{0.1}(g-r)$ color (mag)
−19
−20
−21
−22
−23
absolute magnitude $M_{0.1i}$ (mag)
1 h^{-1} Mpc
28.0
32.0
24.0
20.0
16.0
12.0
8.0


$\mu_{0.1i}$
n
$M_{0.1i}$
22 20 18
2 4 6
−20 −22
$^{0.1}(g-r)$
1.2
1.0
0.8
0.6
0.4
0.2

Environment correlates with everything (of course), but color and luminosity (star formation history) are the *informative* correlations (in the SDSS, anyway).

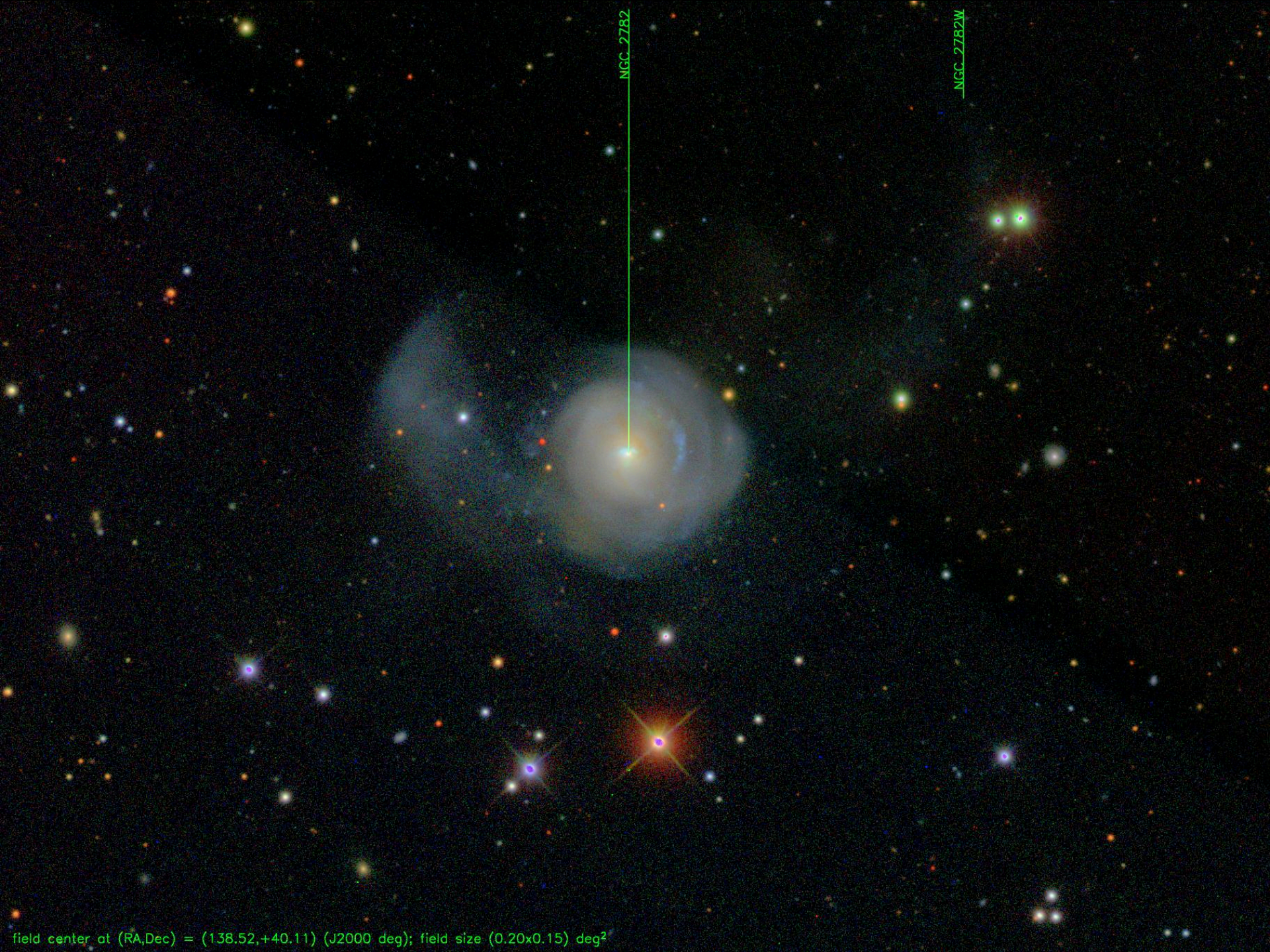
reference: Blanton et al, astro-ph/0310453

the study of galaxy environments requires

- large solid angle to boundary ratio (*eg*, 100x100 Mpc^2 square at the redshift of interest)
- multi-band imaging
- high resolution and high *S/N* imaging
- spectroscopy

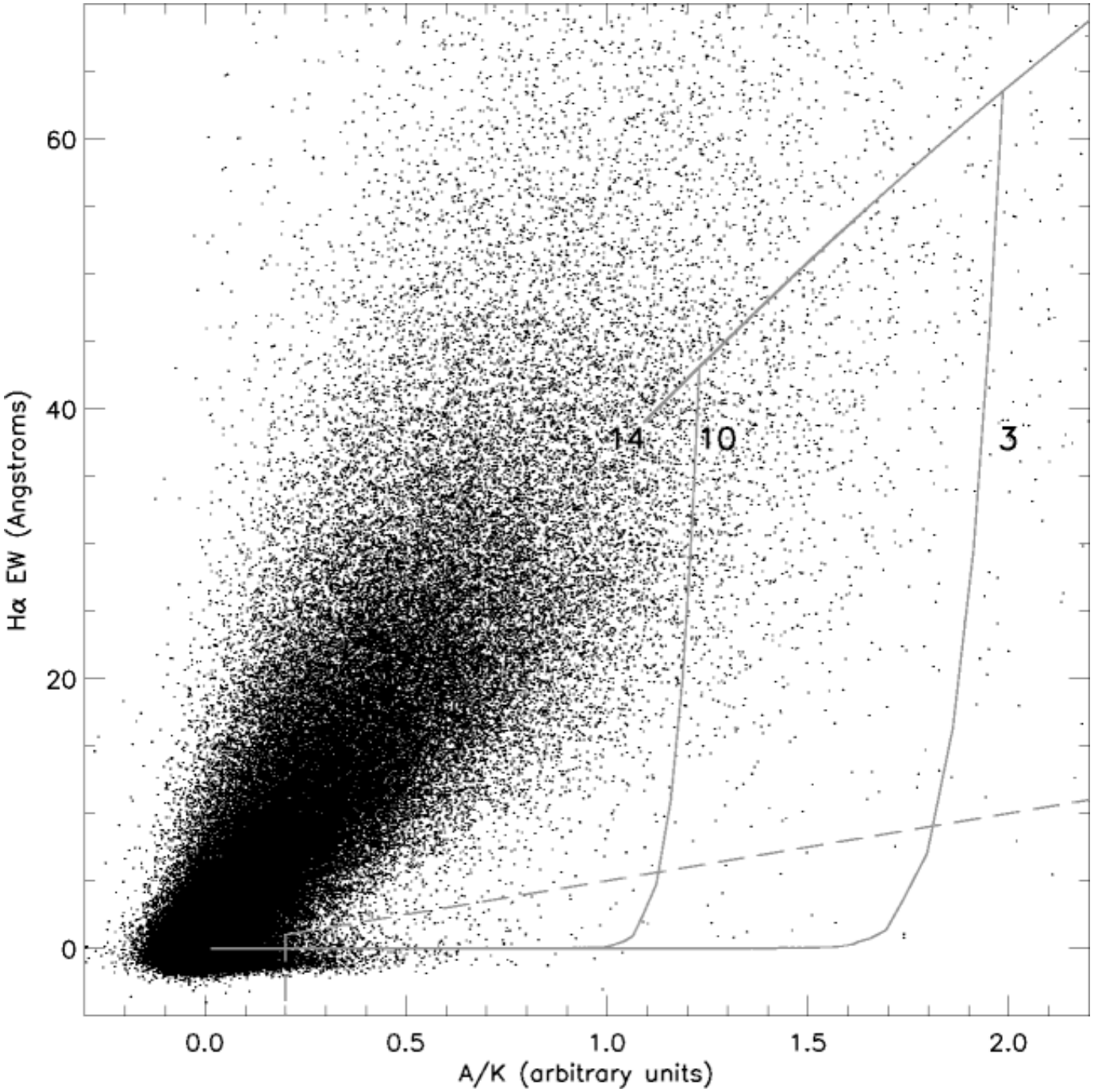
It is *not enough* simply to find correlations;

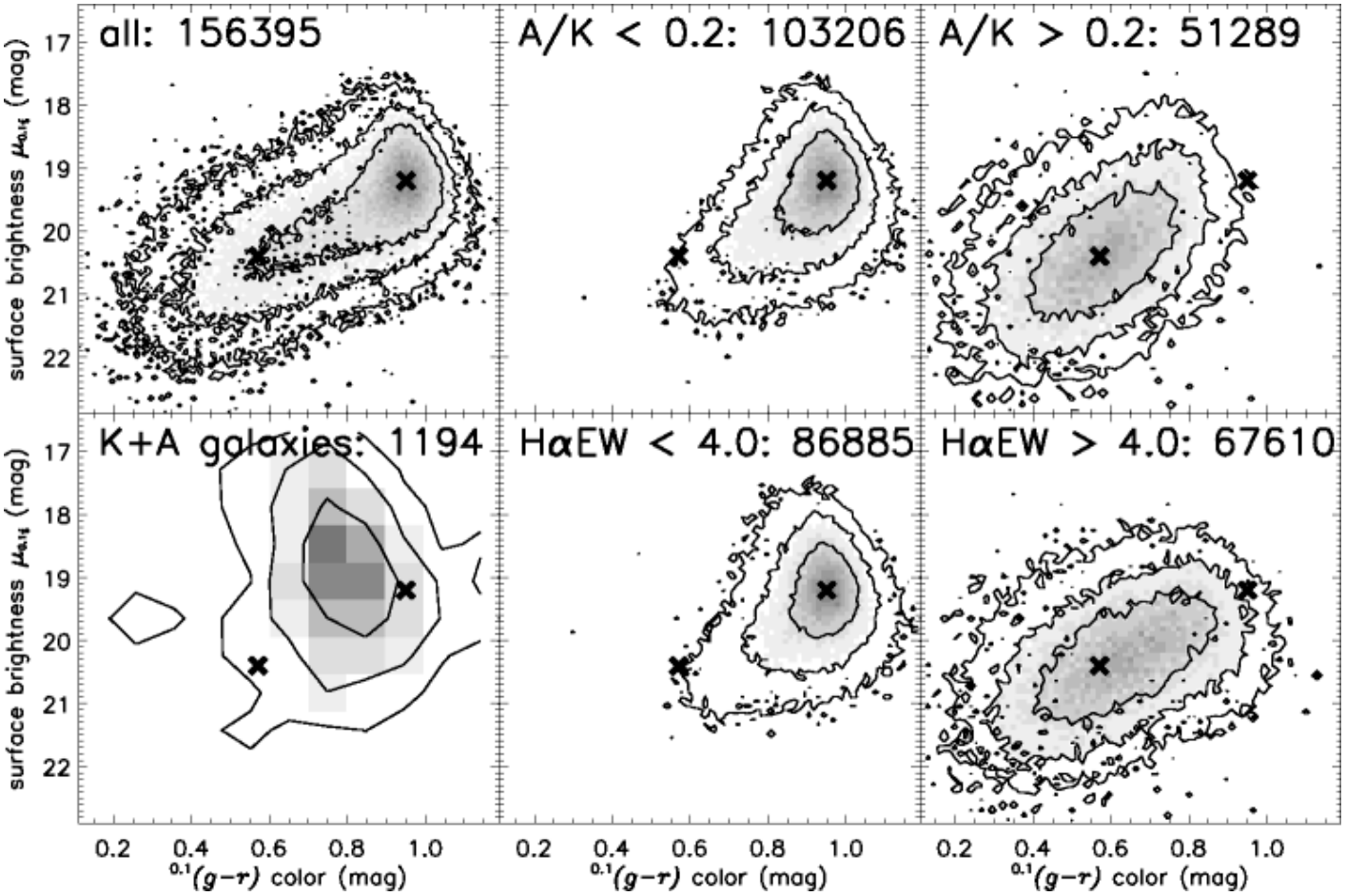
correlations must be shown to be explanatory or independently *informative*.


NGC 2782
NGC 2782W
field center at (RA,Dec) = (138.52,+40.11) (J2000 deg); field size (0.20x0.15) deg²

merger rate

- fundamental in CDM cosmogony
- ought to evolve rapidly
- observed to be “too low” at $z=0.1$


Hα EW (Angstroms)
60
40
20
0
0.0
0.5
1.0
1.5
2.0
A/K (arbitrary units)
14
10
3


all: 156395
A/K < 0.2: 103206
A/K > 0.2: 51289
K+A galaxies: 1194
HαEW < 4.0: 86885
HαEW > 4.0: 67610
surface brightness $\mu_{0.1i}$ (mag)
17
18
19
20
21
22
0.2
0.4
0.6
0.8
1.0
$^{0.1}(g-r)$ color (mag)

event rate: ~10^{-4} h^3 Mpc^{-3} Gyr^{-1}

If this is a *merger rate* then the bulge-dominated galaxy population is growing by 1 percent per Gyr.

reference: Quintero et al, astro-ph/0307074

the study of the merger rate requires

- large volume (eg, 10^{-2} Gpc^3) to measure rare events
- high *S/N* spectroscopy or multi-band imaging
- deep imaging for tidal features

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- multi-band imaging,
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the end