Bursty stellar populations and AGN in bulges

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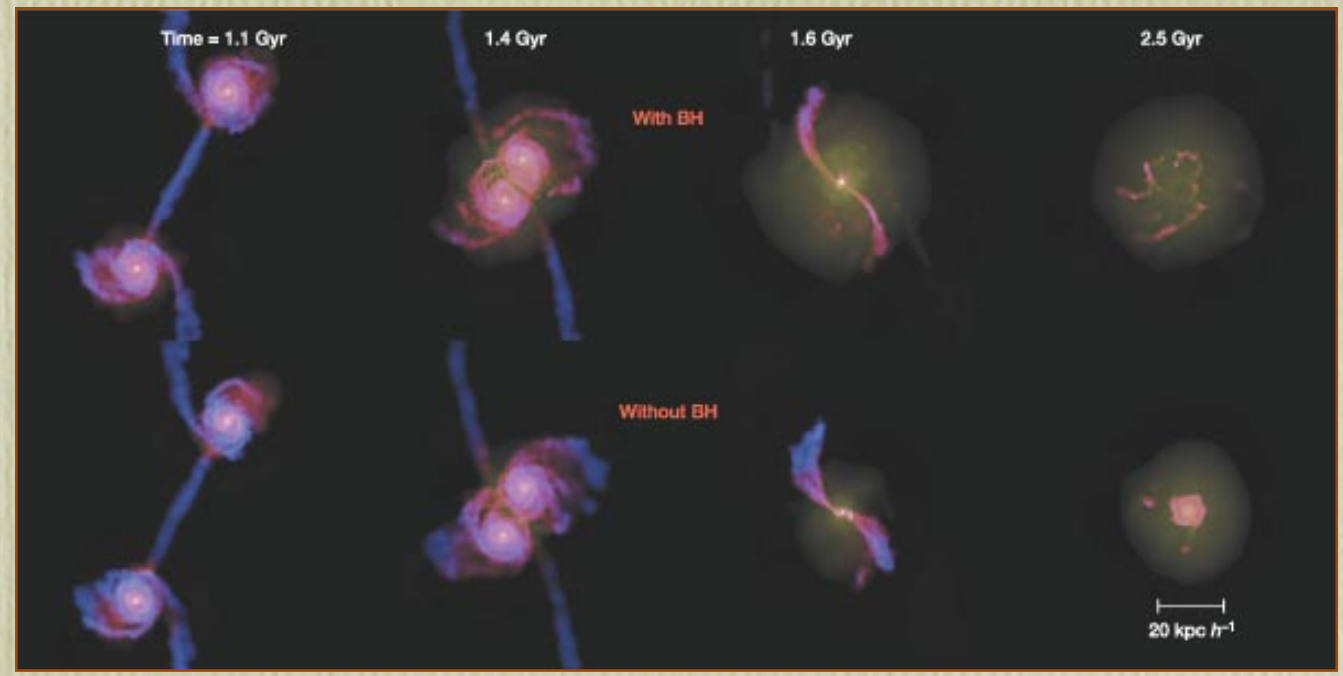
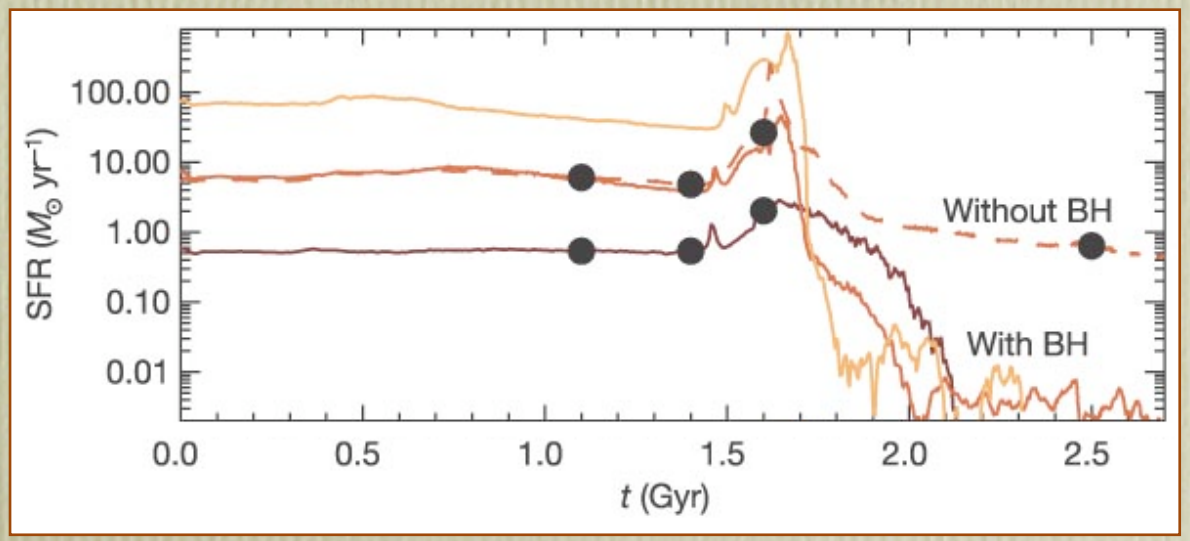
Guinevere Kauffmann, Tim Heckman

Mergers and BH growth: Theory/Simulations



Di Matteo, Springel, Hernquist, Nature 2005



- AGN-starburst connection:
  - Need to funnel gas to nucleus of galaxy
- AGN first?
  - shocks cause starburst
- Starburst first?
  - provide fuel for AGN
- 3rd party involvement?
  - fuels both starburst and AGN
  - e.g. major/minor merger, bar instability

See also Cattaneo et al 2005; Hopkins et al 2006 etc.

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  - $0.01 < z < 0.07$ (3" fiber => 0.6 - 4 kpc diameter)
  - stellar surface mass density > $3 \times 10^8 M_\odot / kpc^2$
    - from where majority of [OIII] luminosity originates (Kauffmann et al. 2003, Heckman et al 2004)
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- Distinguish phase of starburst using continuum alone
  - Avoid traditional bias against finding AGN in post-starburst galaxies by selecting on emission line strength
- Improve the signal-to-noise ratio of current post-starburst indicators (Hδ absorption line)

Building stellar populations with PCA

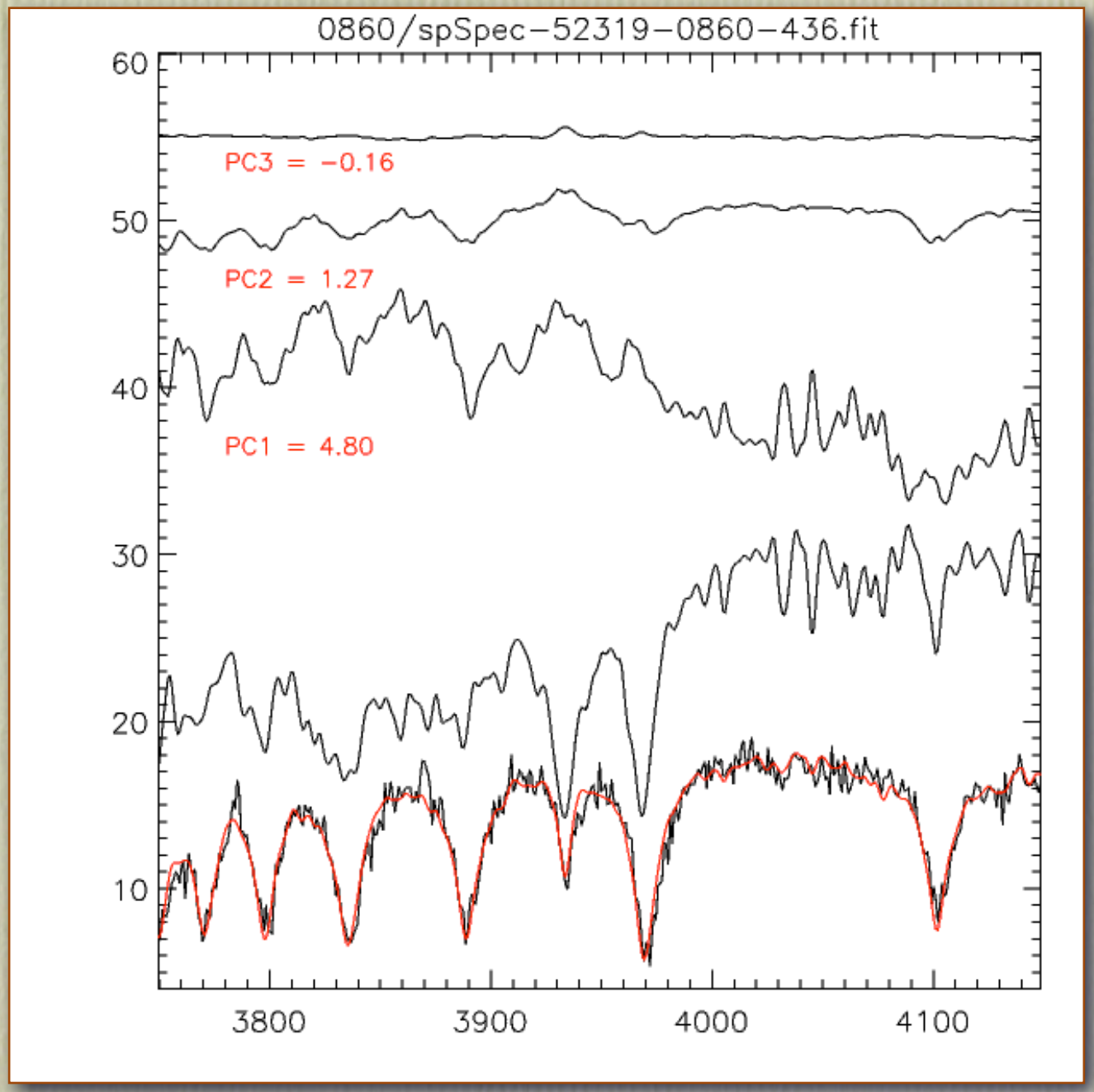
Espec 3 →
+
Espec 2 →
+
Espec 1 →

+

Mean →

=

Galaxy →
PCA reconstruction



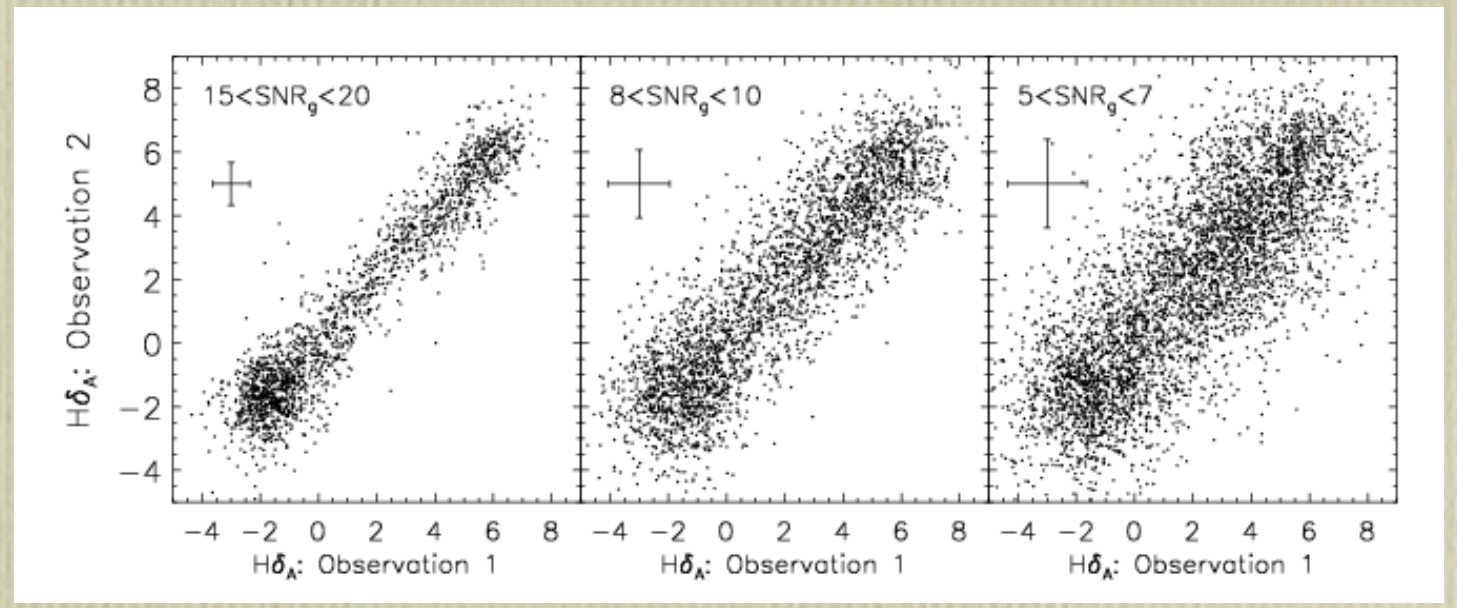
Excess Ca II (H&K)

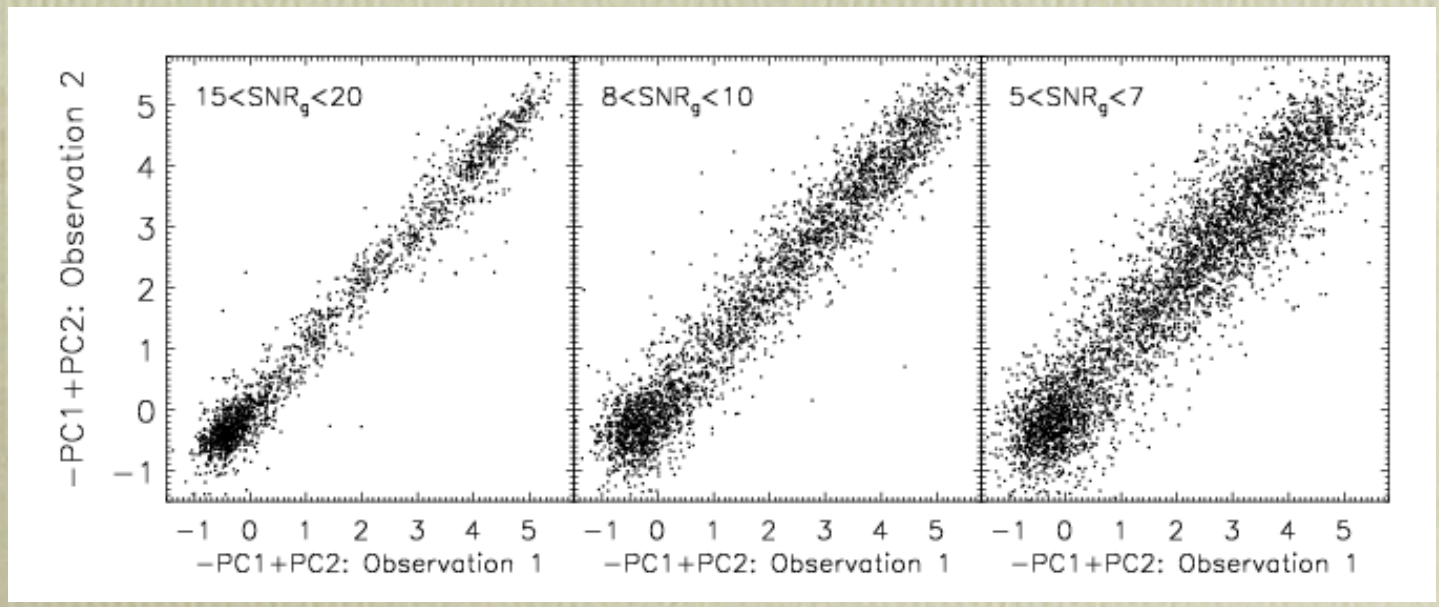
Excess Balmer Absorption

D4000 ∝ 1/Hδ

Bruzual & Charlot 03 models

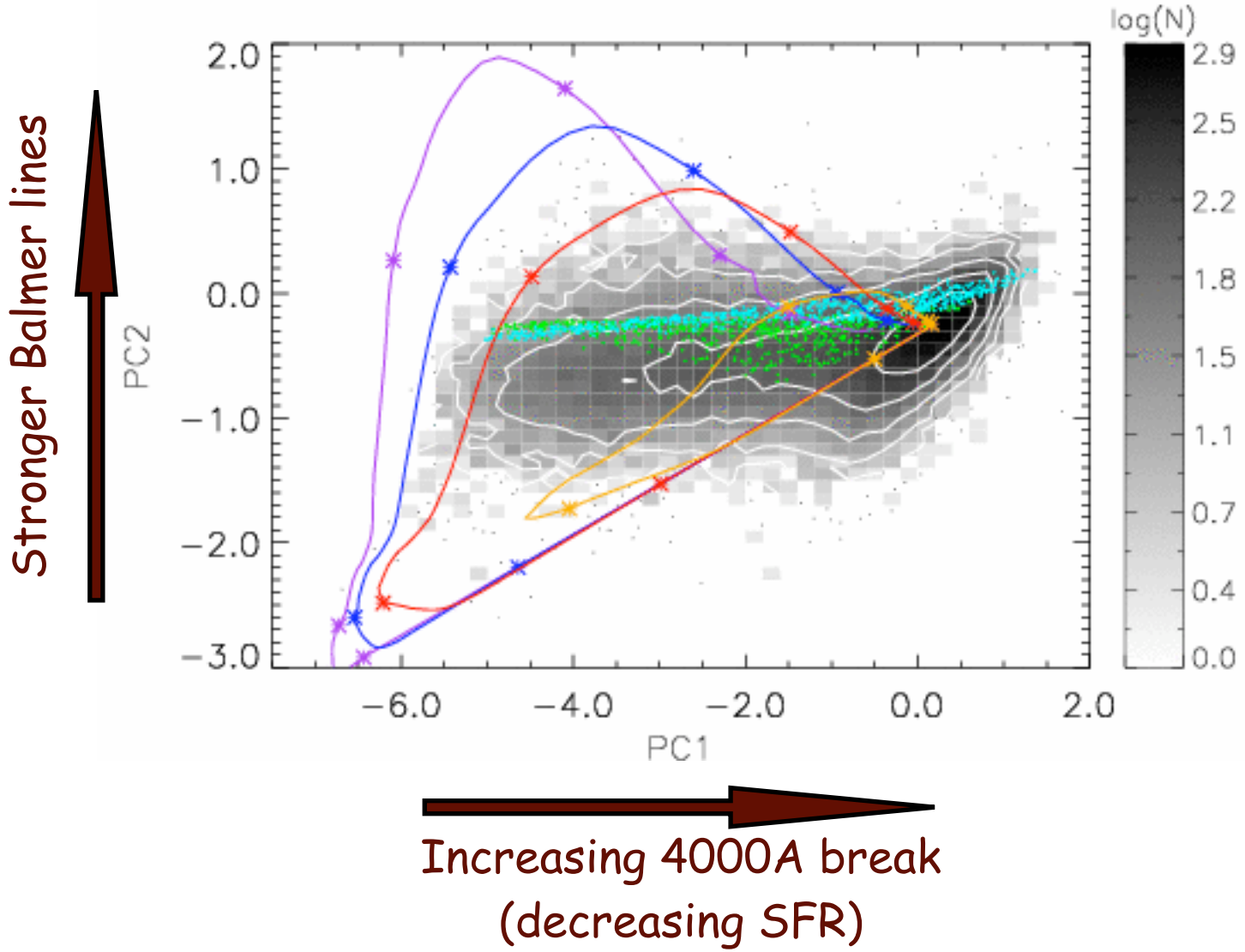
Why bother?





- **Duplicate observations**, as a function of signal-to-noise ratio of the spectra

Comparison with models

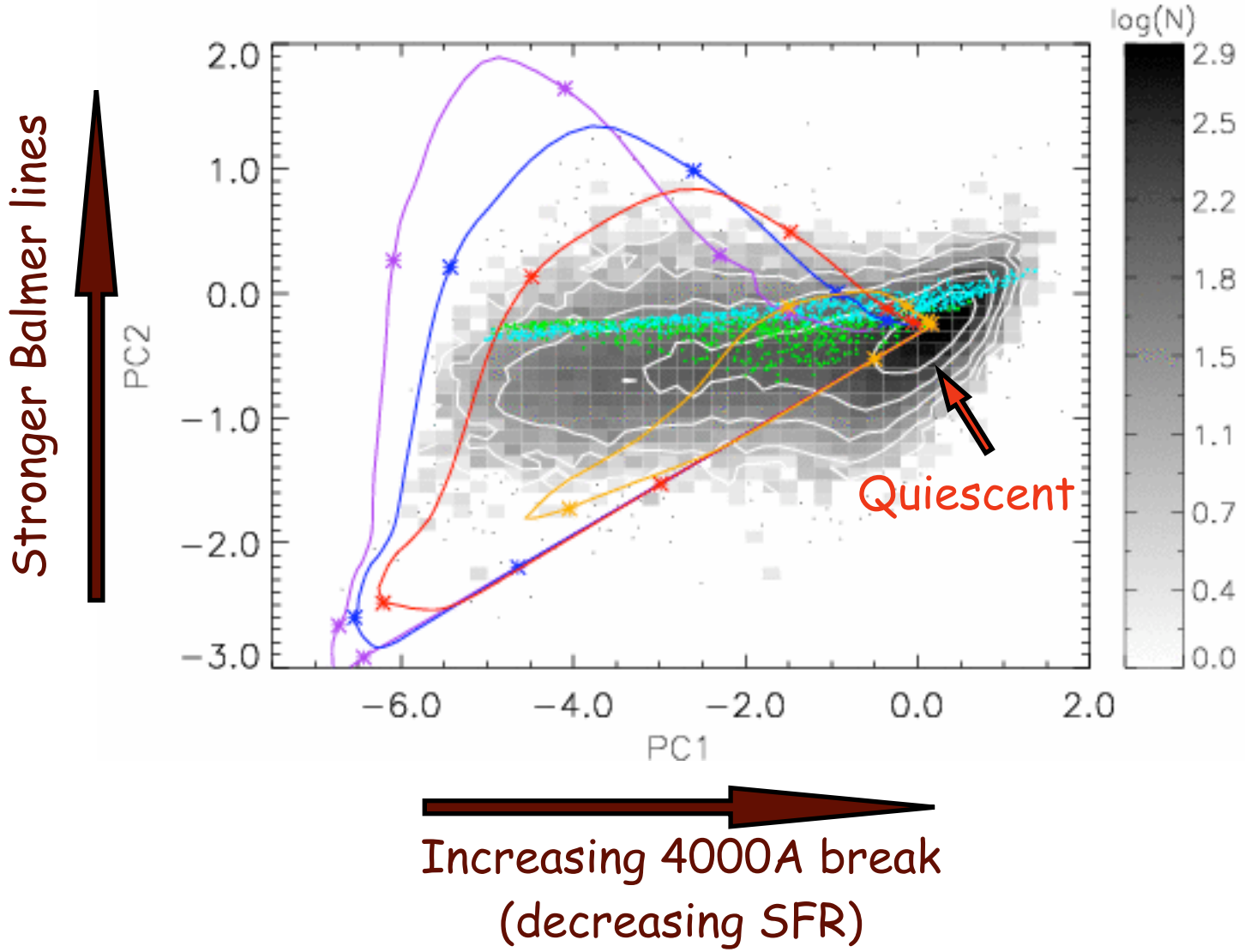


Points: exponentially declining star formation

Tracks: Tophat starbursts on SDSS elliptical

Mass fraction of stars formed in burst=0.5%, 1%, 3%, 20%

Comparison with models



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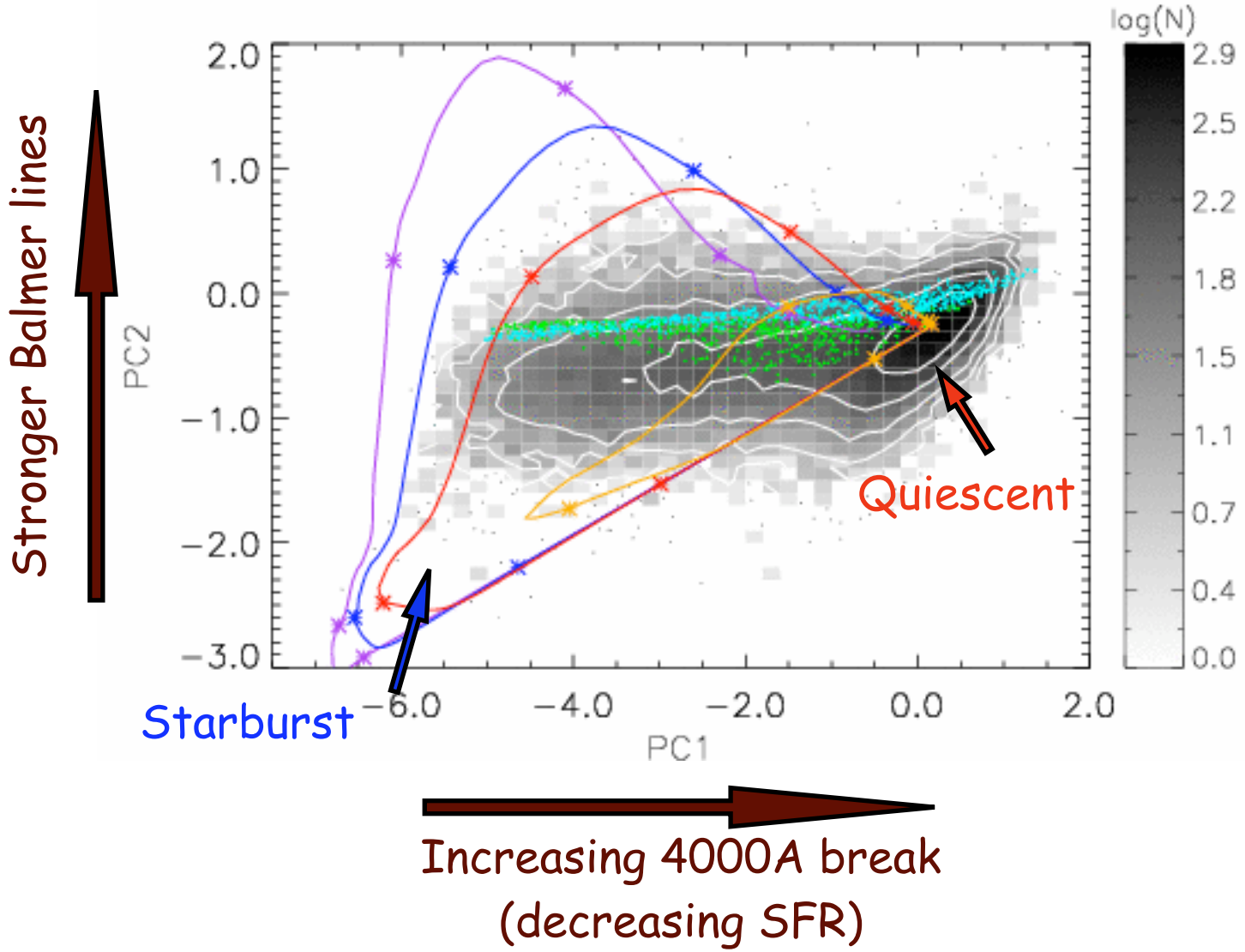

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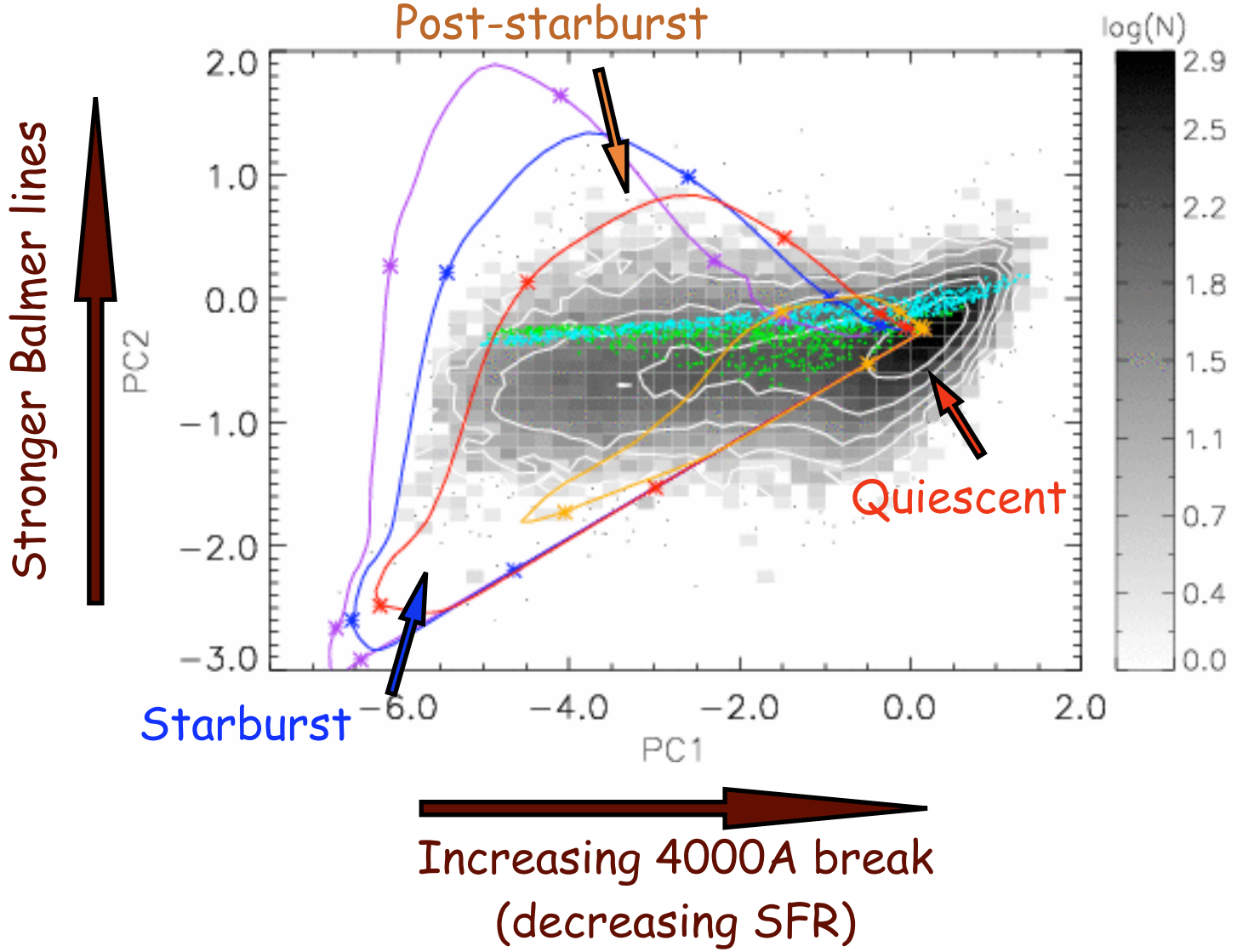

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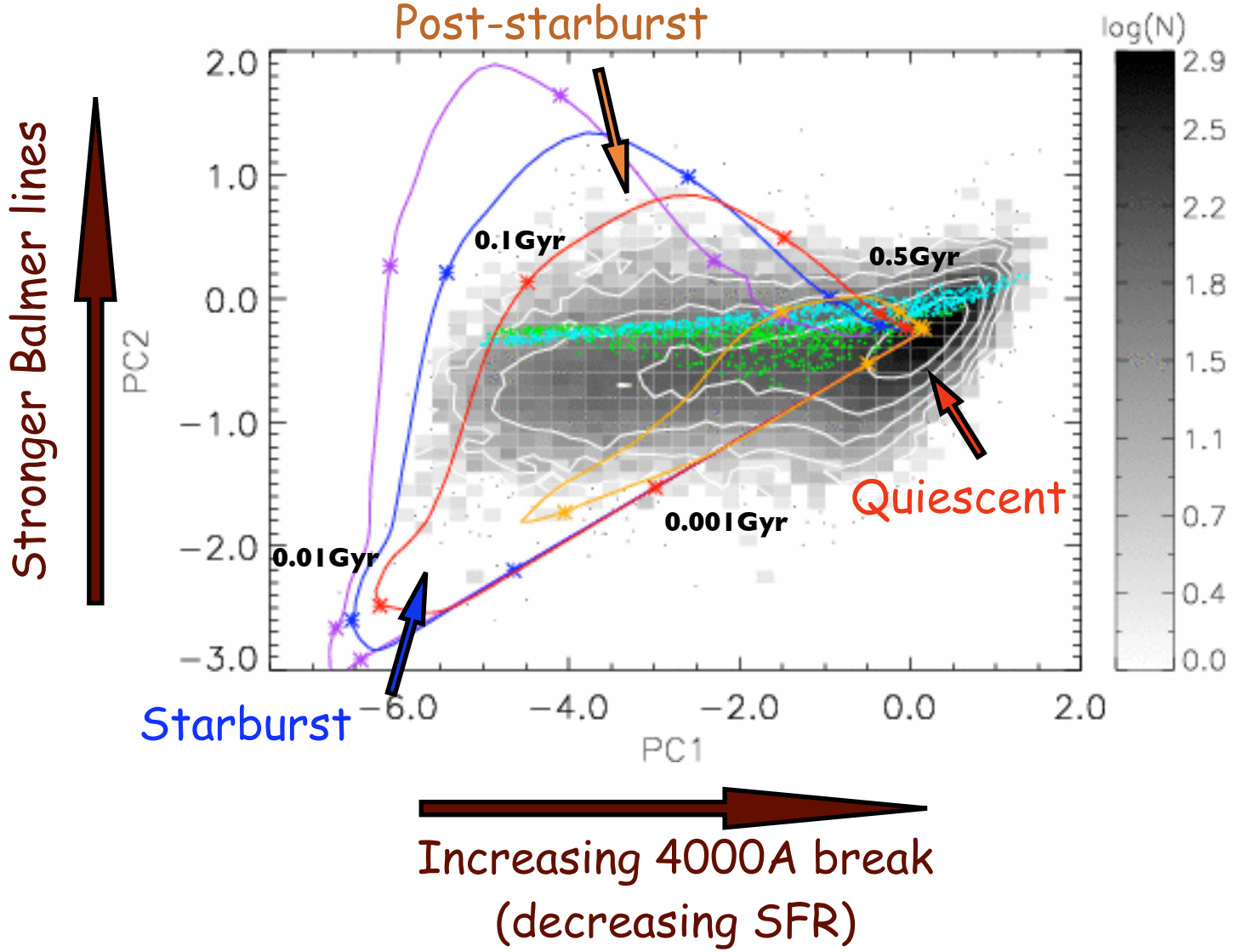

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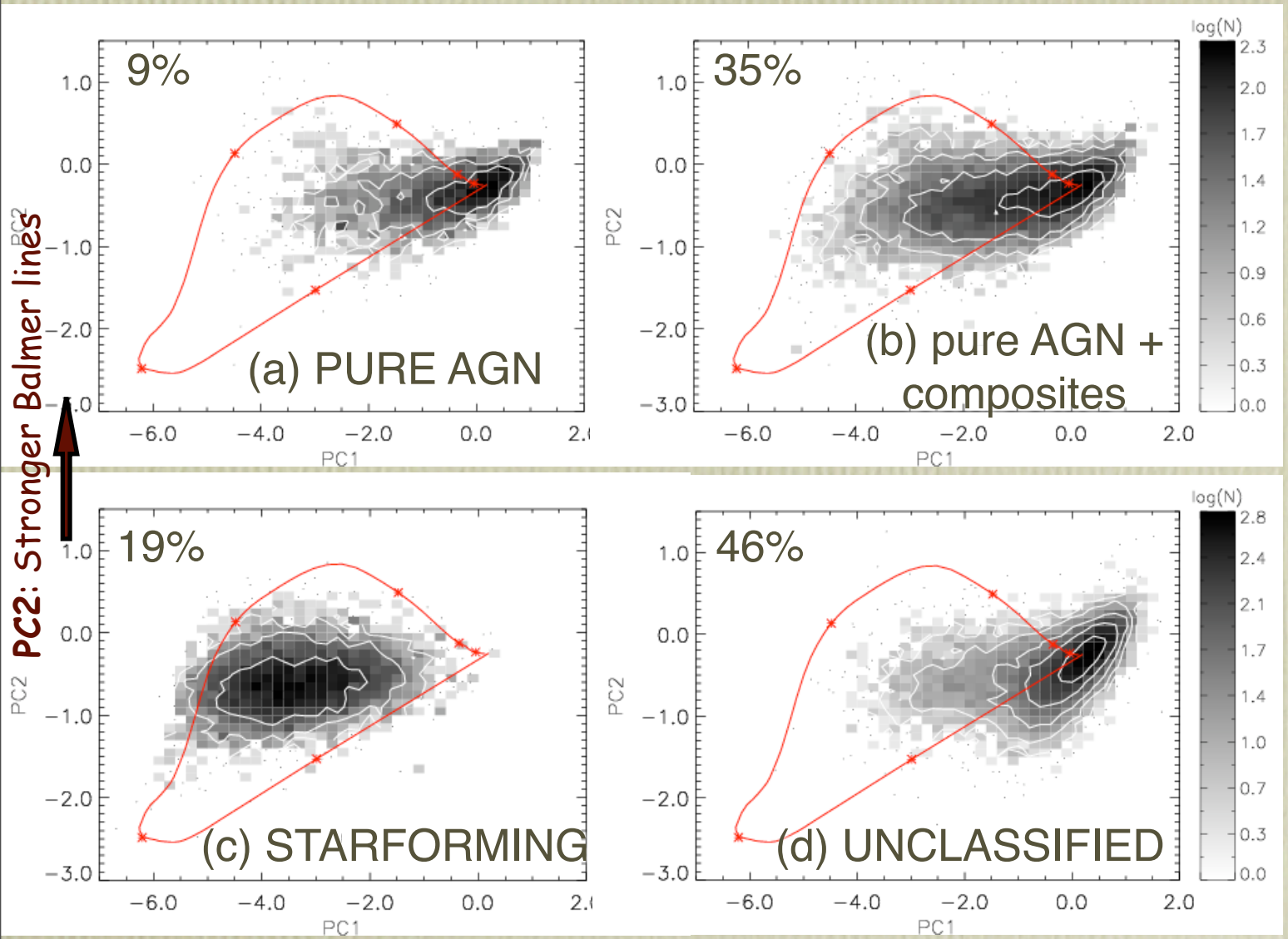
The stellar populations of AGN hosts



Use Narrow emission ratios to split into 4 classes

- Hα, NII, Hβ and [OIII] (Baldwin, Phillips, Terlevich 1981)
- assume standard unified model for relation between Type I and Type II AGN

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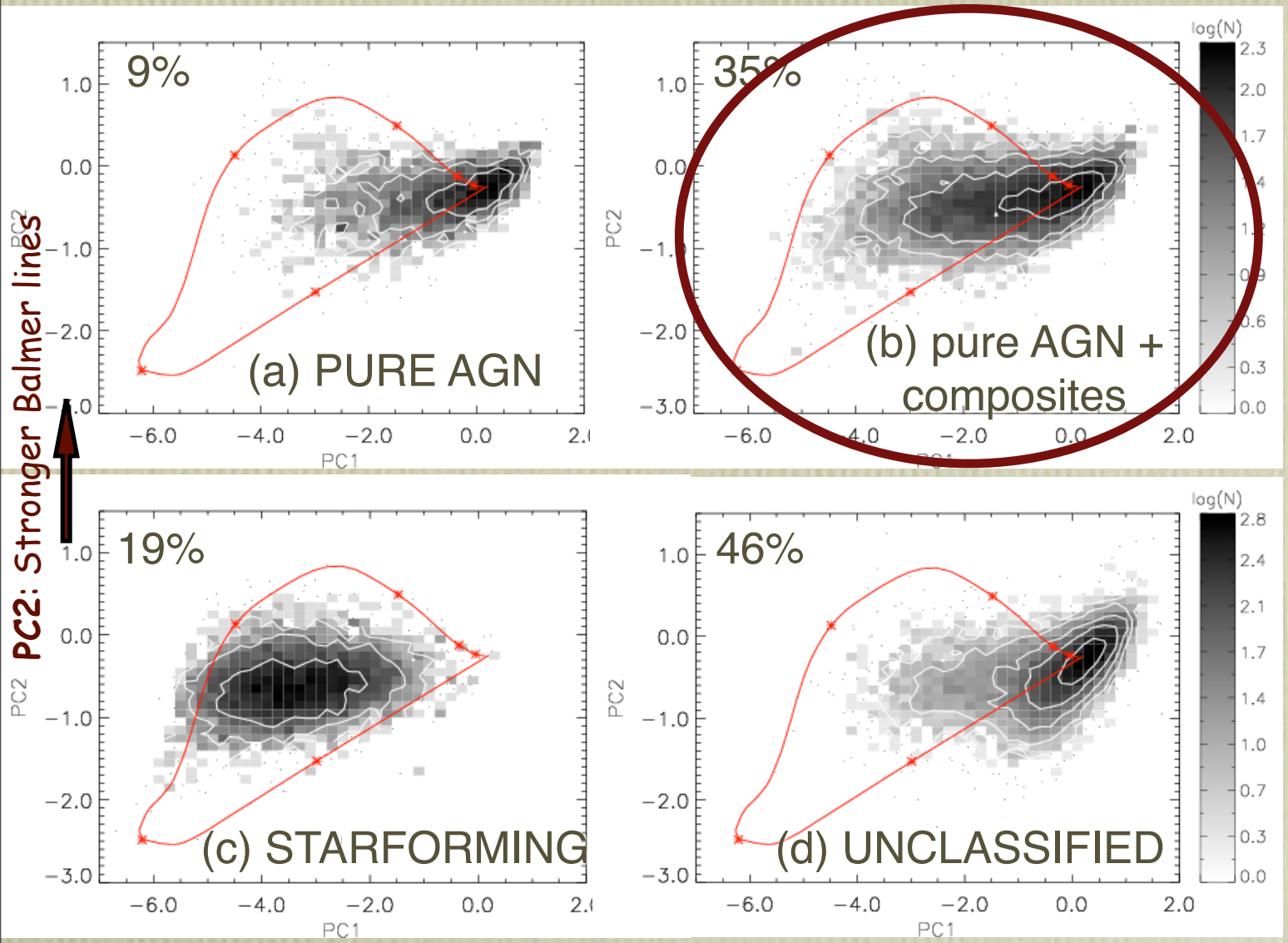

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A link with mergers?

- Simulation merger remnants tend to be compact, but with signs of disturbance up to 1Gyr after major merger (e.g. Mihos & Hernquist 1994, Cox et al 2006)

PLOTS method adapted from :
Cappellari M., Copin Y., 2003

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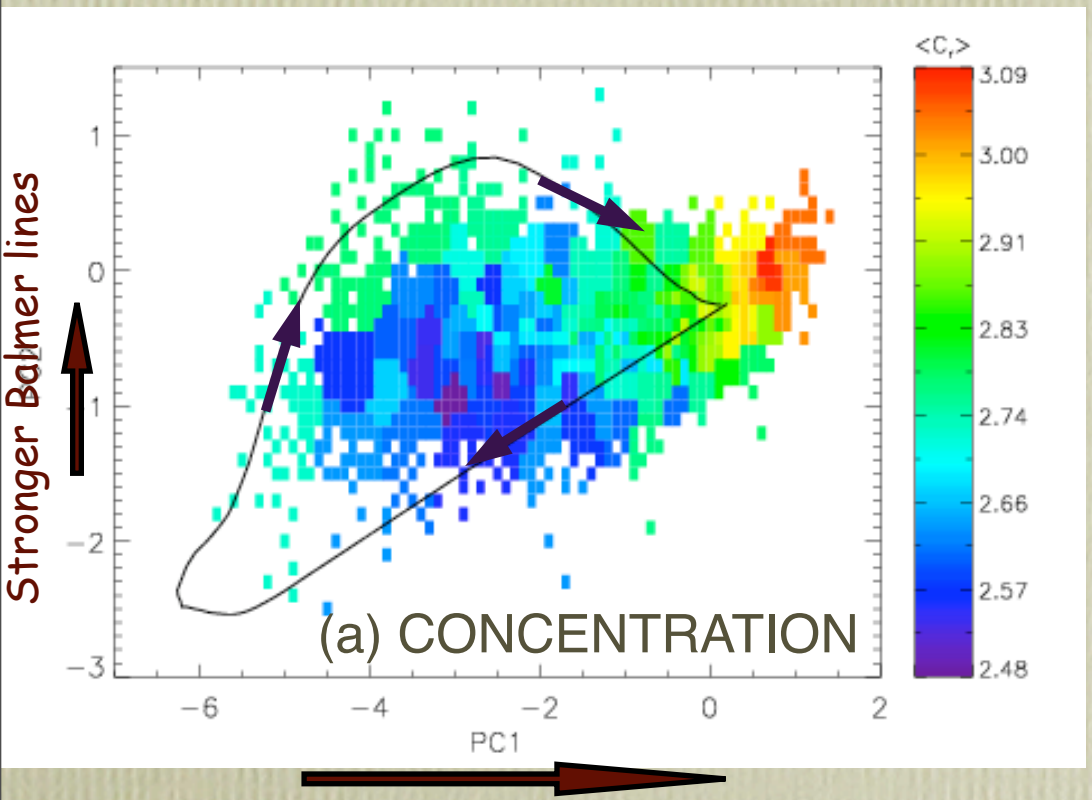

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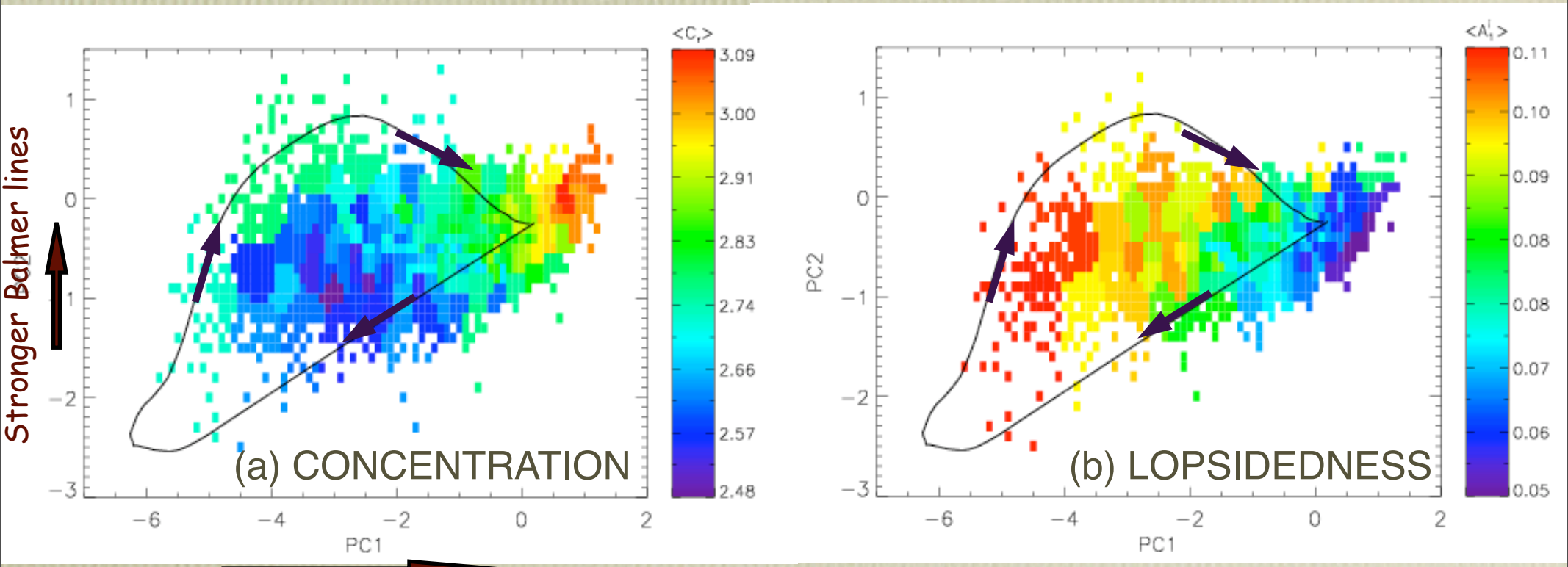

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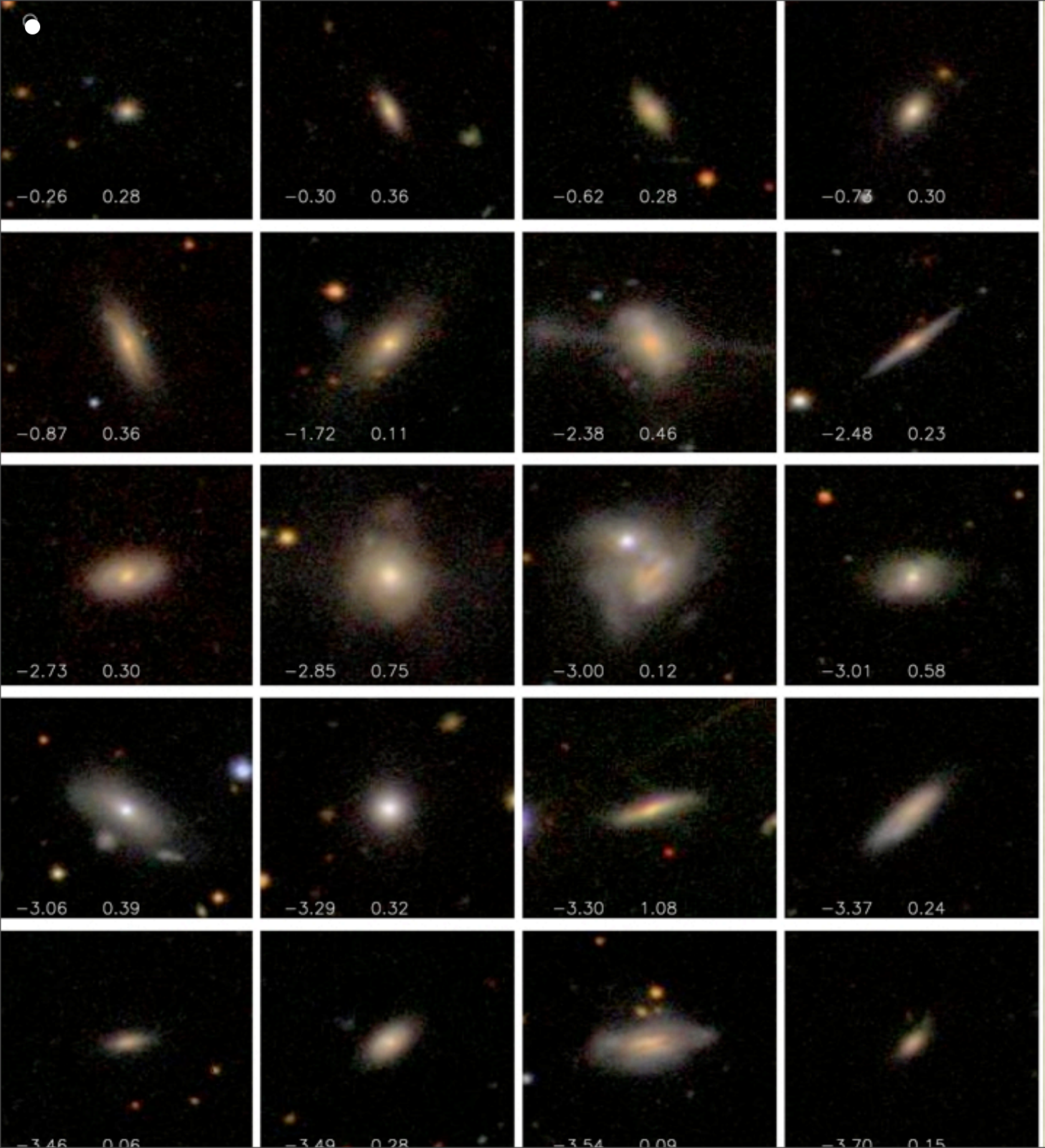
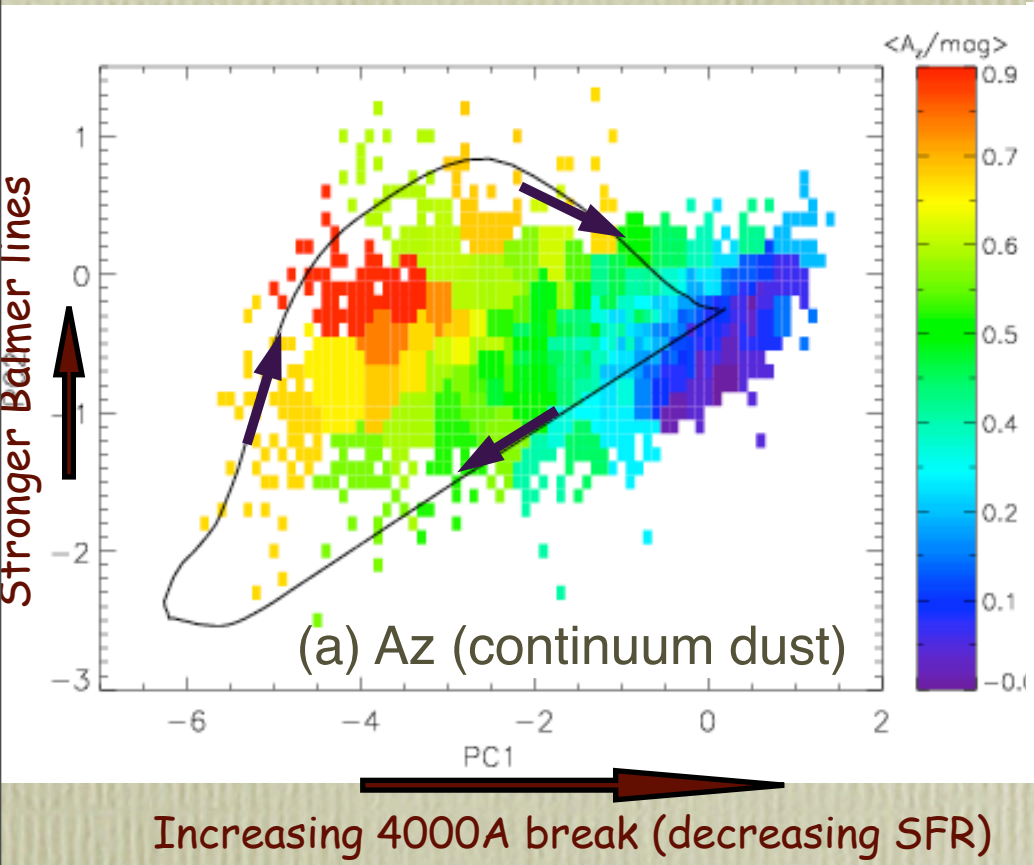
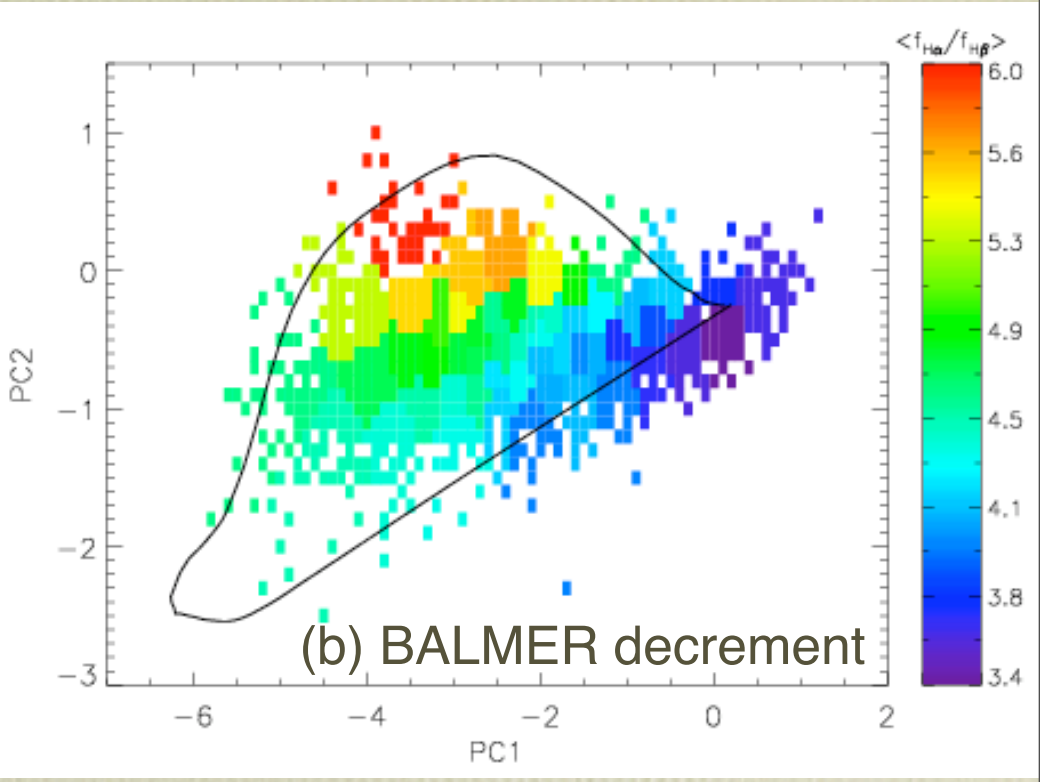


Examples of galaxies with post-starburst bulges

Obscured AGN - June 2007

An interesting dust trend...

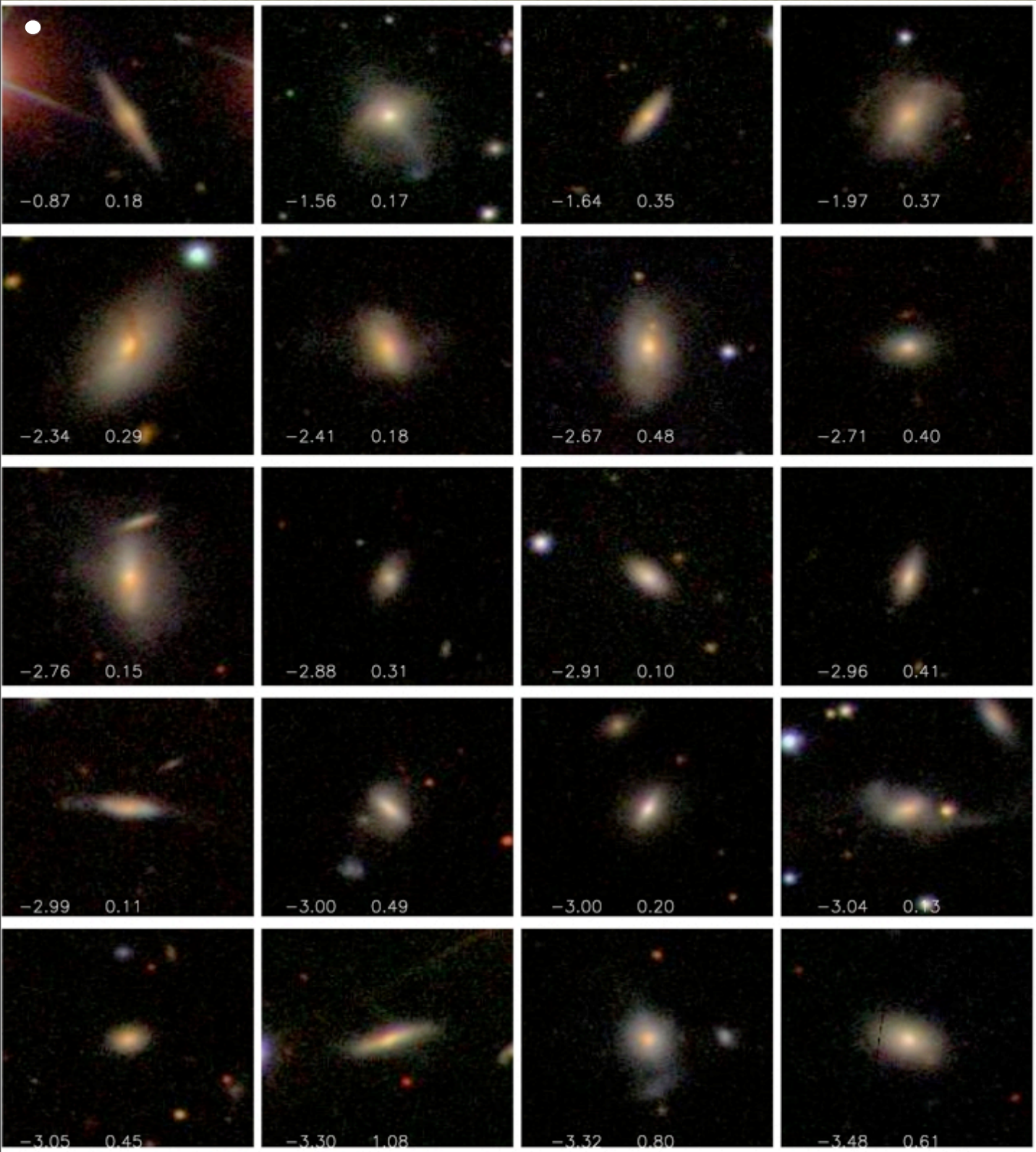




Increasing 4000A break (decreasing SFR)

But where is the dust (3" diameter fibres)?
* Dusty AGN torus?
* AGB stars? (>50Myr after burst)

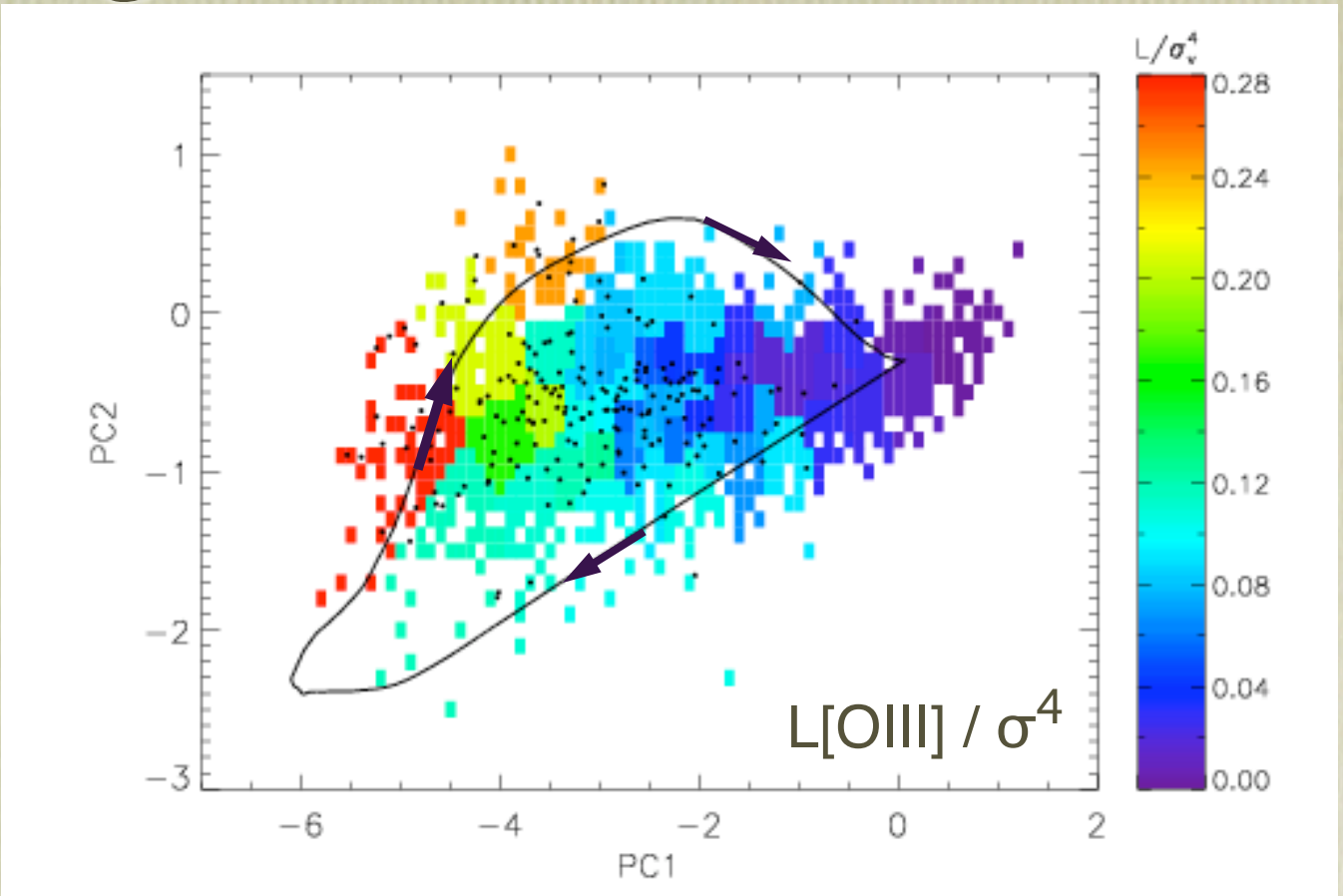
Spitzer IRS spectra on the way!!



Galaxies with dustiest post-starburst bulges

Obscured AGN - June 2007

The growth of black holes. I



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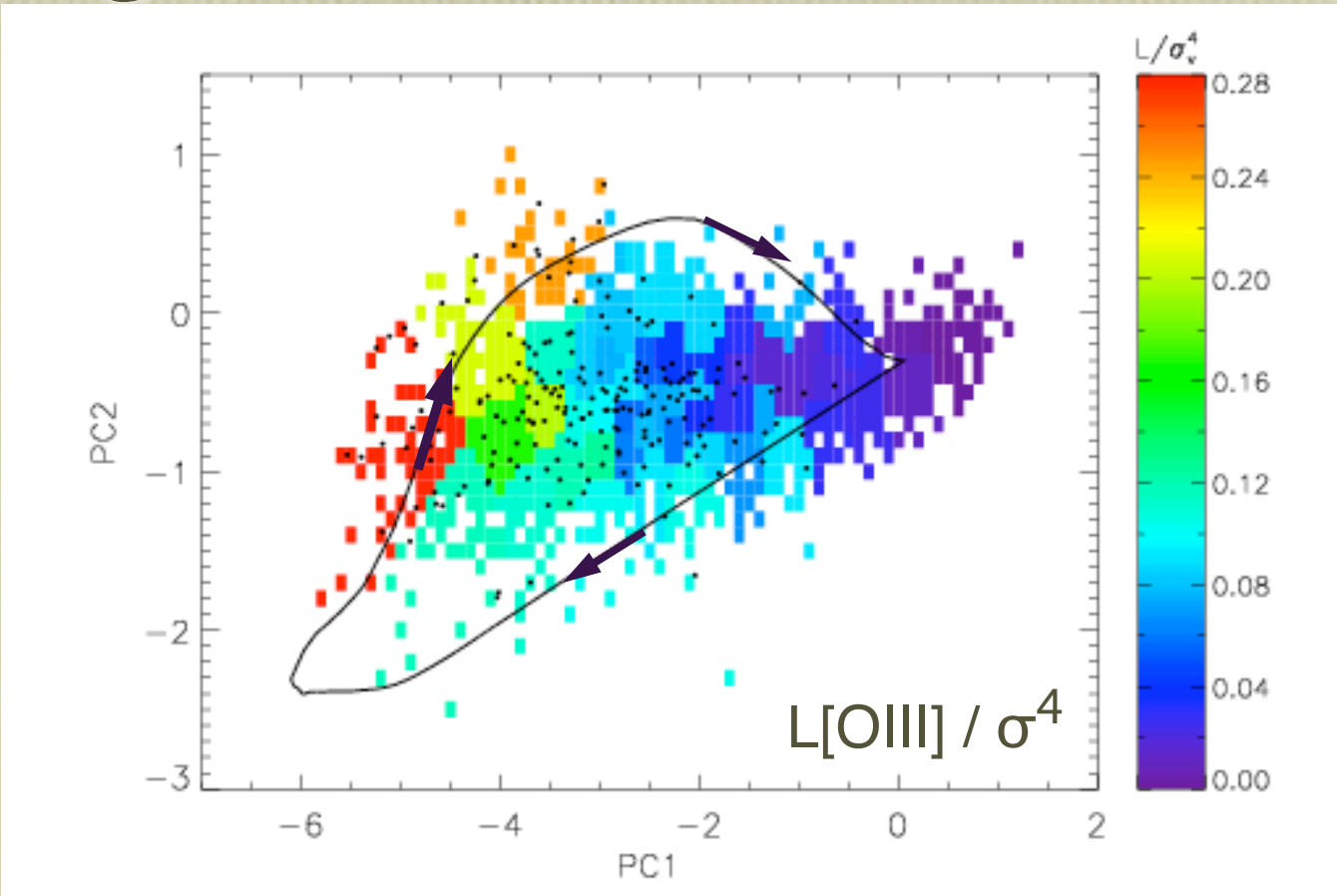
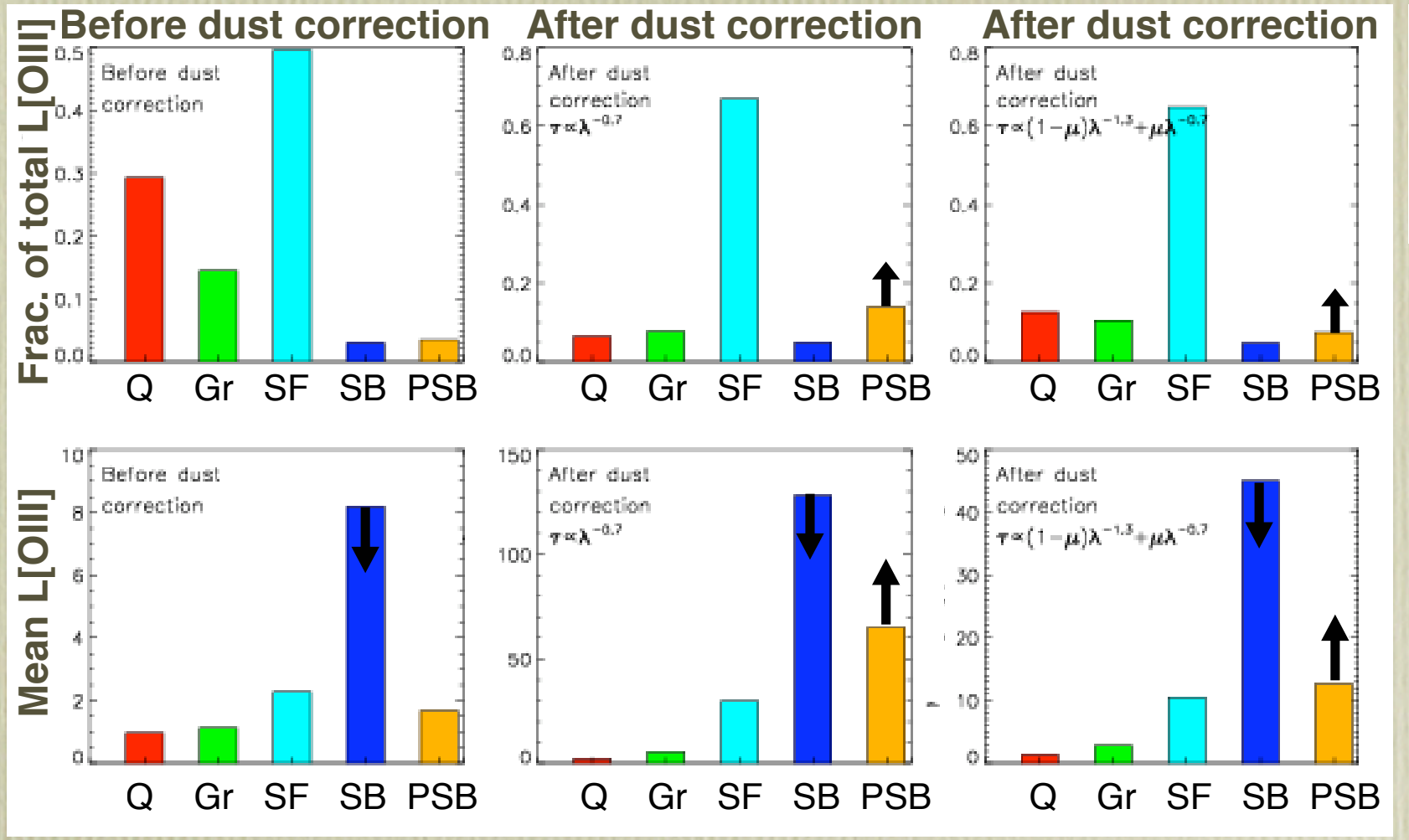
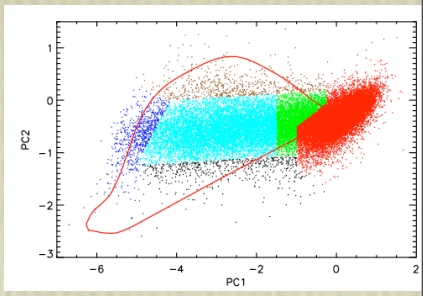


- 50% of black hole growth is accounted for by only ~200 bulges (/ 33000)
  - distributed throughout the starforming, starburst and post-burst classes
  - a strong starburst is a helpful, but not necessary, condition for black hole growth
  - No clear evidence for substantial feedback suddenly halting starformation in the majority of low-z (low luminosity) AGN

The growth of black holes. II





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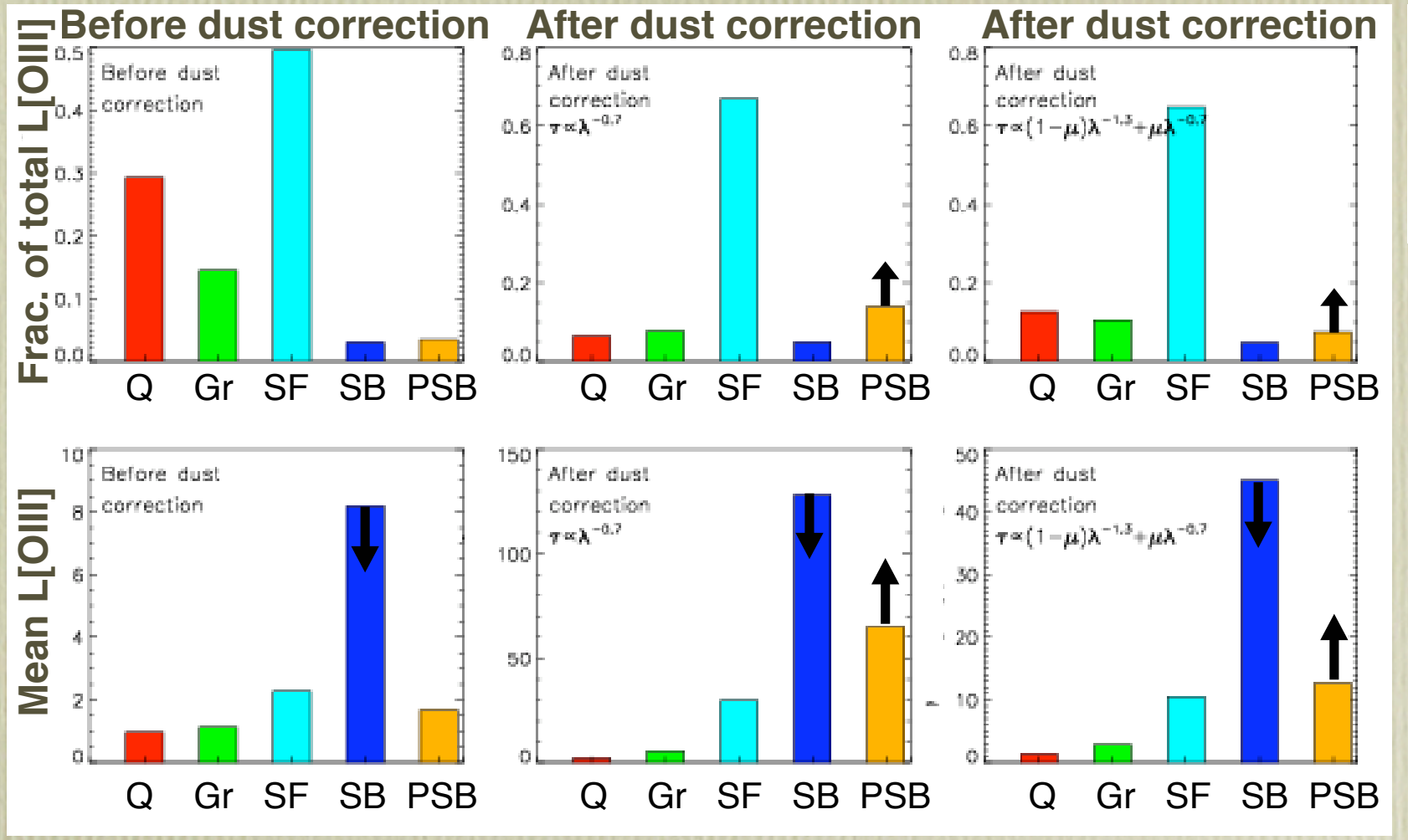
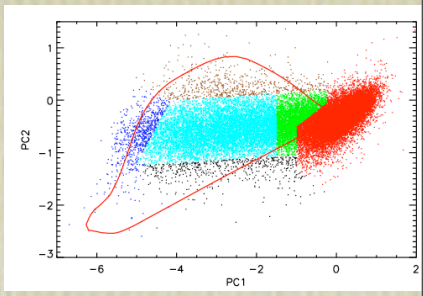




- 45% of low-z AGN are hosted by bulges with quiescent stellar populations
  - But have low accretion rates, and contribute only ~5-10% to total black hole growth
- 4% of AGN are hosted by bulges along the strong (M_{burst}>**1%** M*) starburst track
  - These contribute at least 10-20% to total black hole growth

Conclusions:

black hole growth in the local Universe

- The **minor-merger+starburst+black hole growth** scenario is a significant, but not dominant, source of low-z black hole growth
  - 4% of AGN are hosted by bulges along the strong (M_{burst}>**1%** M*) starburst track
  - These contribute at least 10-20% to total black hole growth
  - AGN hosts in the young strong-starburst track show tidal tails/lopsidedness etc.
  - Post-starburst galaxies are compact and dusty
- **But, > 60%** of black hole growth occurs in bulges with unspectacular recent star formation histories
- A strong (recent/ongoing) starburst in galaxy host bulge is a **helpful**, but **not necessary,** condition for strong accretion onto black hole
- Correction for dust attenuation is extremely important to get the correct global view of the starburst-AGN connection
- > 50% of post-starbursts host AGN: no clear evidence for catastrophic feedback in low-z AGN

See Wild et al (2007) on astro-ph soon!

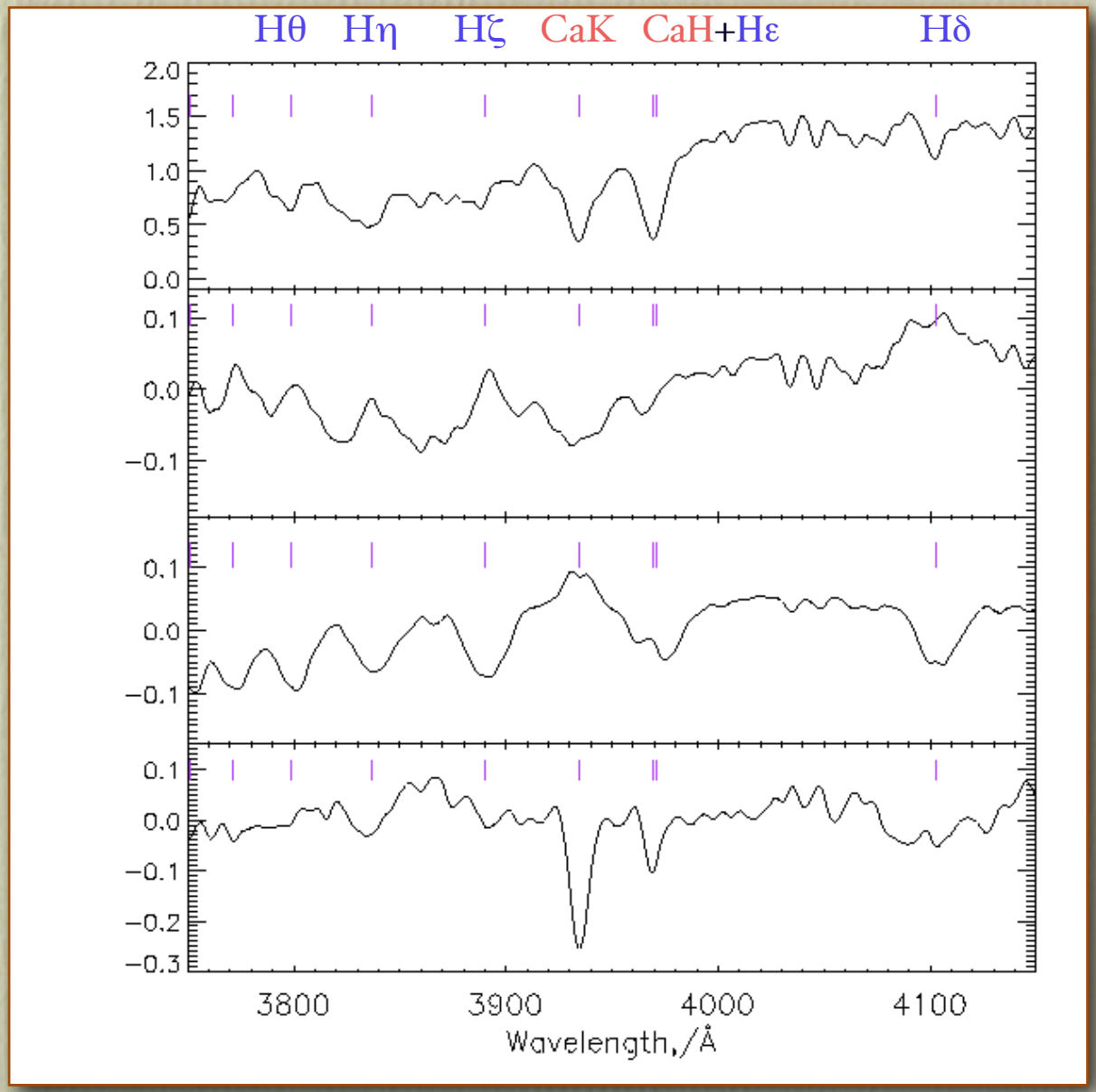
New stellar population measure: "Eigenspectra"

Mean →

Espec 1 →

Espec 2 →

Espec 3 →



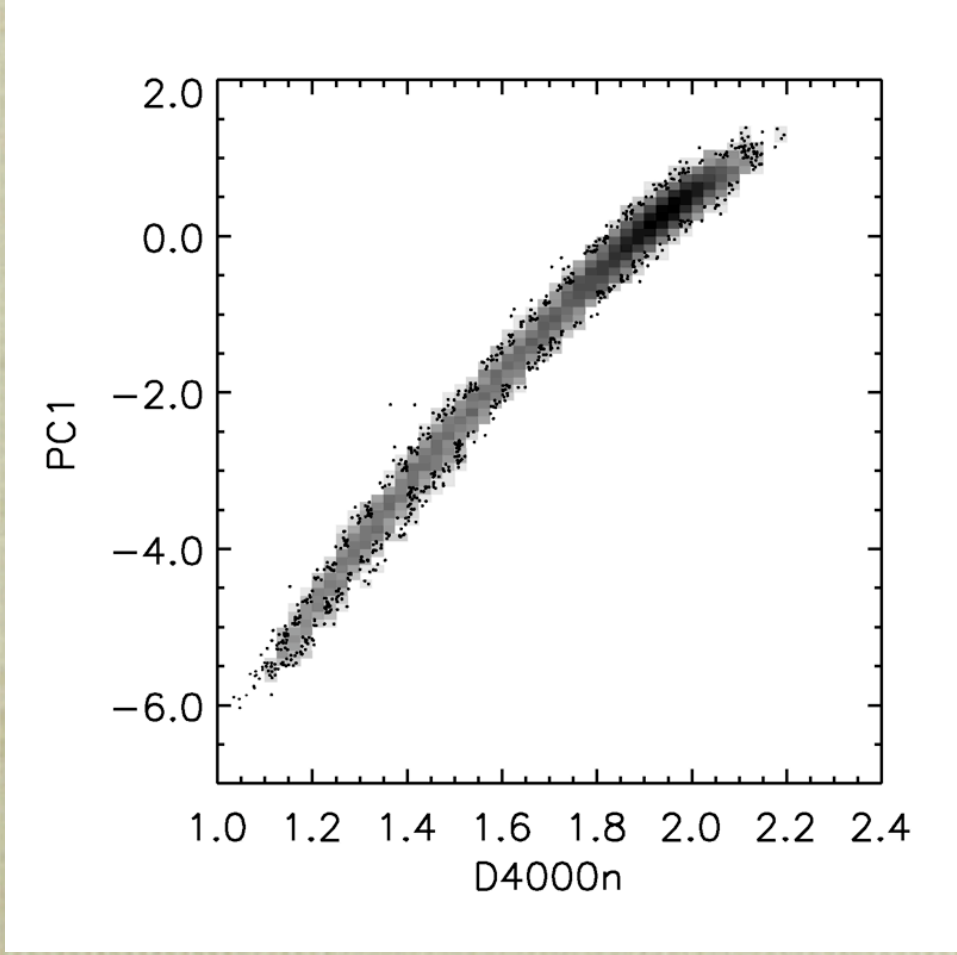
BC03 models

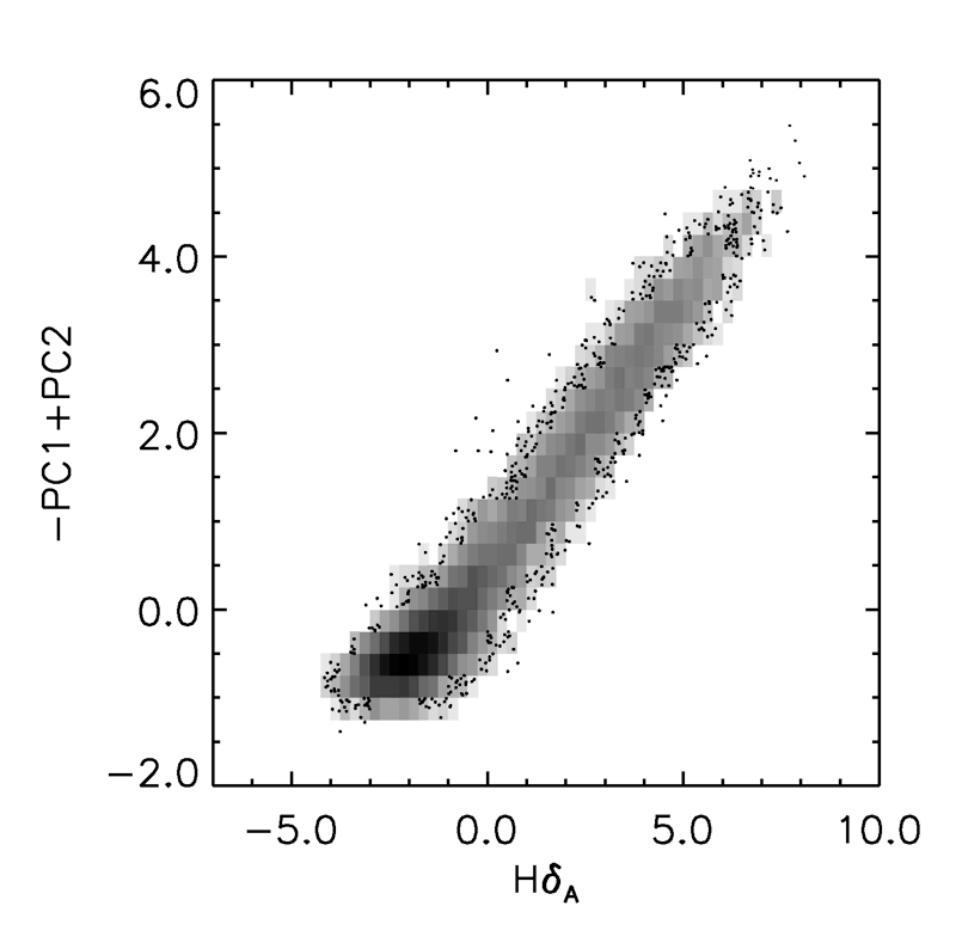
D4000 ∝ 1/Hδ

Excess Balmer

Excess Ca II (H&K)

Old vs. New indices





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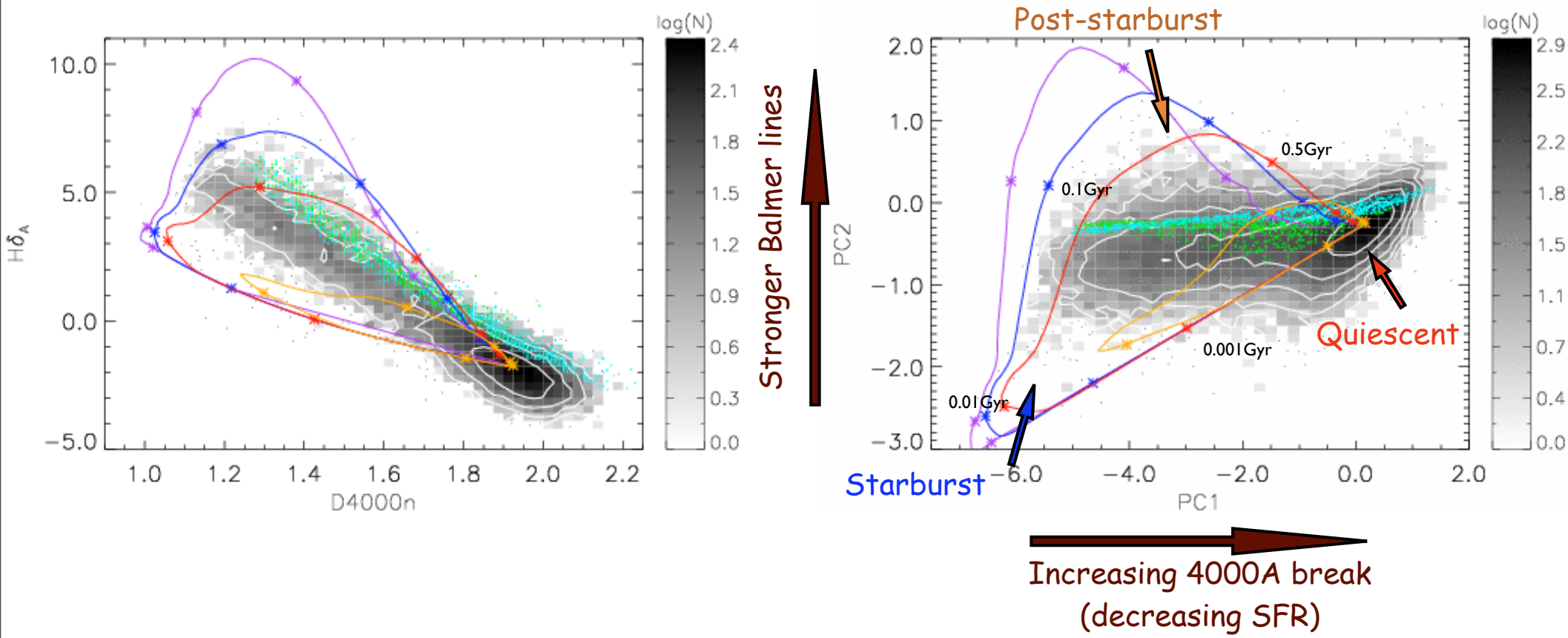

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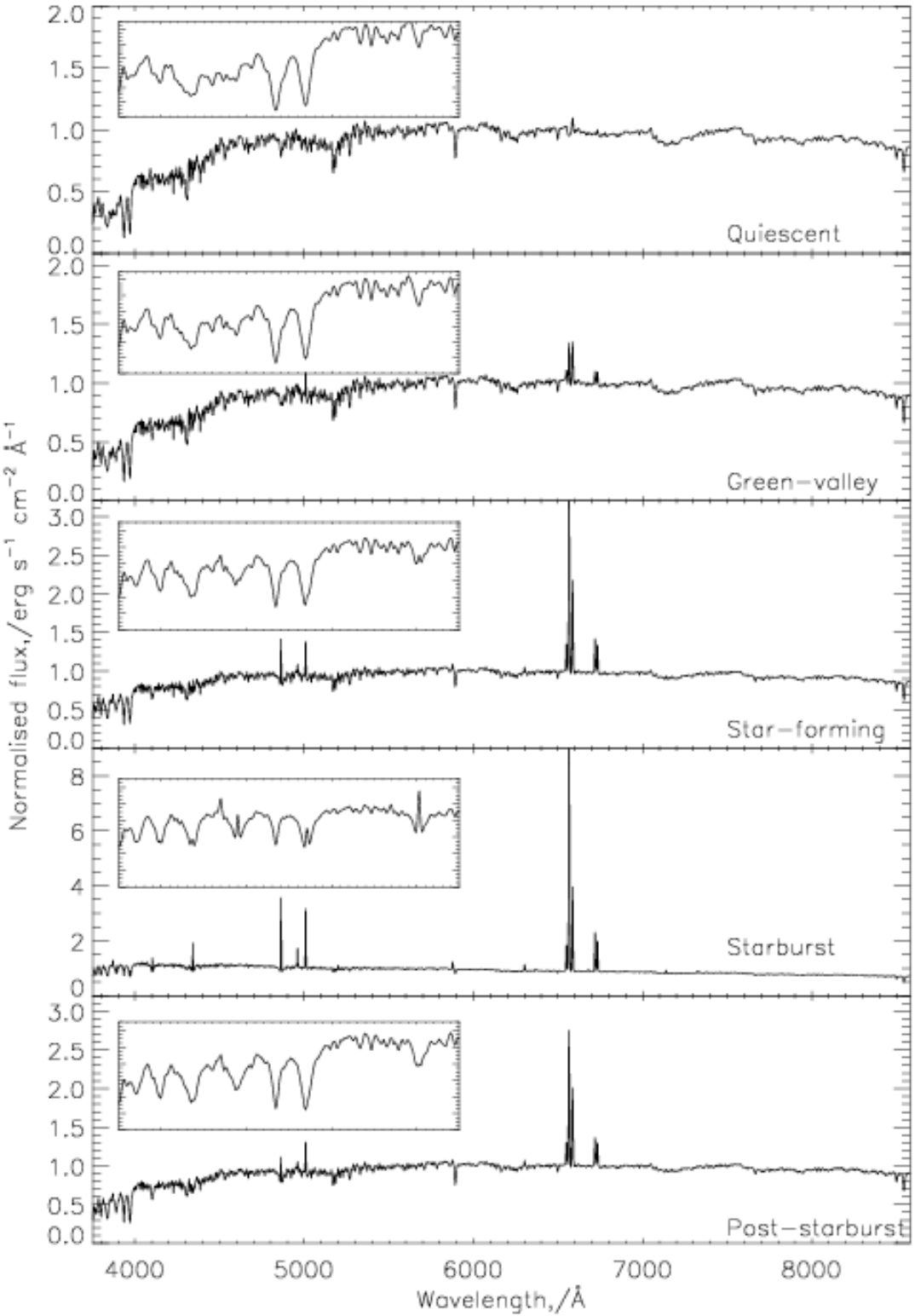
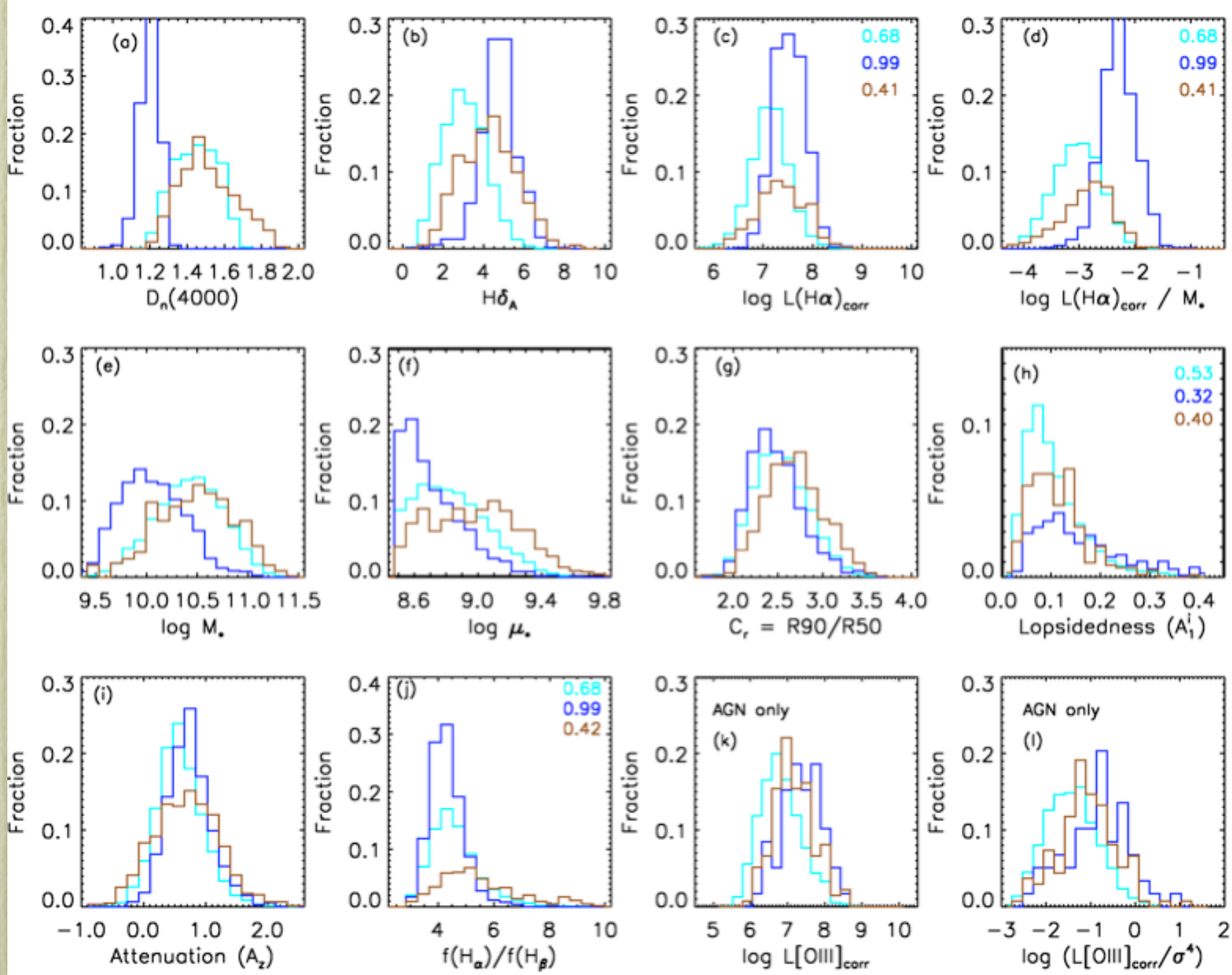

Quiescent
Green−valley
Star−forming
Starburst
Post−starburst
Normalised flux$_\lambda$/erg s^{-1} cm^{-2} Å^{-1}
Wavelength,/Å
4000
5000
6000
7000
8000


(a)
(b)
(c)
(d)
(e)
(f)
(g)
(h)
(i)
(j)
(k)
(l)
Fraction
0.68
0.99
0.41
0.53
0.32
0.40
0.42
AGN only
$D_n(4000)$
$H\delta_A$
log $L(H\alpha)_{corr}$
log $L(H\alpha)_{corr}$ / $M_\bullet$
log $M_\bullet$
log $\mu_\bullet$
C_r = R90/R50
Lopsidedness (A_1^i)
Attenuation (A_z)
$f(H_\alpha)/f(H_\beta)$
log $L[OIII]_{corr}$
log $(L[OIII]_{corr}/\sigma^4)$