VIMOS PUBLIC EXTRAGALACTIC REDSHIFT SURVEY

VIPERS: The decline and fall of the most massive star-forming galaxies since z~1

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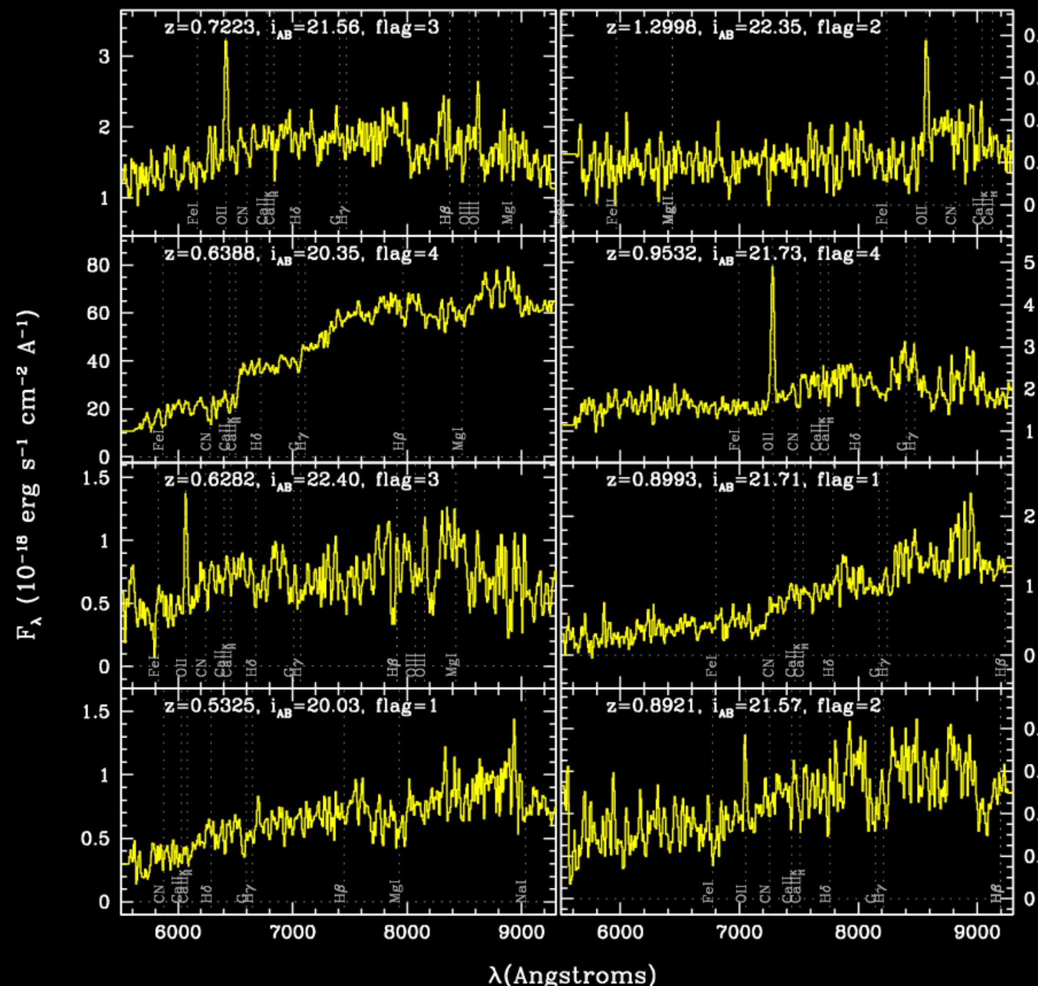
VIPERS

VIMOS PUBLIC EXTRAGALACTIC REDSHIFT SURVEY

An ESO survey exploring the early Universe

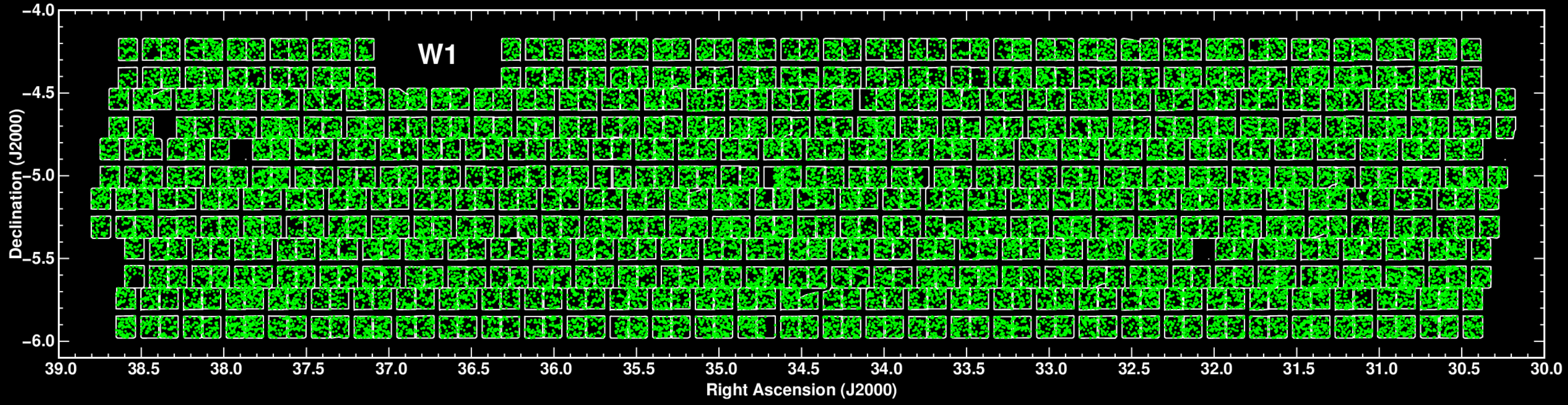
- ESO large programme (440 hrs; PI: Gigi Guzzo) to obtain redshifts for 100K galaxies at $0.5<z<1.2$, using VIMOS on 8.2m VLT
- Completed in 2015. Now public
- LR-red grism (5500-9500Å), R~220, 7.2Å/pix, 14Å FWHM
- Targeted $i_{AB}<22.5$ galaxies. Simple *ugri* colour cut to exclude $z<0.5$ sources
- Total 97,414 spectra obtained
- d4000 index measured for each galaxy, OII fluxes



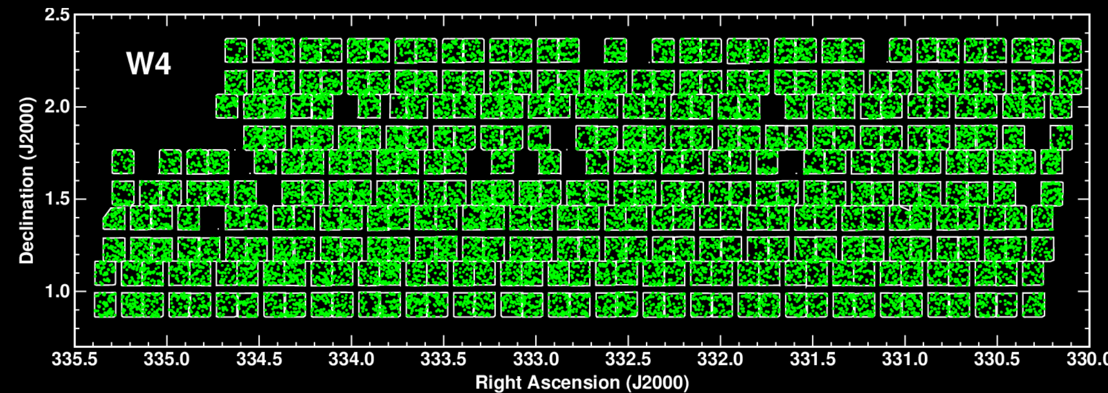
Guzzo et al. 2014, A&A, 566, 108

Scodeggio et al. 2016, arXiv:1611.07048

VIPERS: Footprint of the redshift survey

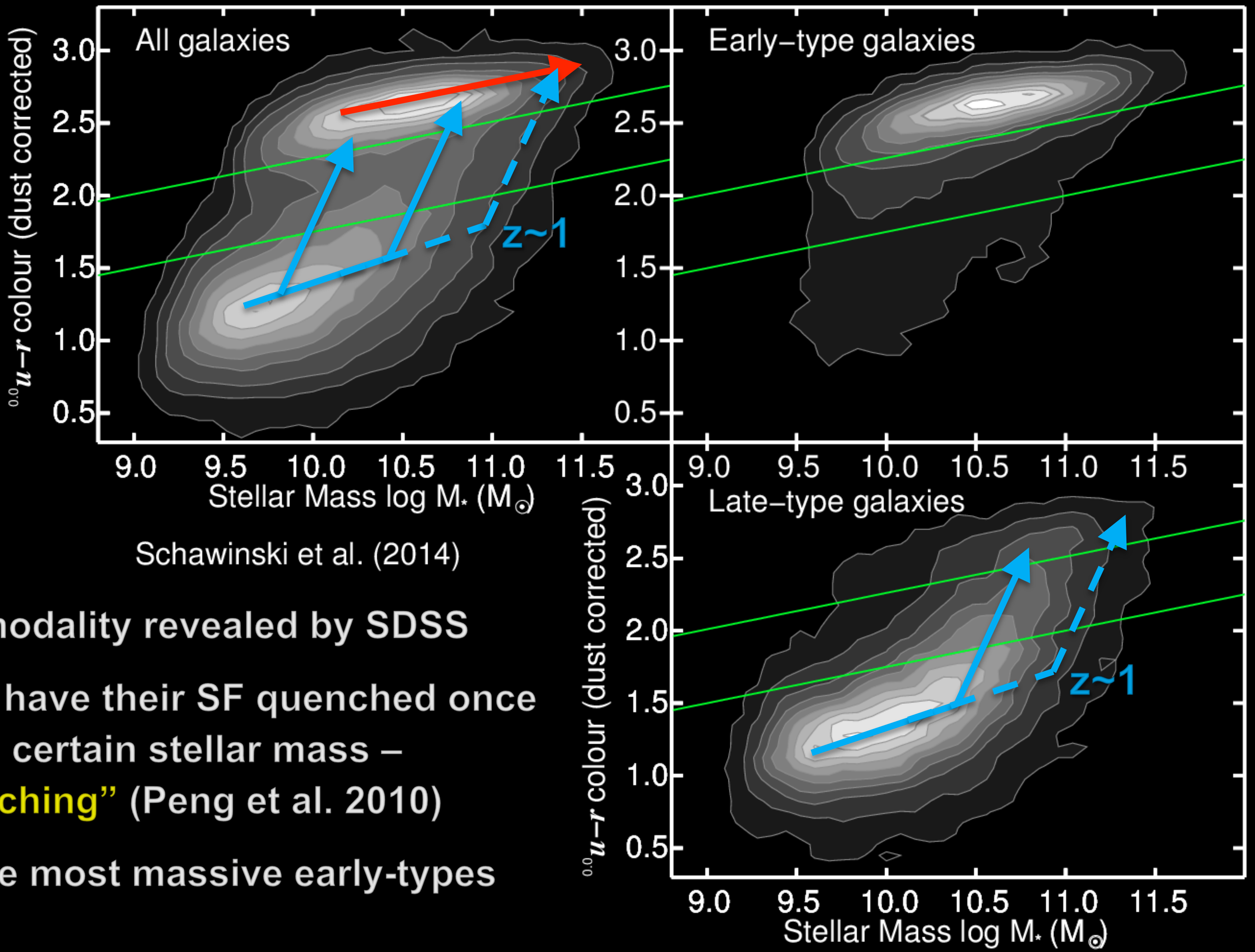


- 288 VIMOS masks
- 24 deg^2 (CFHTLS-Wide: W1,W4)
- One pass only. Gaps left, slits put on 47% of targets



- Deep *ugrizK* photometry (i_{AB}~26, 0.64'' FWHM), enabling PSF-convolved Sérsic profile fits (r_e,η) to *i*-band emission from each galaxy (Krywult+2017) and stellar mass estimates from SED fitting

Introduction: Galaxy bimodality and mass quenching

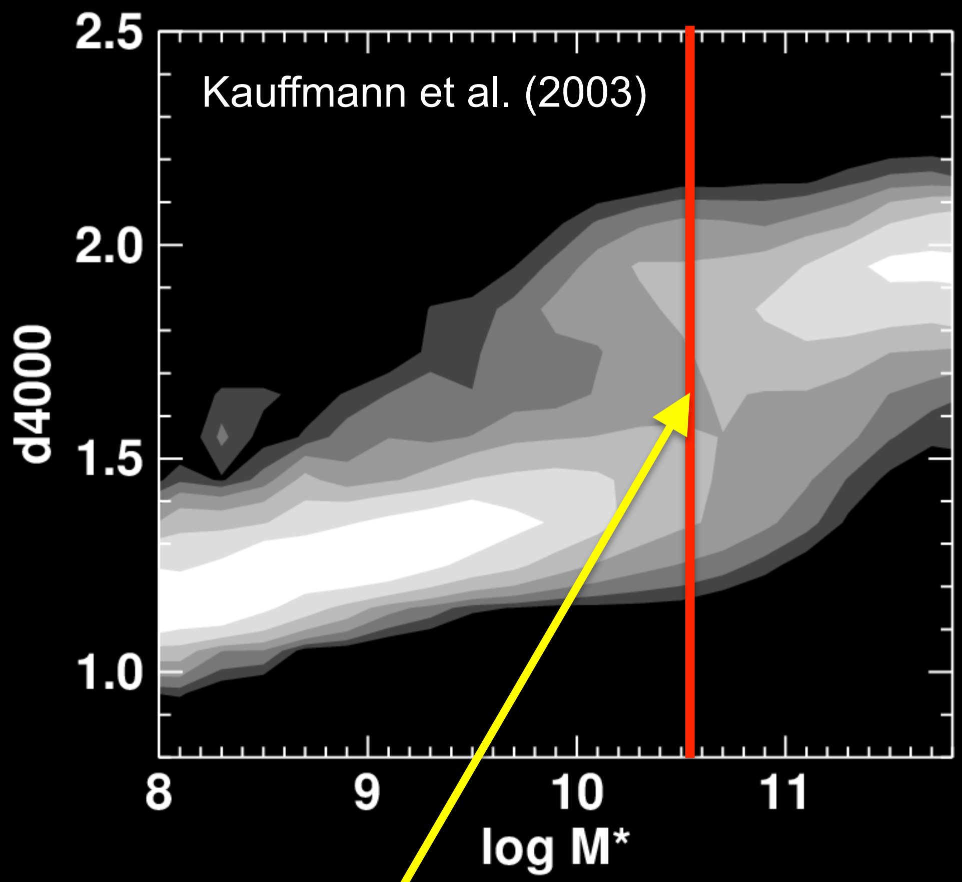


Schawinski et al. (2014)

- Galaxy bimodality revealed by SDSS
- Late-types have their SF quenched once they reach a certain stellar mass – "mass quenching" (Peng et al. 2010)
- How are the most massive early-types assembled?

Introduction: Bimodality in the galaxy distribution

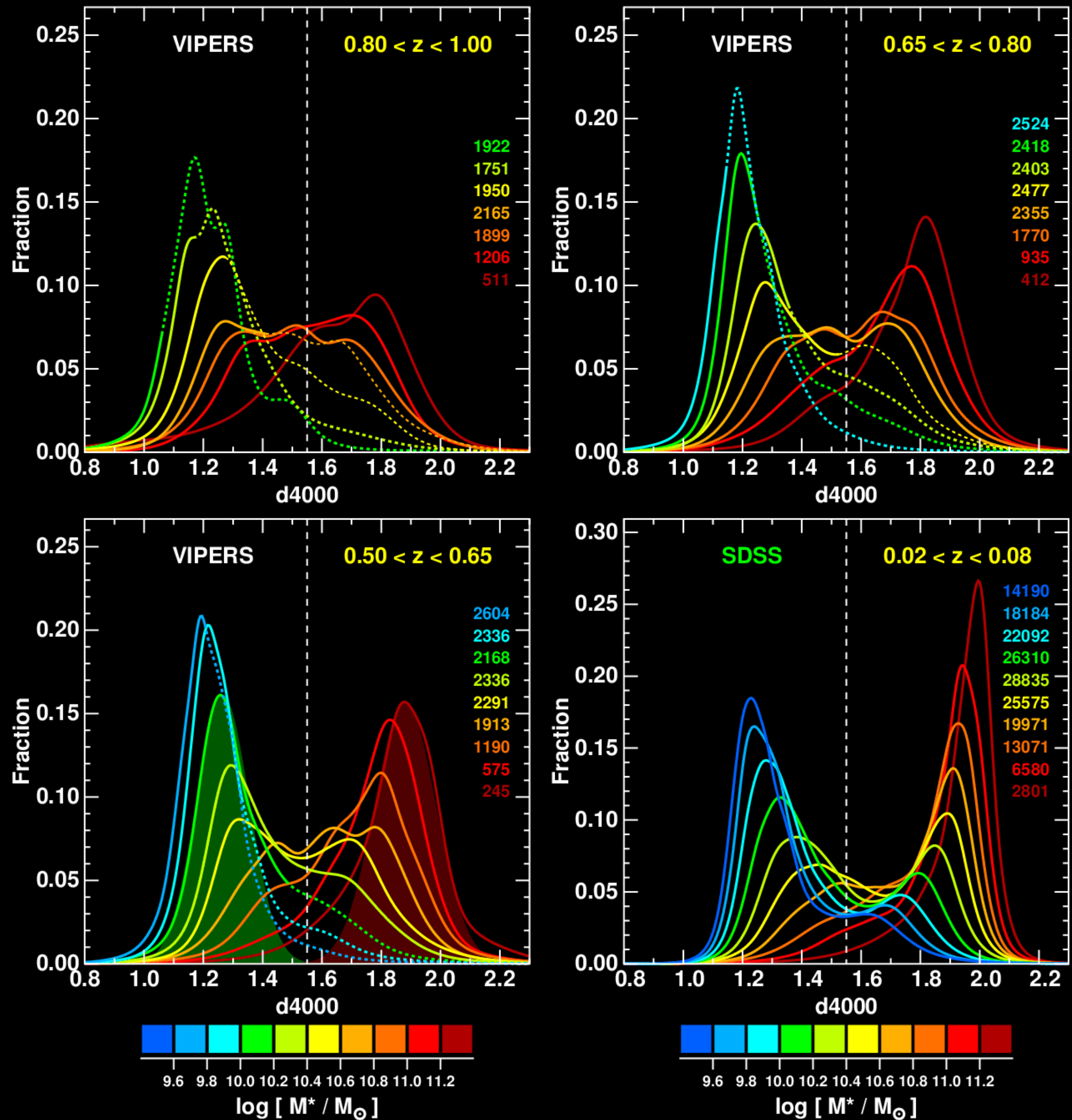
- The classic SDSS-based papers of Kauffmann+, Blanton+ etc studied the fundamental distributions of galaxy properties. In particular the bimodality of the blue cloud and red sequence, identifying the transition mass where galaxies are quenched
- d4000 spectral index used as proxy for mean stellar age to separate young, star-forming and old passive galaxies (with no bias from dust)
- VIPERS allows us to repeat these analyses for 0.5<z<1.0 galaxies, and follow the galaxy bimodality to z~1, in particular the blue cloud and the trigger for star-forming spirals to be "mass-quenched"



Characteristic mass of ~$3 \times 10^{10} M_\odot$ when galaxies in the blue cloud move to the red sequence

Results: Bimodality in the galaxy d4000 distribution versus M*

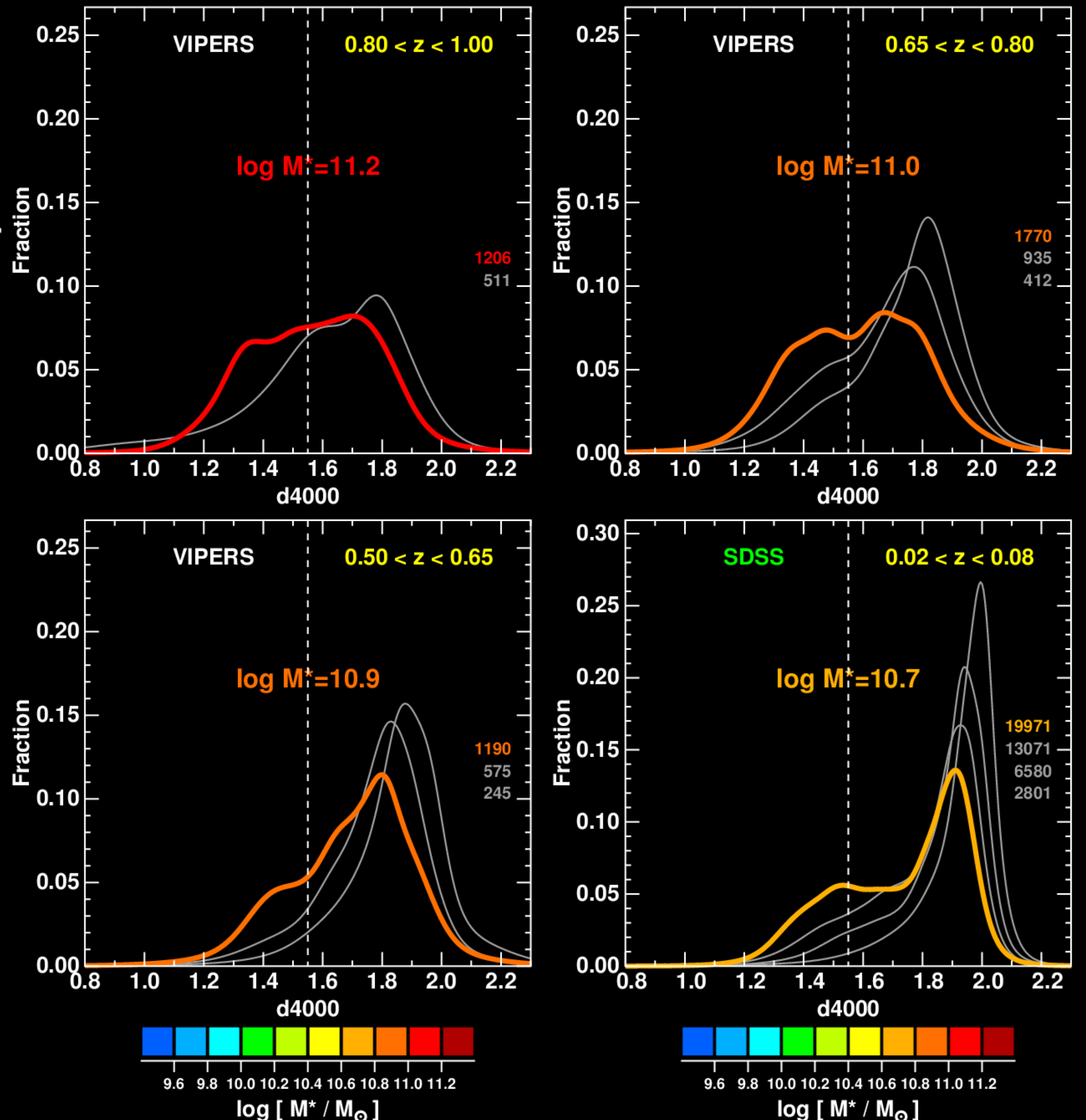
- d4000 distribution for galaxies in 0.2 dex wide M* bins determined using the adaptive kernel estimator
- Build-up of red sequence over time, starting at the high mass end.
- No "Green Valley" at z~0.9, deepens over time
- Fit Gaussian functions to the d4000 distributions for the blue cloud and red sequence populations



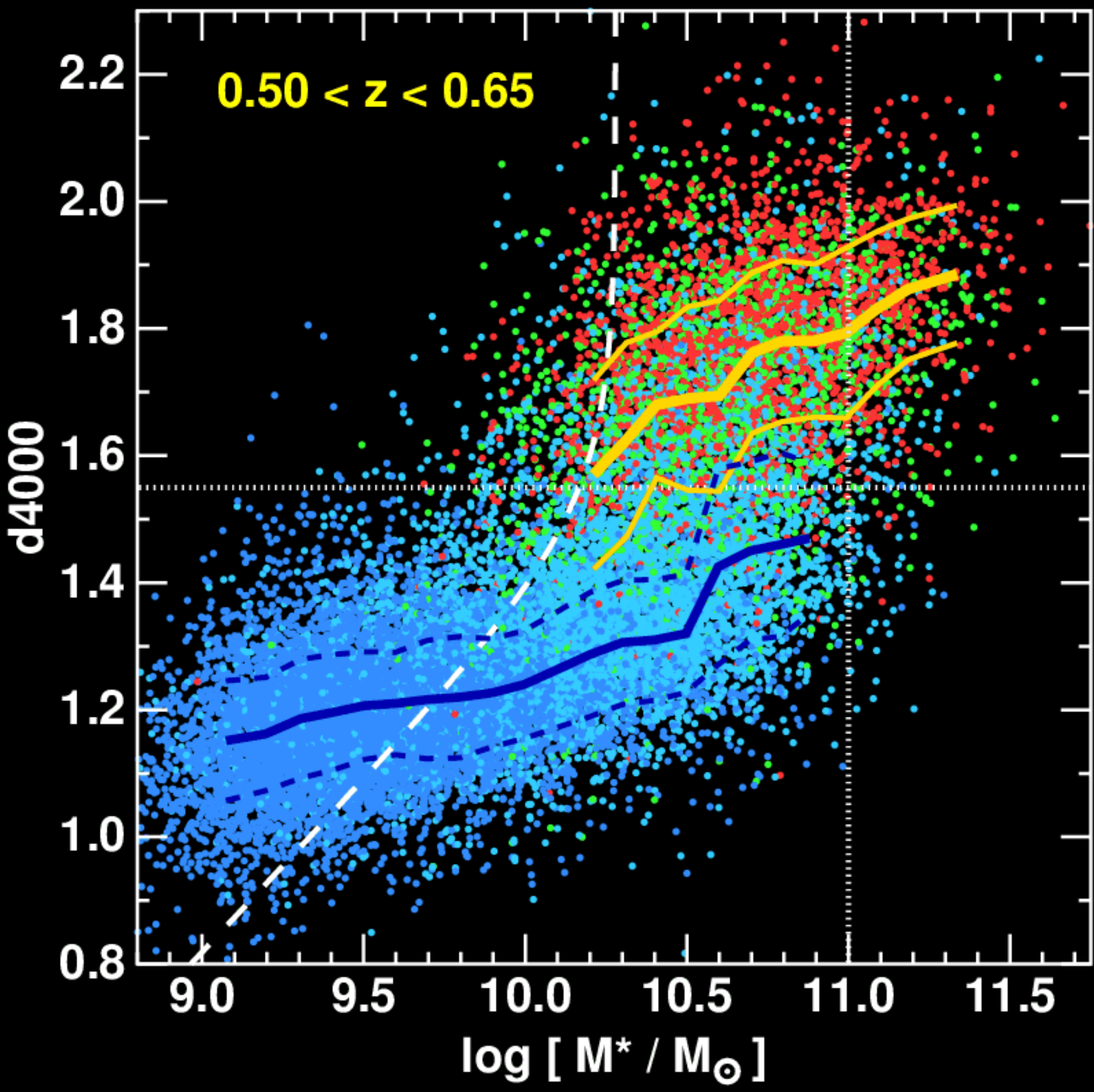
Results: Evolving high-mass limit of the blue cloud

- Estimate high-mass limit of the blue cloud as the highest stellar mass bin for which we can fit a Gaussian function to a feature in the d4000 dist. for d4000<1.55

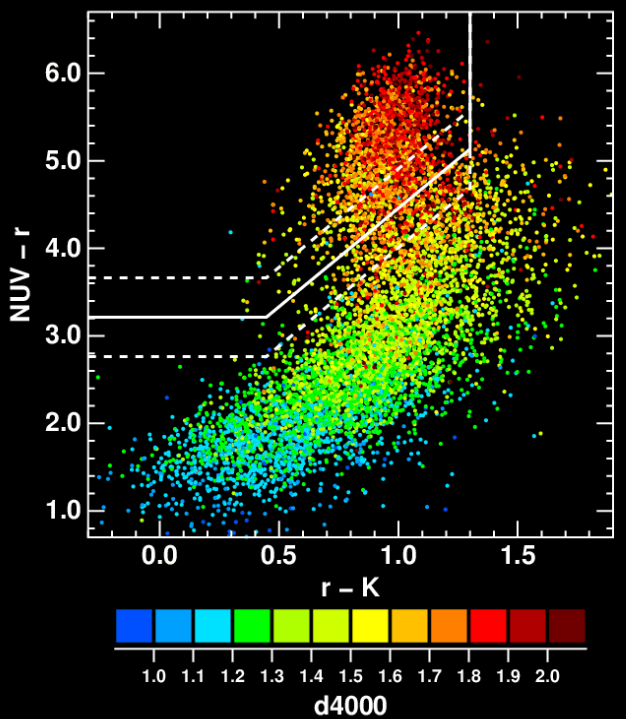
- Blue cloud extends up to $\mathcal{M} = 10^{11.2}\ M_{\odot}$ at z~0.9, but then retreats steadily over time, reaching only $\mathcal{M} = 10^{10.7}\ M_{\odot}$ by the present day



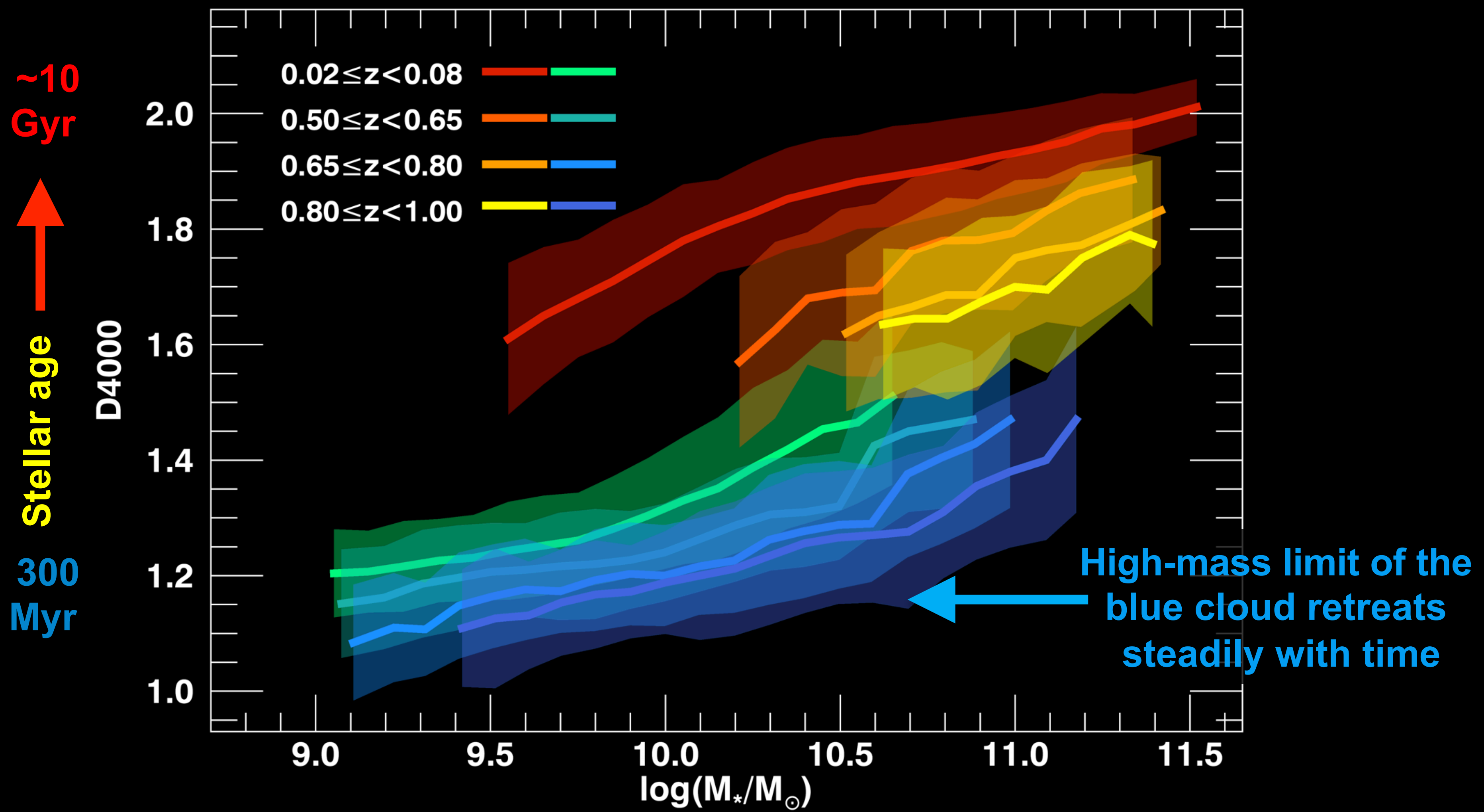
Results: Evolution of the red and blue sequences



- NUVrK classification in good agreement with d4000
- Curves show best-fit Gaussian function to d4000 distribution of blue/red gals

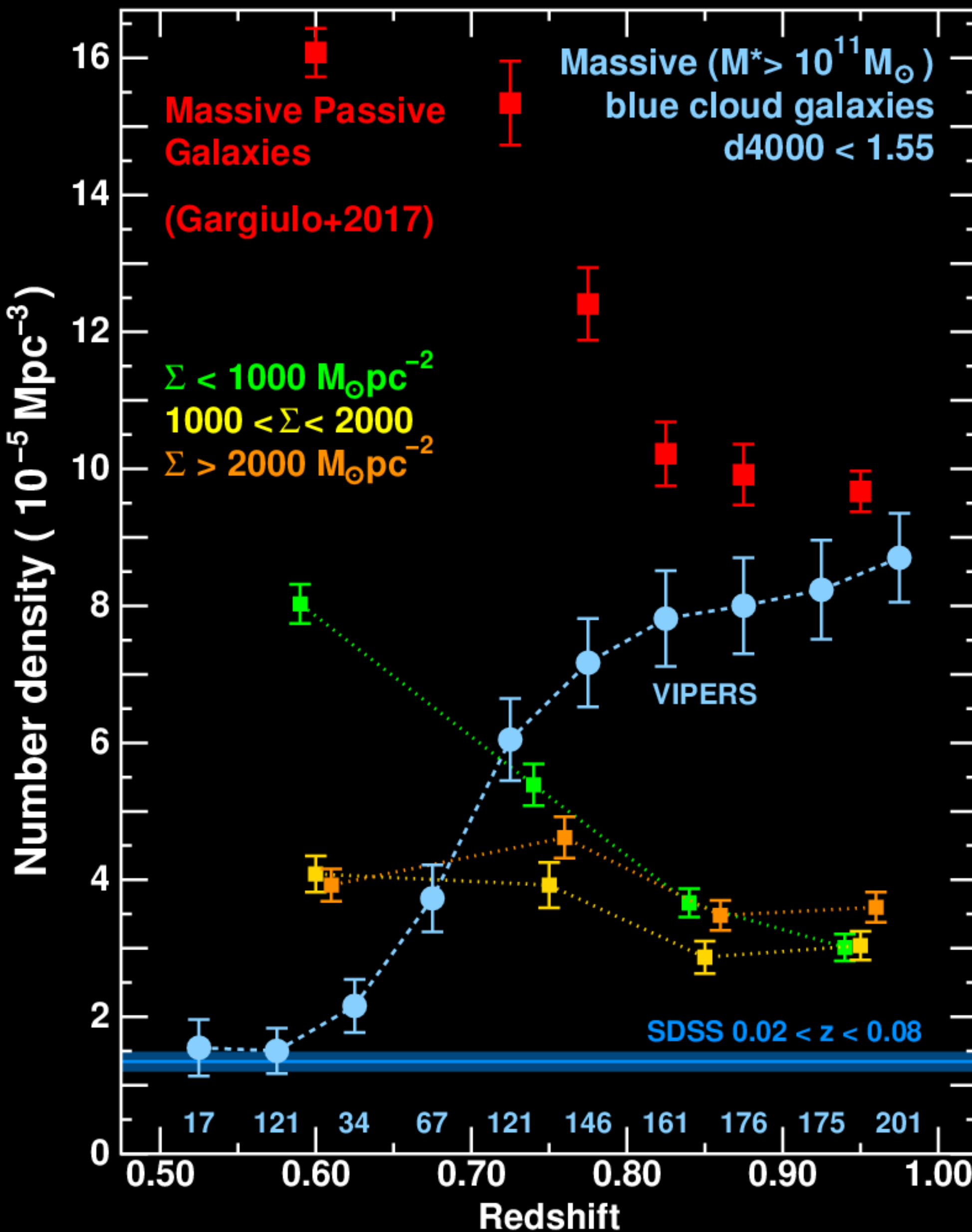


Results: Evolution of the blue cloud and red sequence

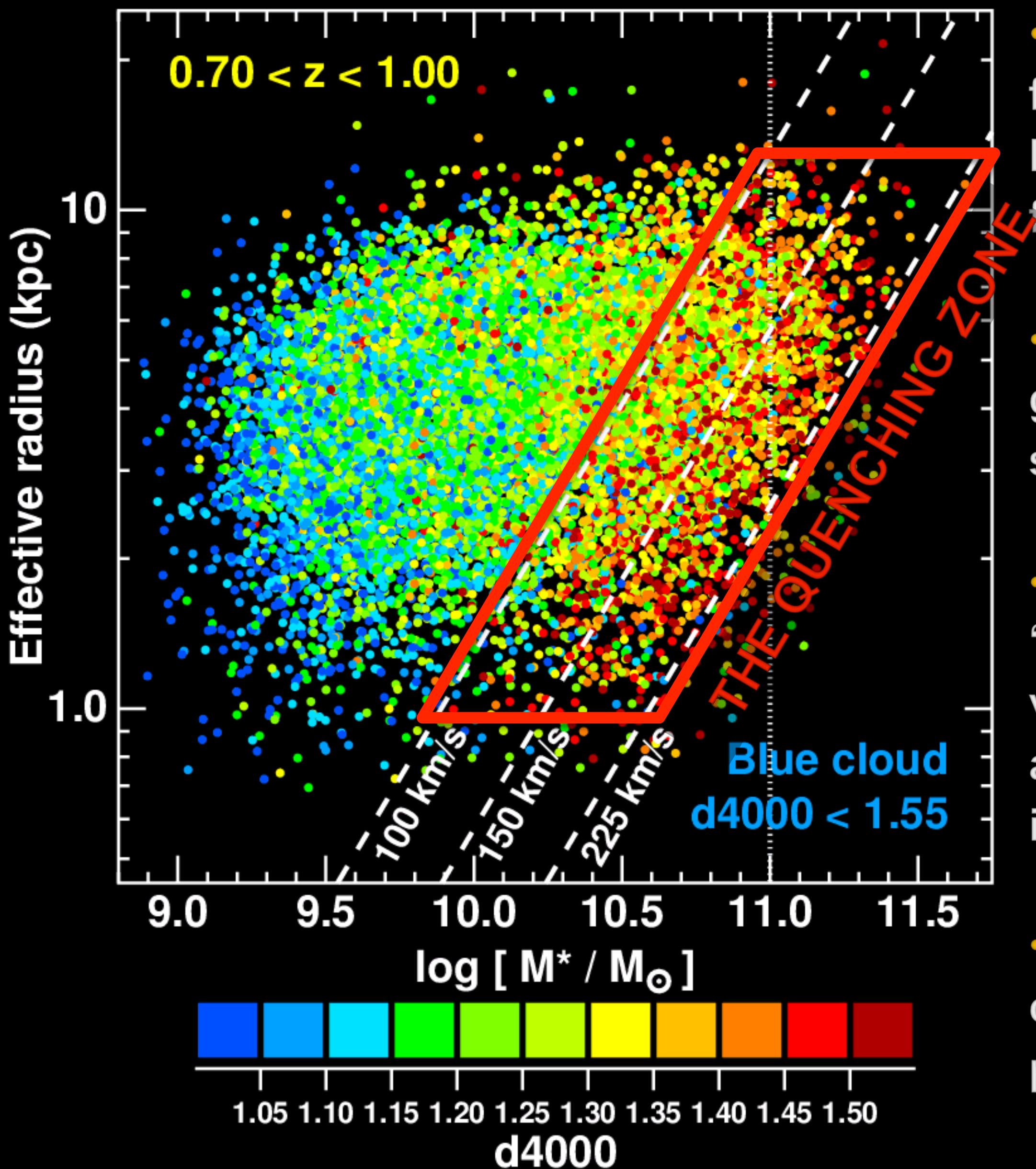


Results: The rapid decline of massive star-forming galaxies

- The comoving number density of massive blue cloud galaxies ($\mathcal{M}$>$10^{11}M_\odot$, d4000<1.55) drops 5x from z~0.8 to z~0.5
- Decline also in zCOSMOS but is strongly affected by cosmic variance
- Huge volume of VIPERS allows large samples of rare massive star-forming galaxies at these redshifts
- Decline in massive blue cloud galaxies is coeval with steady increase in massive passive galaxies (Gargiulo et al. 2017)

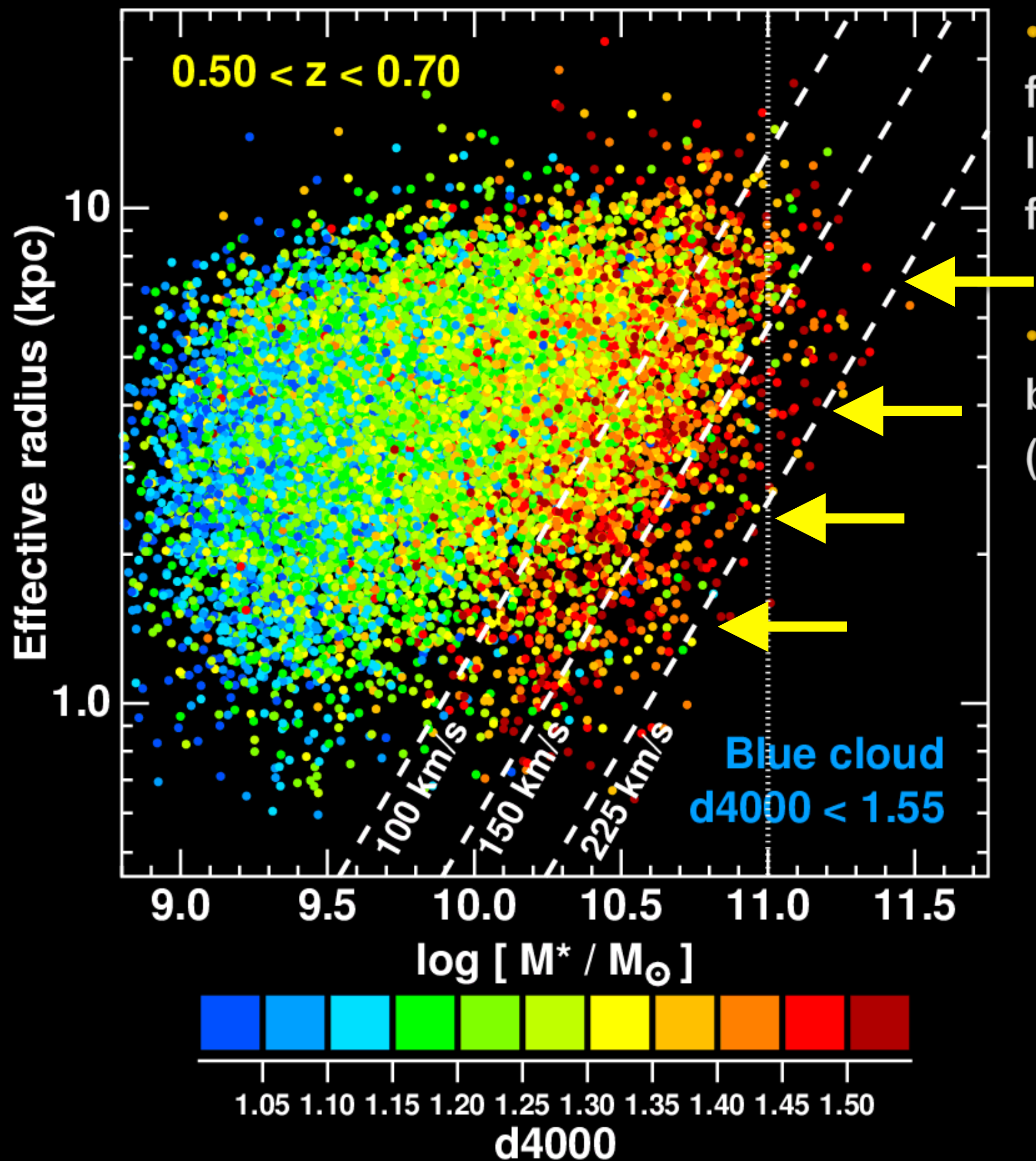


Results: The size-mass relation of star-forming galaxies



- The high-mass limit of star-forming galaxies runs along lines of constant σ_{inf}, just as for quiescent galaxies
- Zone of exclusion where galaxies cannot grow through star formation
- As galaxies enter the "quenching zone", their d4000 values increase, pushing them away from the blue cloud and into the Green Valley
- The quenching zone at z~0.8 coincides with the location of present day quiescent galaxies

Results: The size-mass relation of star-forming galaxies



- The high-mass limit of star-forming galaxies runs along lines of constant σ_{inf}, just as for quiescent galaxies
- High-mass limit is pushed back to lower stellar masses (at fixed size) by z~0.6

Summary

- VIPERS is a new public redshift survey enabling the distribution of galaxy properties (e.g. stellar mass, size, d4000) to be measured in comparable detail at $0.5<z<1.0$ as in the local Universe
- Final data release available now: www.vipers.inaf.it

- The high-mass limit of the blue cloud galaxy population has declined steadily with time from $\mathcal{M}\sim10^{11.2}M_\odot$ at $z\sim1$ to $10^{10.7}M_\odot$ today

- Comoving number density of $\mathcal{M}>10^{11}M_\odot$ blue cloud galaxies drops 5x from $z\sim0.8$ to $z\sim0.5$. Coeval increase in massive passive galaxies

- “Mass quenching” depends also on galaxy size. High-mass limit of blue cloud and “quenching zone” forms line of constant $\mathcal{M}\ /\ r_e$

- Haines et al. 2017, A&A, 605, 4
- Gargiulo et al. 2017, A&A, 606, 113
- Scodeggio et al. 2016, arXiv:1611.07048