Galaxies Lec 7

High Redshift Galaxies

How to find High Redshift

Lyman Break Revolution

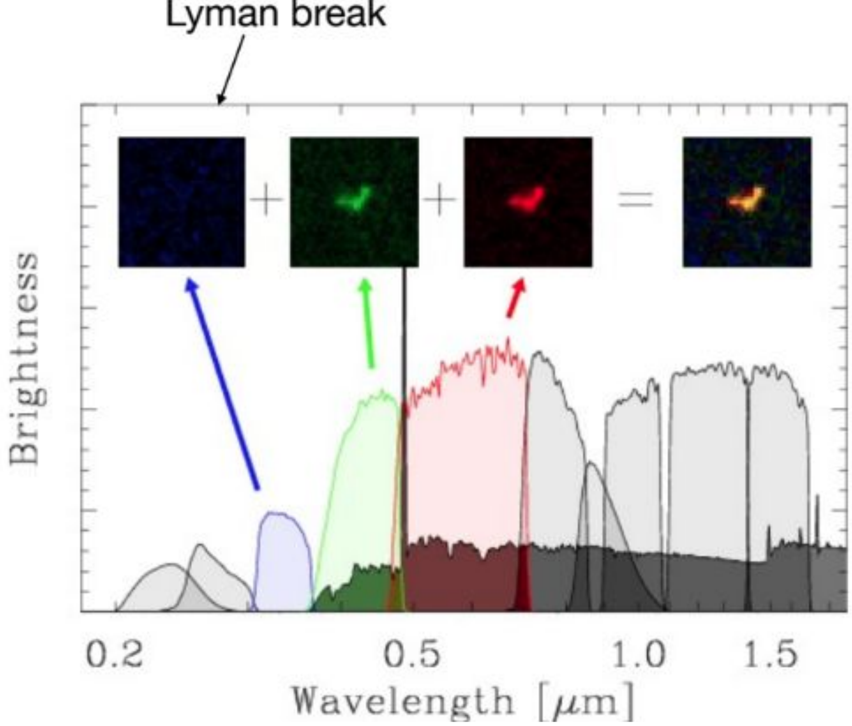
Lyman break is when light of higher wavelength than the lyman limit wavelength ionizes the hydrogen atom and thus showing no emission line.

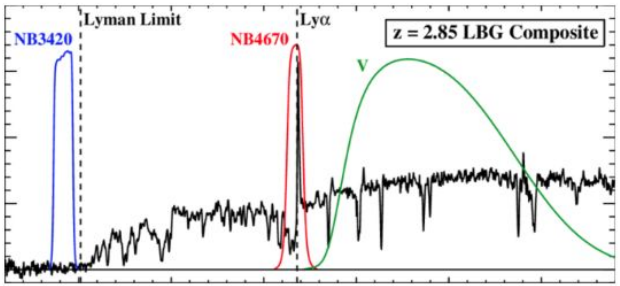
Taking multiple UV filters, galaxies dropout because the break occurs at different redshifts.

Select those that dropout at redder wavelengths => more redshift and then take spectra.

Emission lines => Lyman Alpha is bright

Dust Reddening Method
Look for where redshifted dust emission in the mm and sub-mm continuum.





Star Formation Rate Density

Measure Star Formation rate indicators

UV continuum flux density, with dust correction and calibration using stellar population models.

Hα luminosity, with dust correction + calibration.

Dust reprocessed light

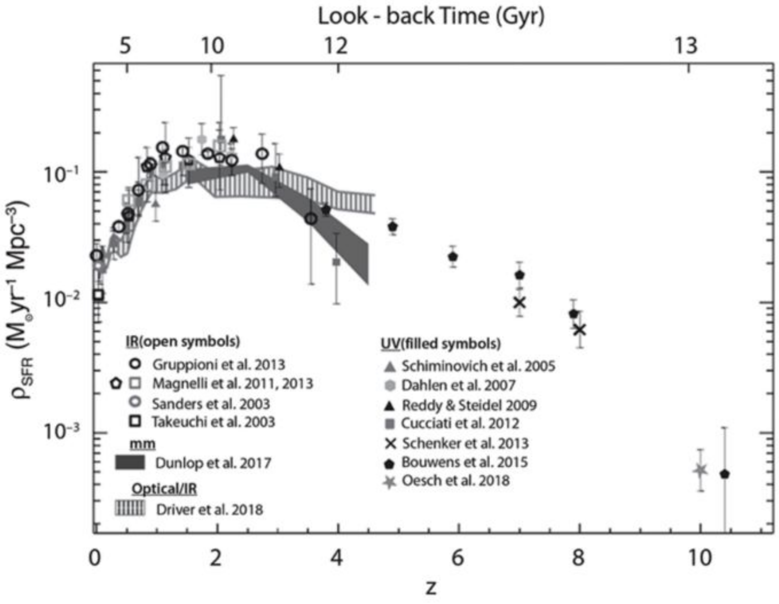
Direct SED fit to observed photometry (or +spectra)

Result =>

Now we want to measure SFR DENSITY

Measure the UV luminosity per galaxy. Get the UV light distribution per redshift to account for density (with dust corrections)

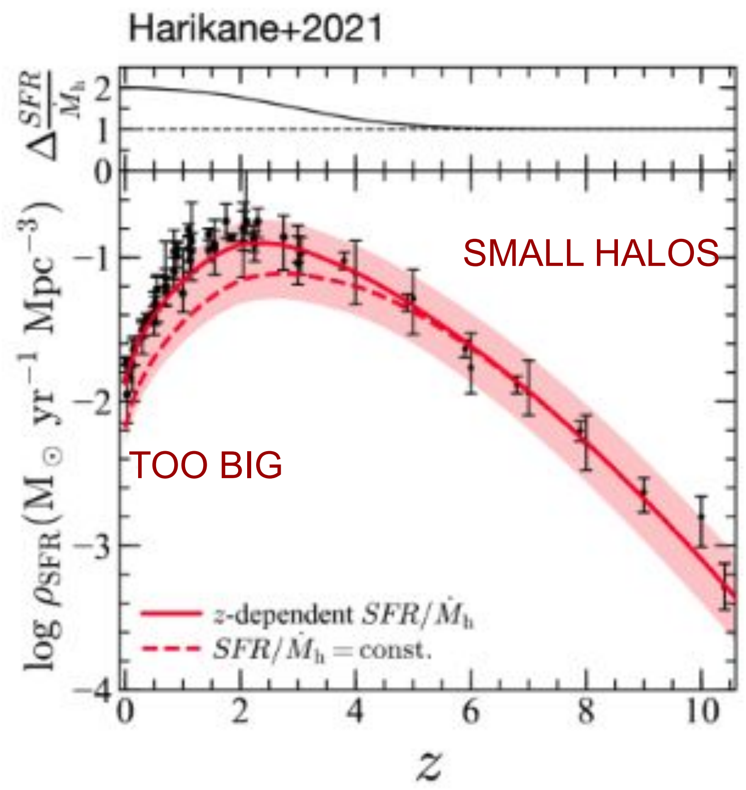
Measure FIR luminosity and repeat to get the dust obscured ones. (reprocessed light from UV)



Before z>2 (Rising Leg): The universe is full of gas, but halos are too small to hold it efficiently. We are waiting for structure to grow.

At z ~ 2(The Peak): Everything aligns. We have the maximum number of halos sitting right in that "Sweet Spot" ($10^{11.6} M_\odot$), AND they are being fed by rapid cold streams.

After z<2 (Falling Leg): The universe expands (cutting off the fuel supply), and halos grow too large (moving out of the sweet spot and into the "hot halo" quenching regime).

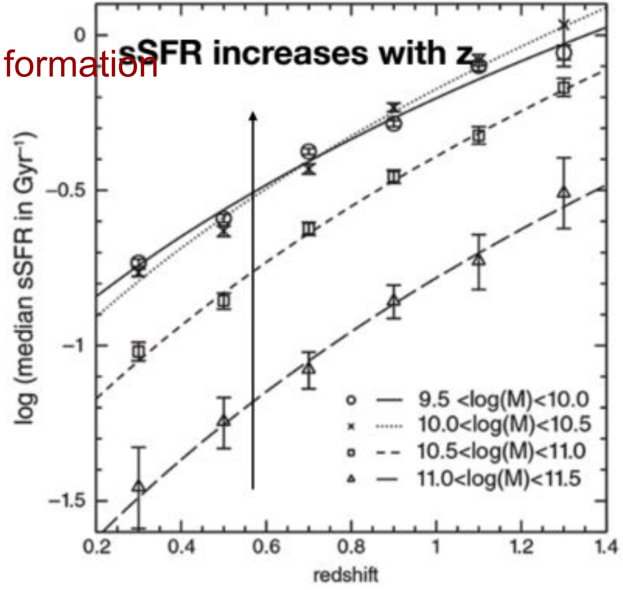


Early SFR was faster (sSFR=SFR/M) and assembled faster => more inflows.

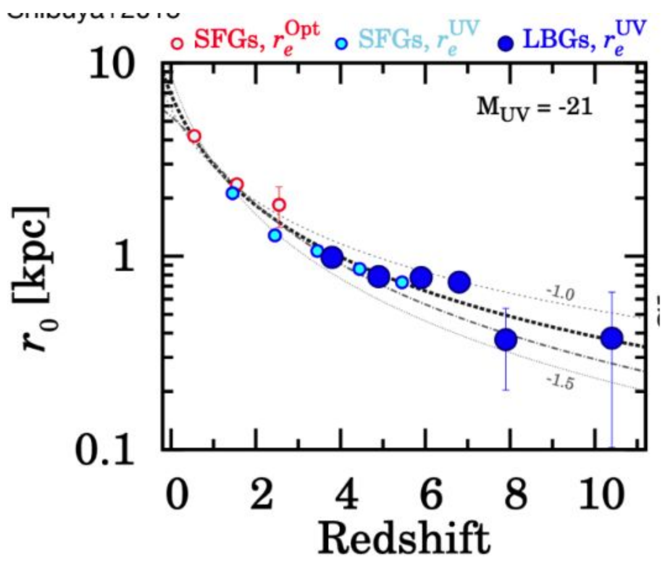
Early chemically diluted

Galaxies where smaller physically => supports growth from small nuggets to larger disks like MW

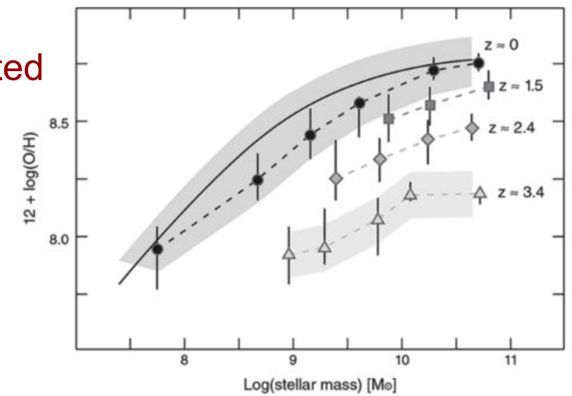
Rapid formation



Size increase with R ~(1+z)^1.1



diluted



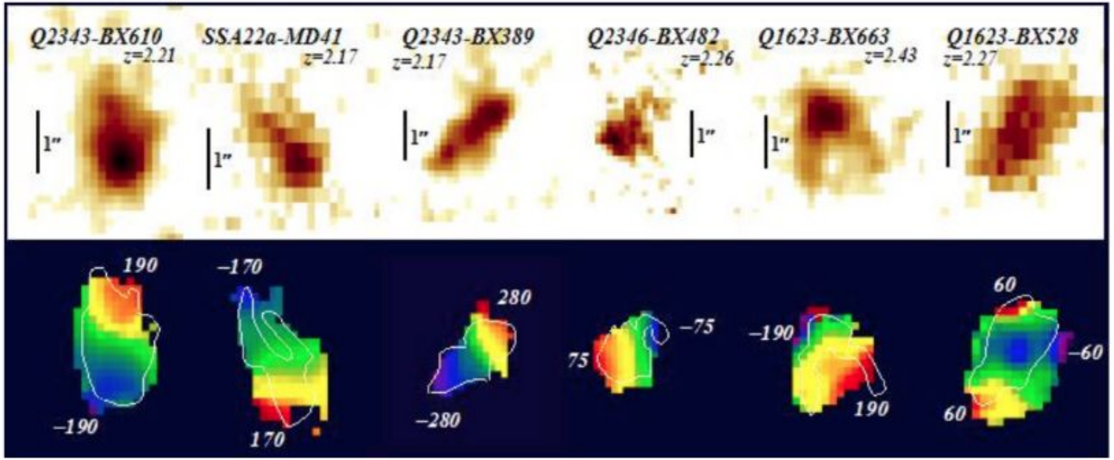
Building Disk Galaxies

We observe some rotation but we also see large velocity dispersion likely very turbulent!

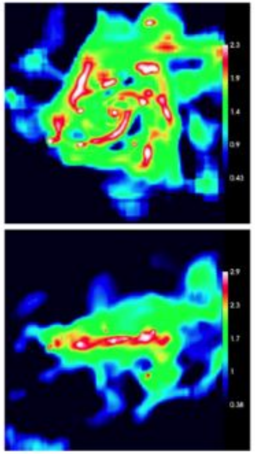
Supports the violent relaxation picture we painted before.

Rotation =>spider diagrams with lines of same amount from the center and sigma=> velo dispersion

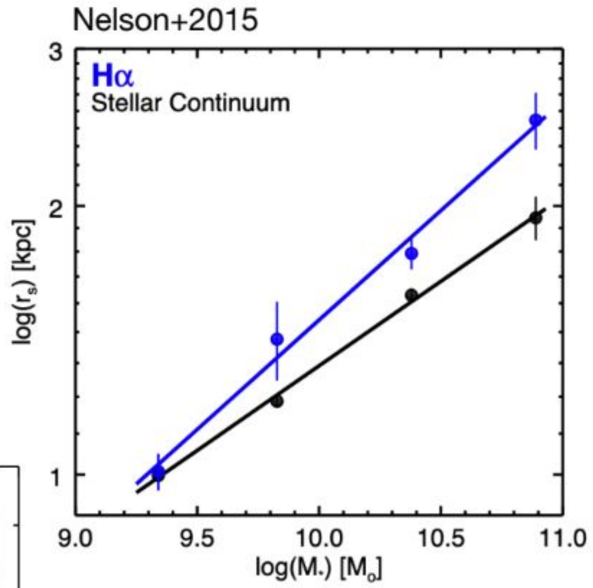
Forster-Schreiber, Genzel et al.



Dekel+2009

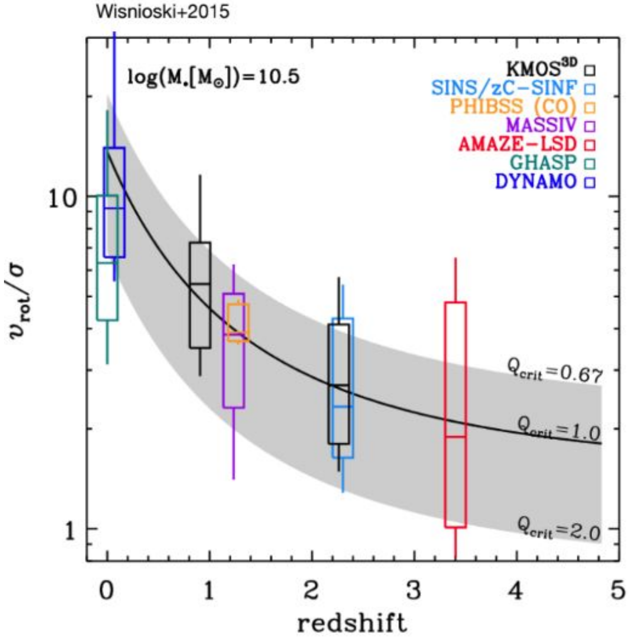


We see inside out growth as the H alpha star forming regions grow larger faster than the old stars indicating its like a tree ring growth (as the halo gets built up).



We also see the disks form as the rotation begins to dominate vs random velocity motions

Thin disk is formed!



Building Ellipticals / Early types

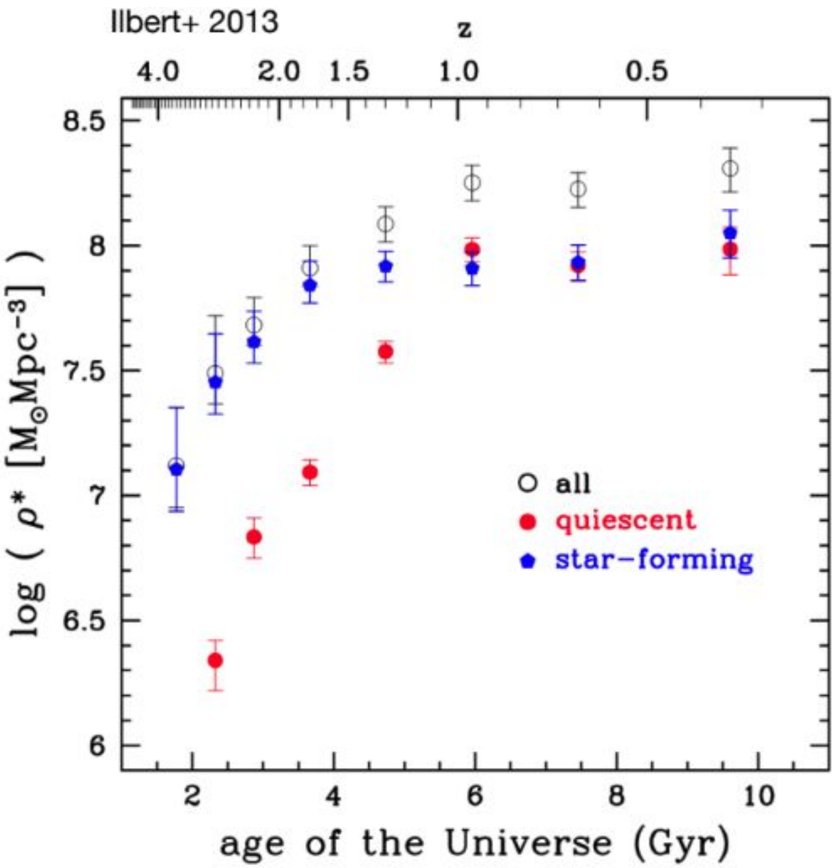
When did the ellipticals come on to the scene?

We look at red galaxies vs blue star forming galaxies and see they MERGE!

Left we see blue galaxies building not quenched!

Then they merge This point represents the moment when the total mass of stars locked up in "dead" galaxies finally equals the mass of stars in "living" galaxies.

~ last 3 billion years



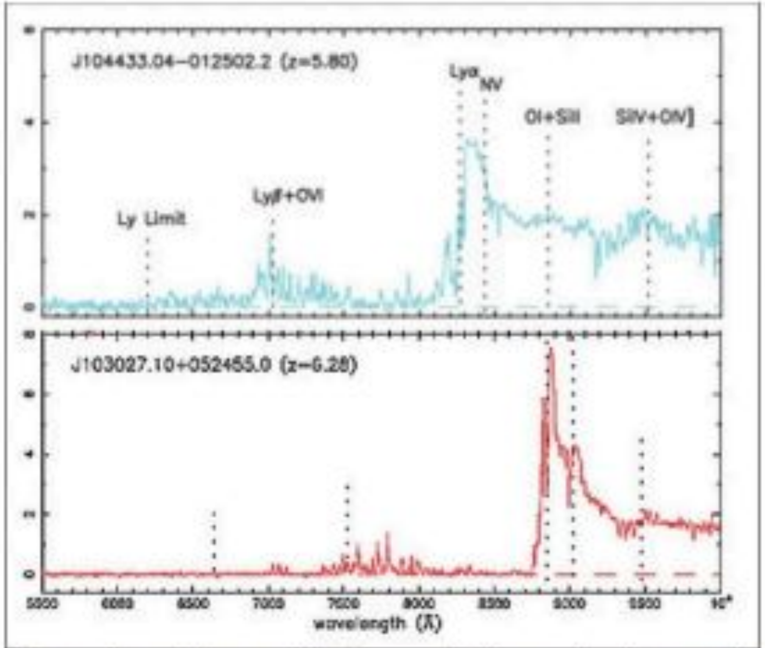
Pushing to reionization

When do we know things are reionized??

Gunn Peterson effect Quasar Lyman Alpha forest falls to zero. (forest is caused by absorption of intervene IGM)

CMB photon anisotropy is suppressed due to thomson scattering

galaxy spectra: UV luminosity as an indicator for the galaxies' evolution. We can find the correlation between the evolution (star formation etc) of the galaxy and redshift to identify reionization.



The spectrum of the very distant quasar (bottom spectrum) compared to the spectrum of a closer quasar (top spectrum). Note the height of the spectral lines on the left side of the spectrum. The bottom image shows the first Gunn-Peterson trough ever discovered.