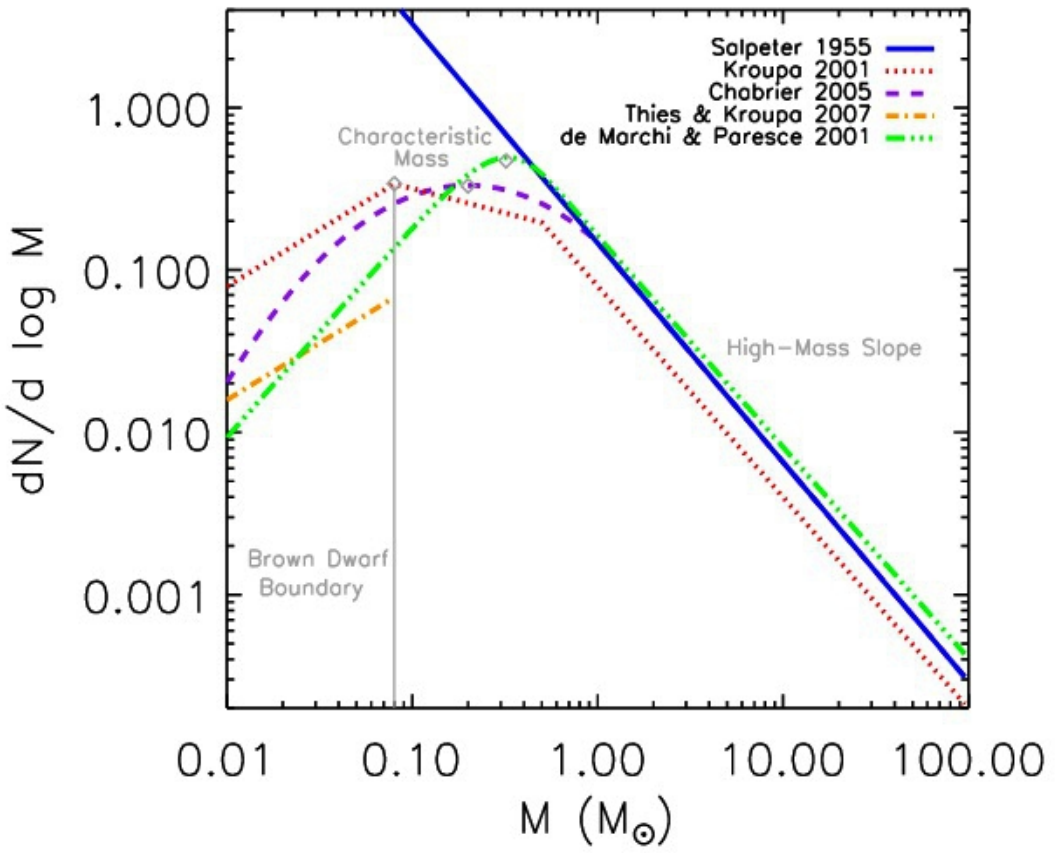
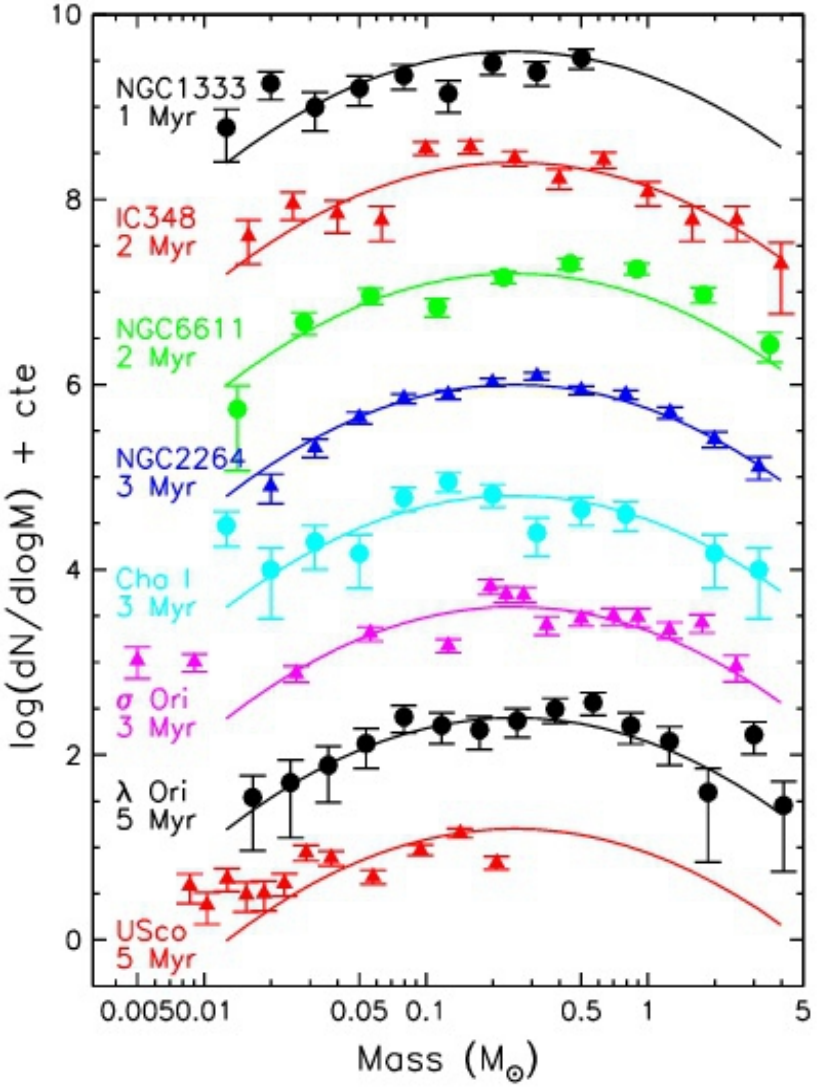
UNUSUAL POPULATIONS OF MASSIVE STARS IN NEARBY GALAXIES:: an investigation with the MaNGA IFU and SDSS main samples

The Stellar Initial Mass Function is a Fundamental Quantity in Astrophysics

Is it universal or does it vary with environment?

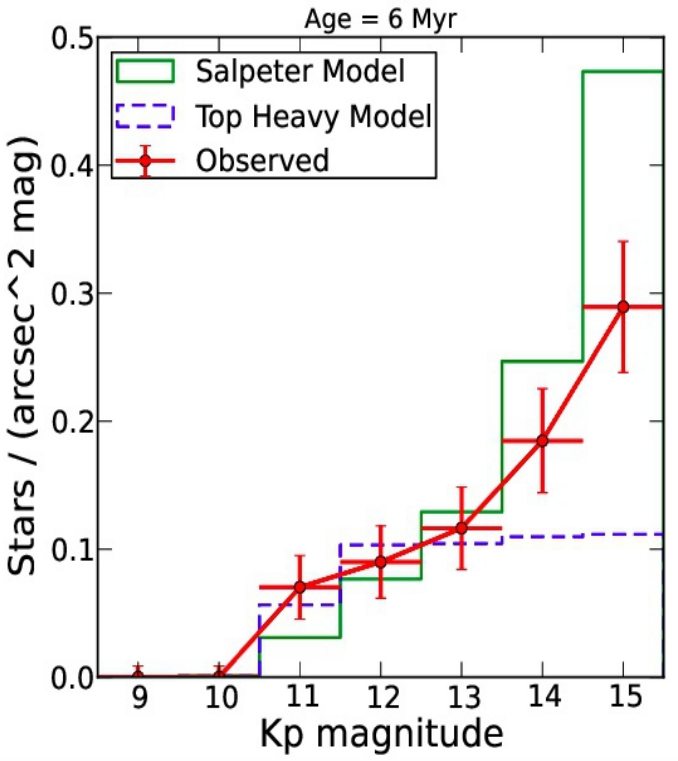




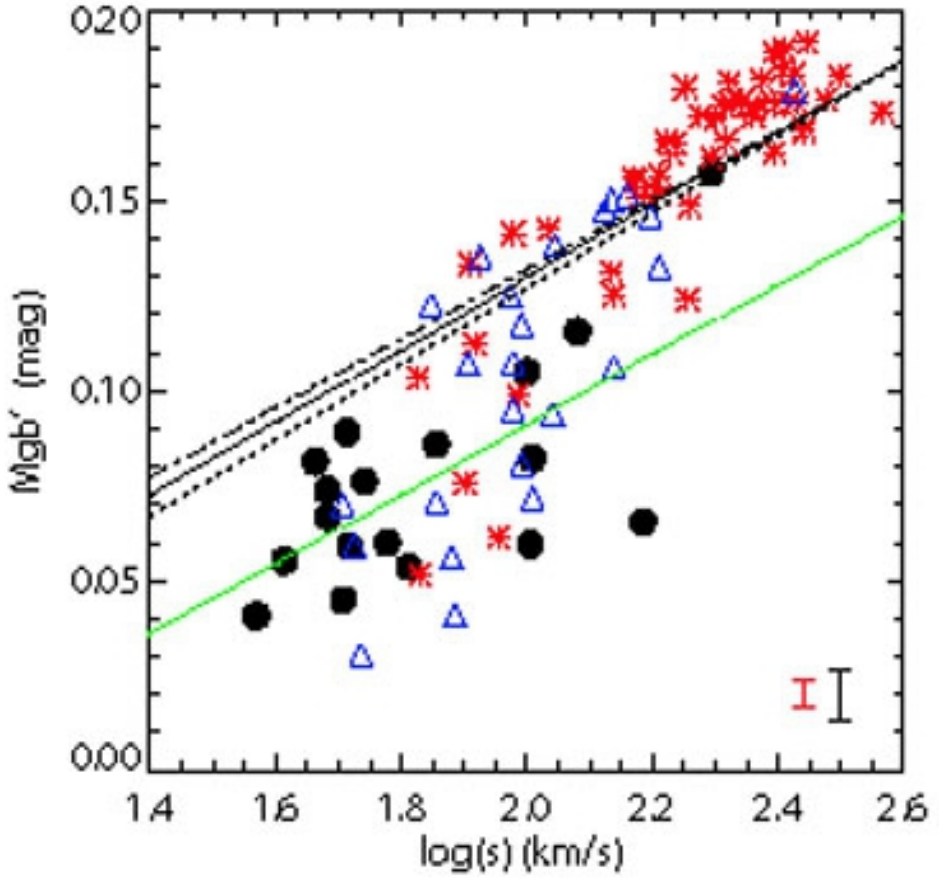
The Galactic Centre may be an interesting demonstrated exception

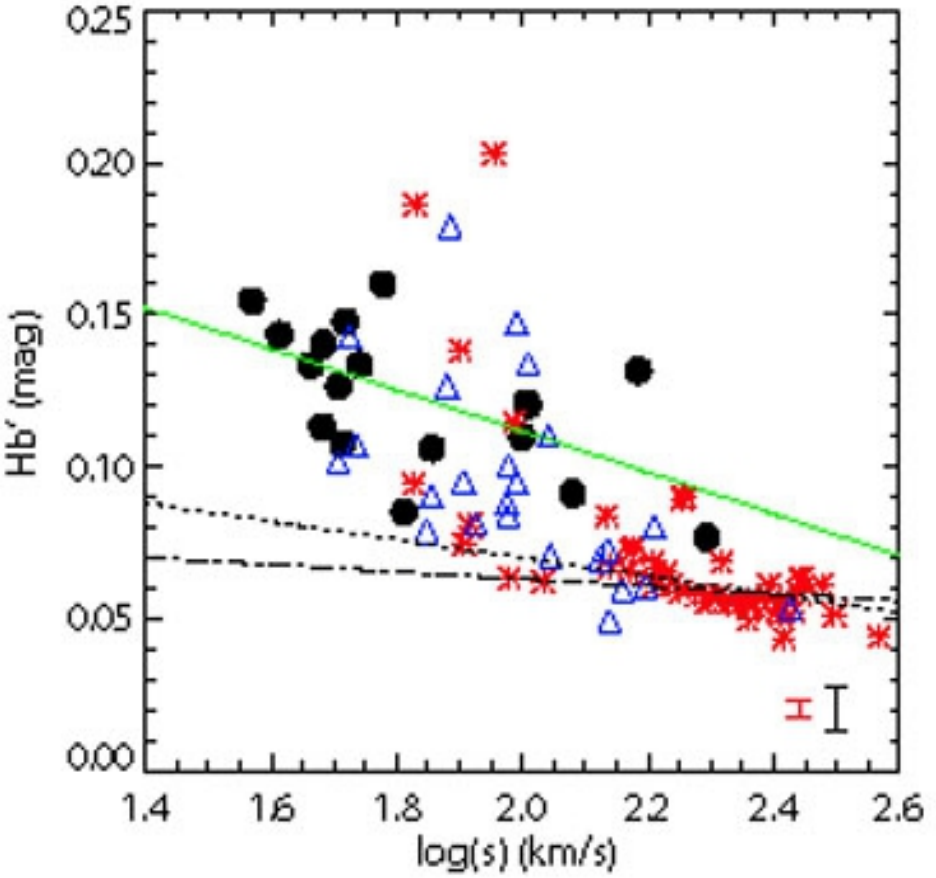
25" X 25" H & K image of the Central Parsec Cluster. Credit: Gemini

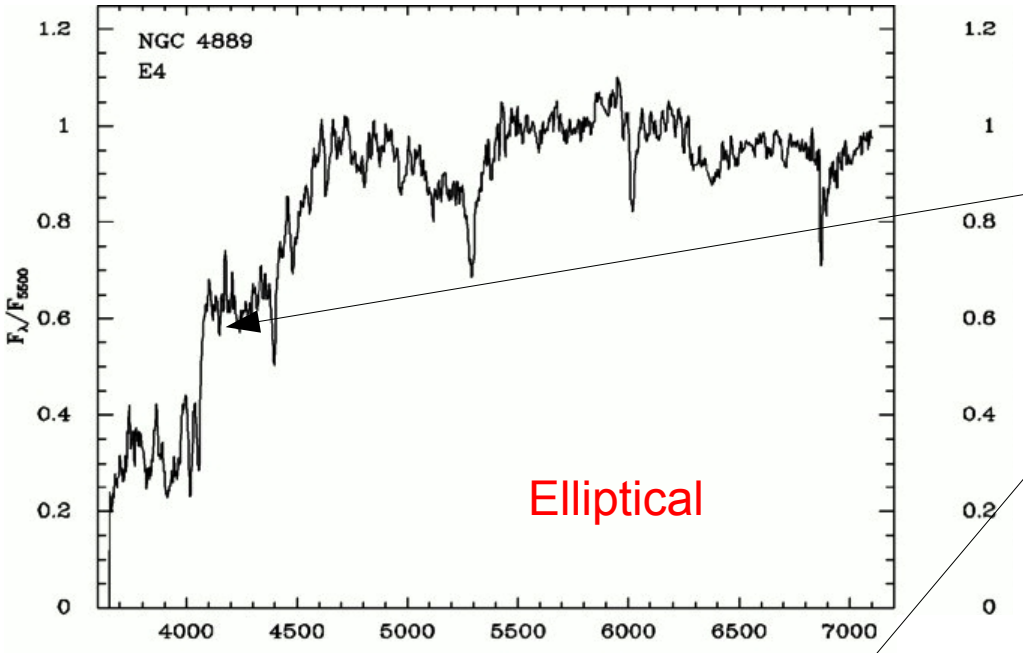
Lu & Ghez 2016

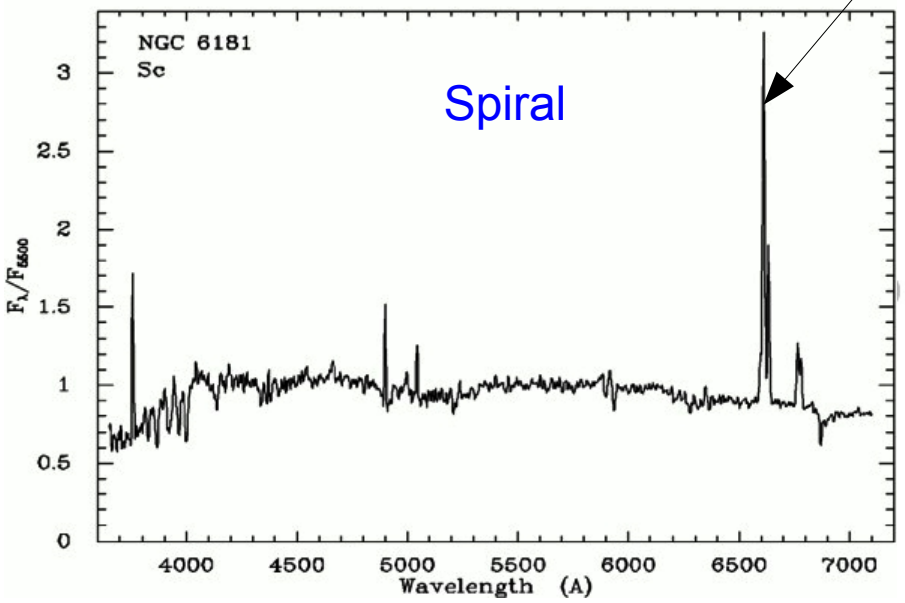


Stellar Populations in Galactic Bulges More Heterogeneous in Comparison to Ellipticals







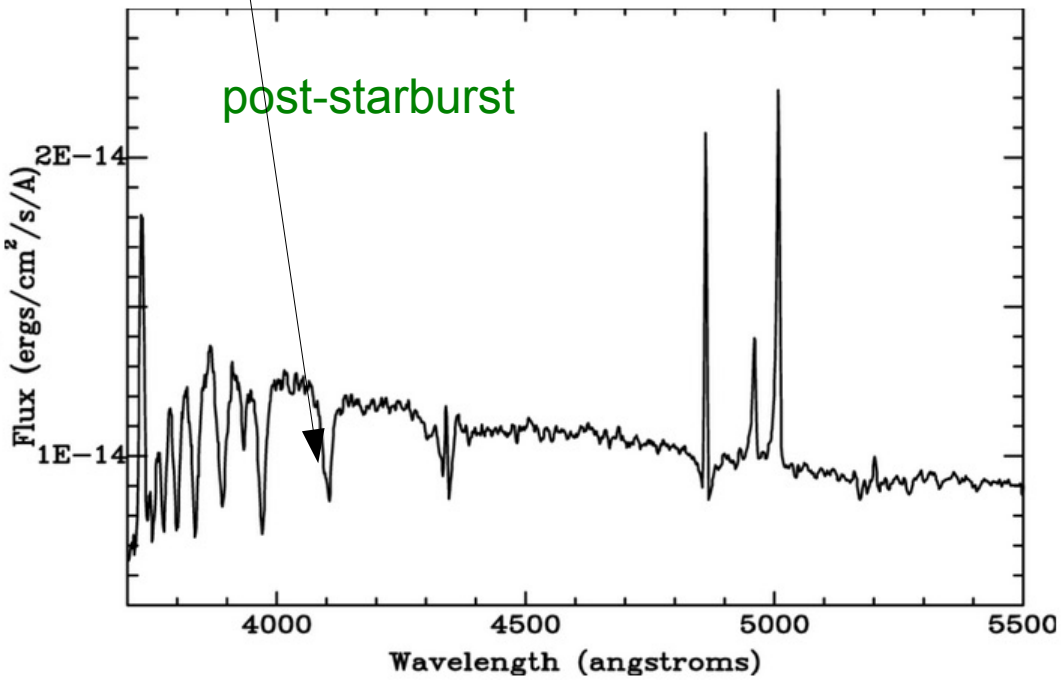


Key Indicators of Stellar AGE

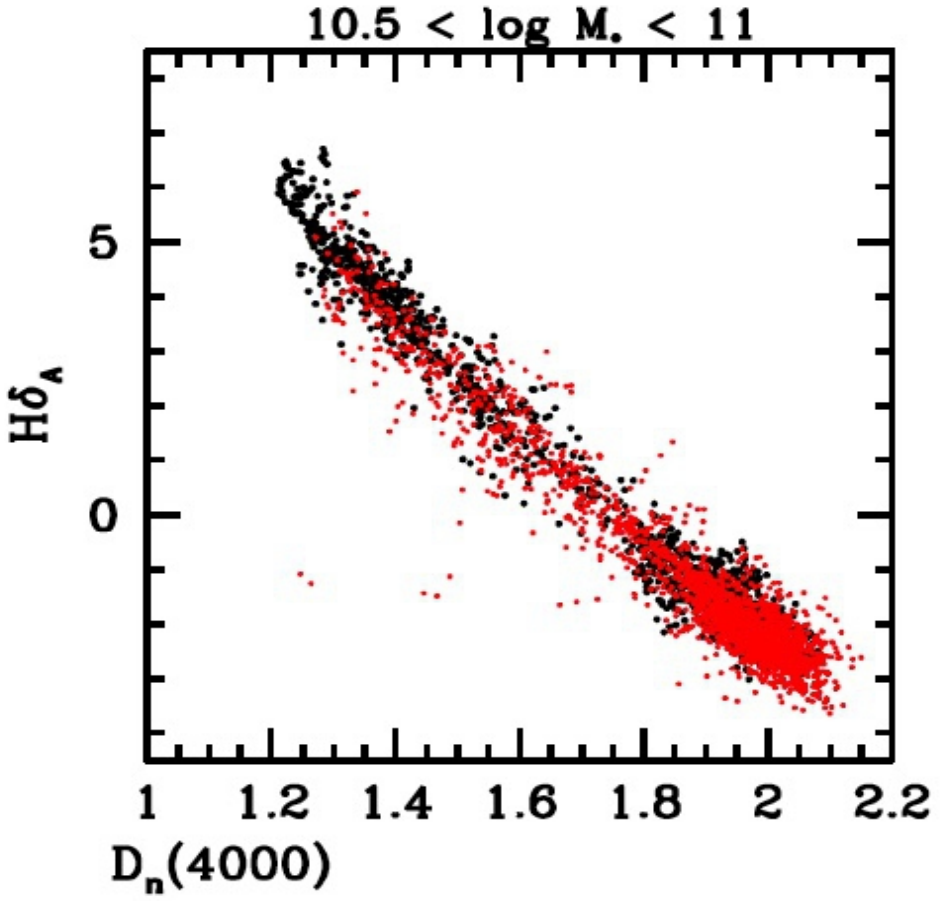
1) 4000 Angstrom break (old)

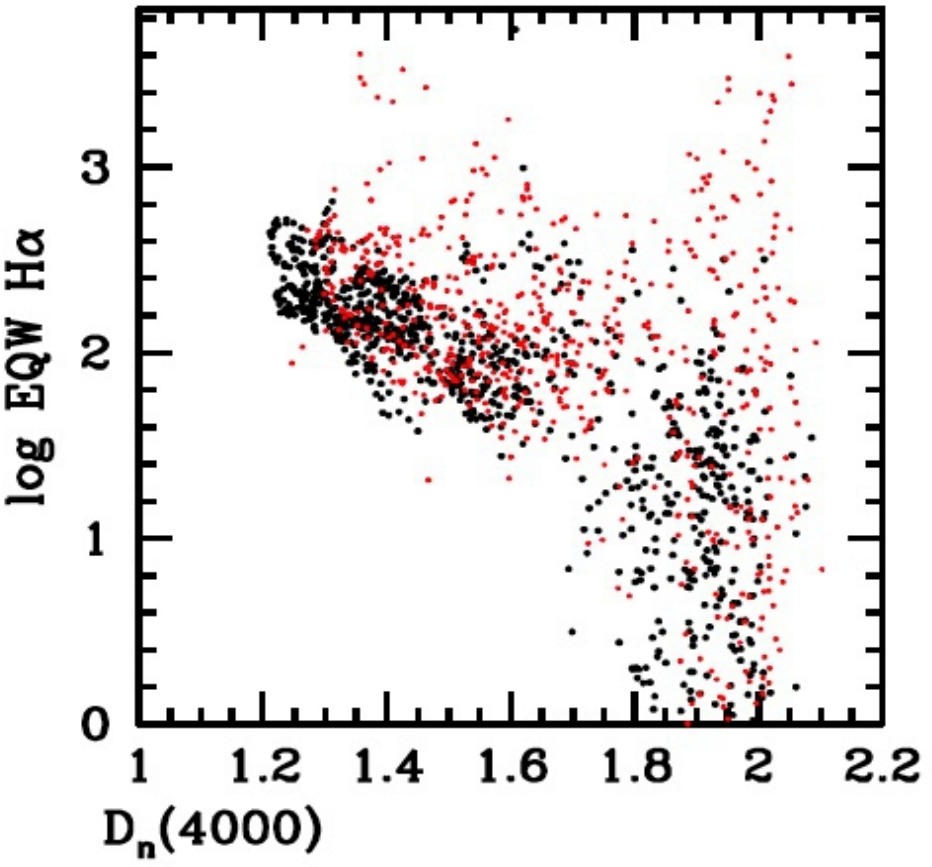
2) Balmer absorption lines (intermediate)

3) Dust-corrected Halpha (young)



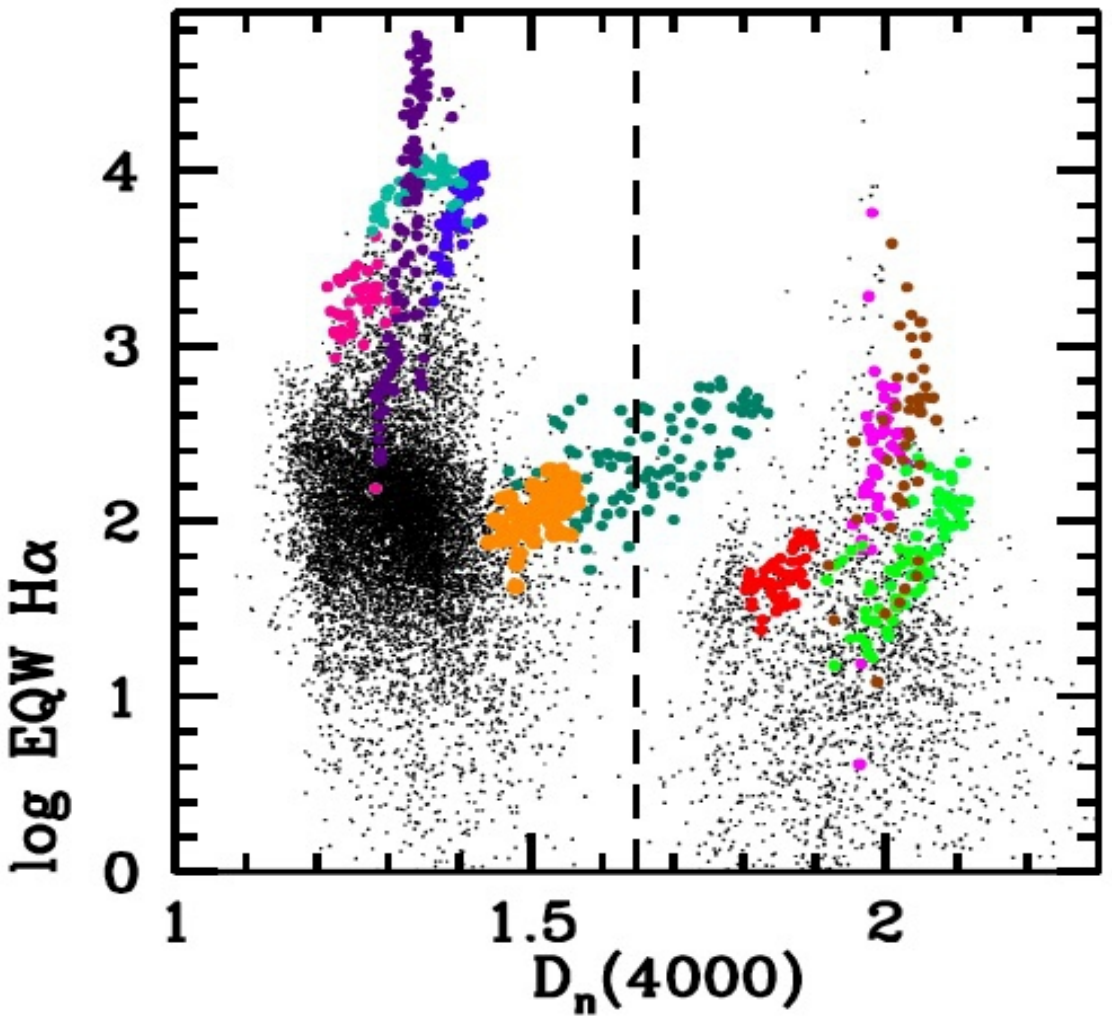
Stellar Population Indicator Scaling Relations for Inner Galaxy Regions (red) and Outer Galaxy Regions (black)





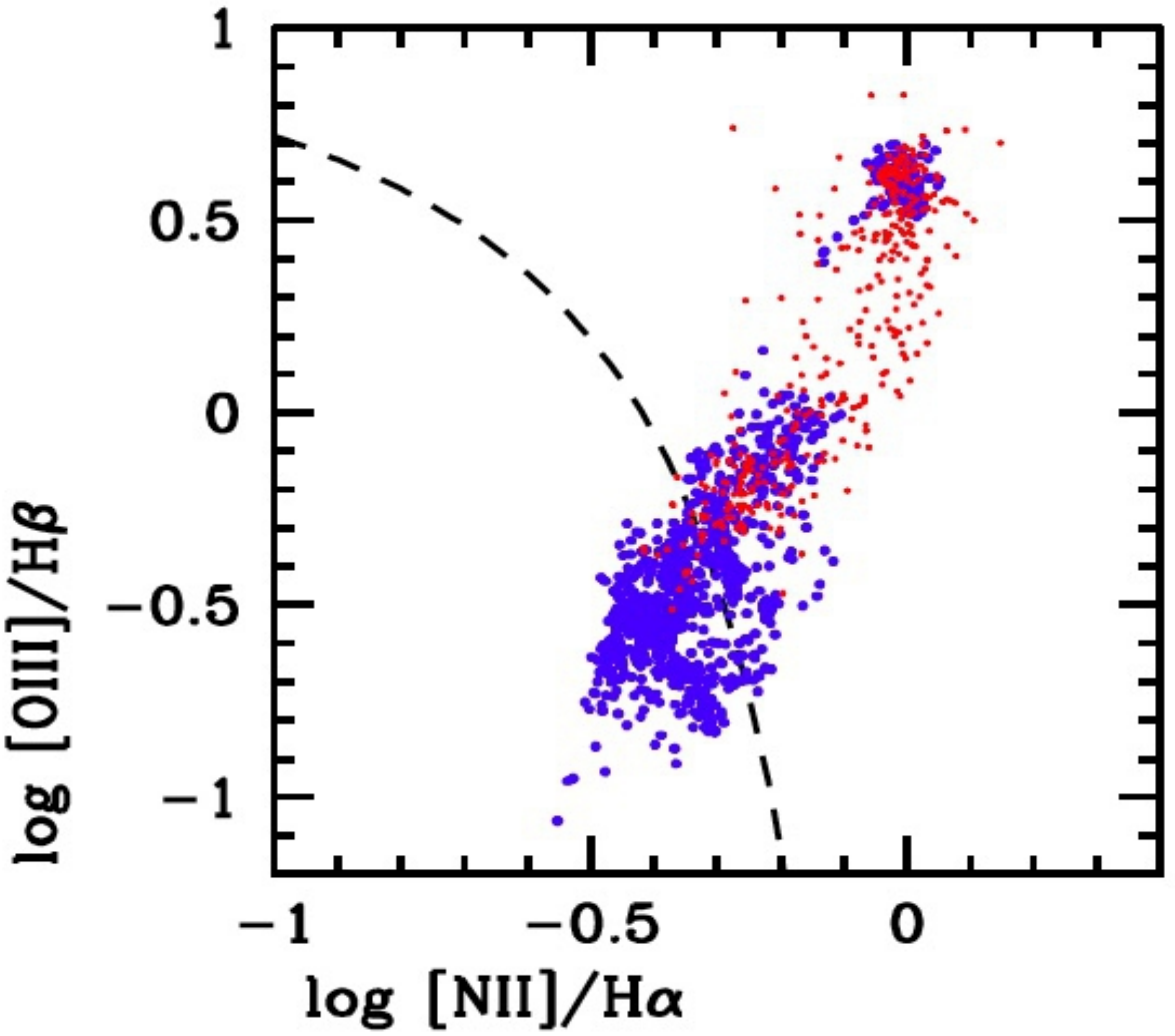
Location of Spaxels from the Outliers
(coloured points are from inner regions of the galaxy)

Blue population



Red population

Location of inner spaxels in BPT diagram for the blue outliers and for the red outliers



OUTLIER SAMPLE OF BULGES WITH D4000< 1.5

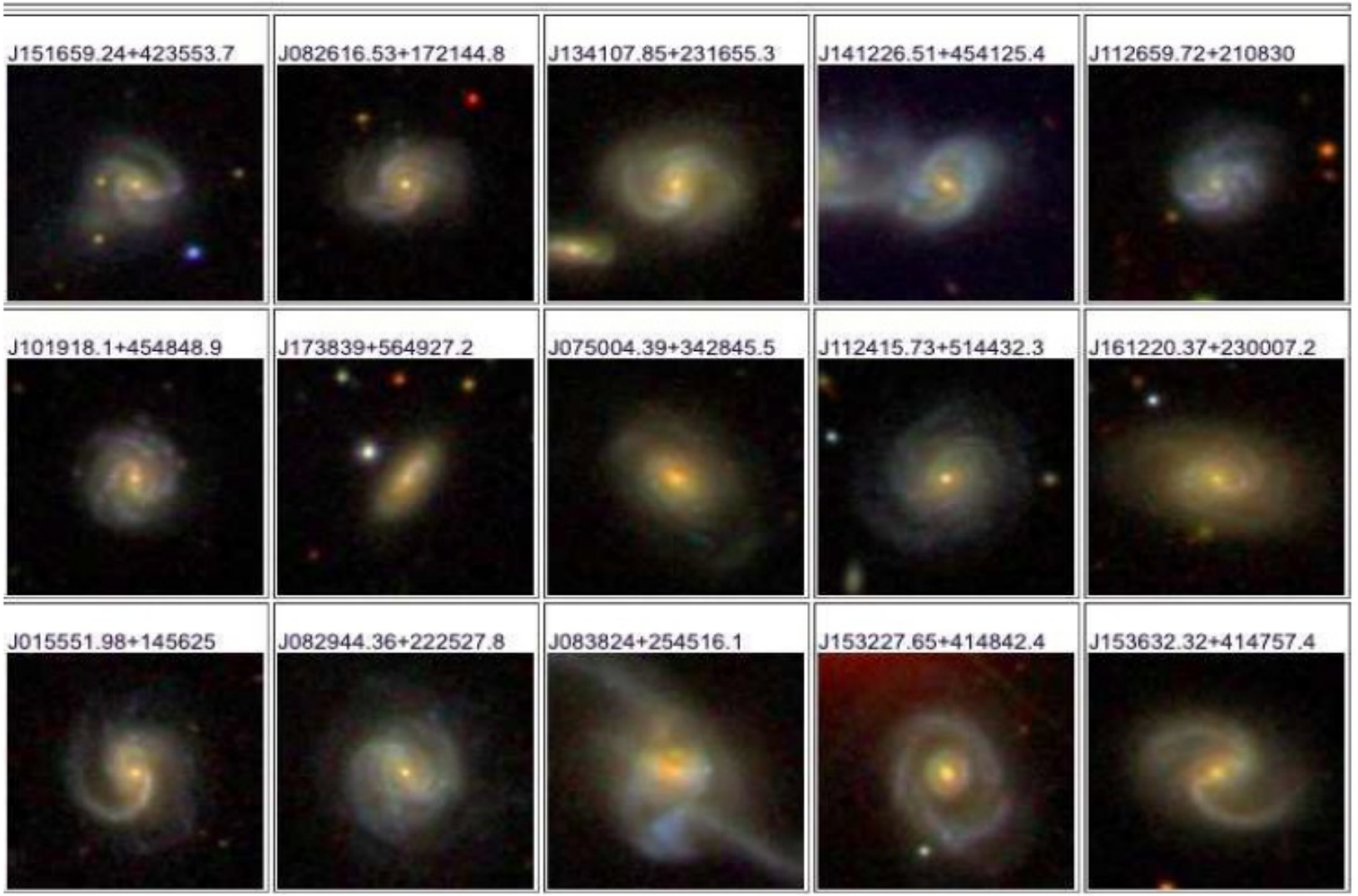


Figure 7. SDSS g, r, i colour images of the outlier sample.

CONTROL SAMPLE

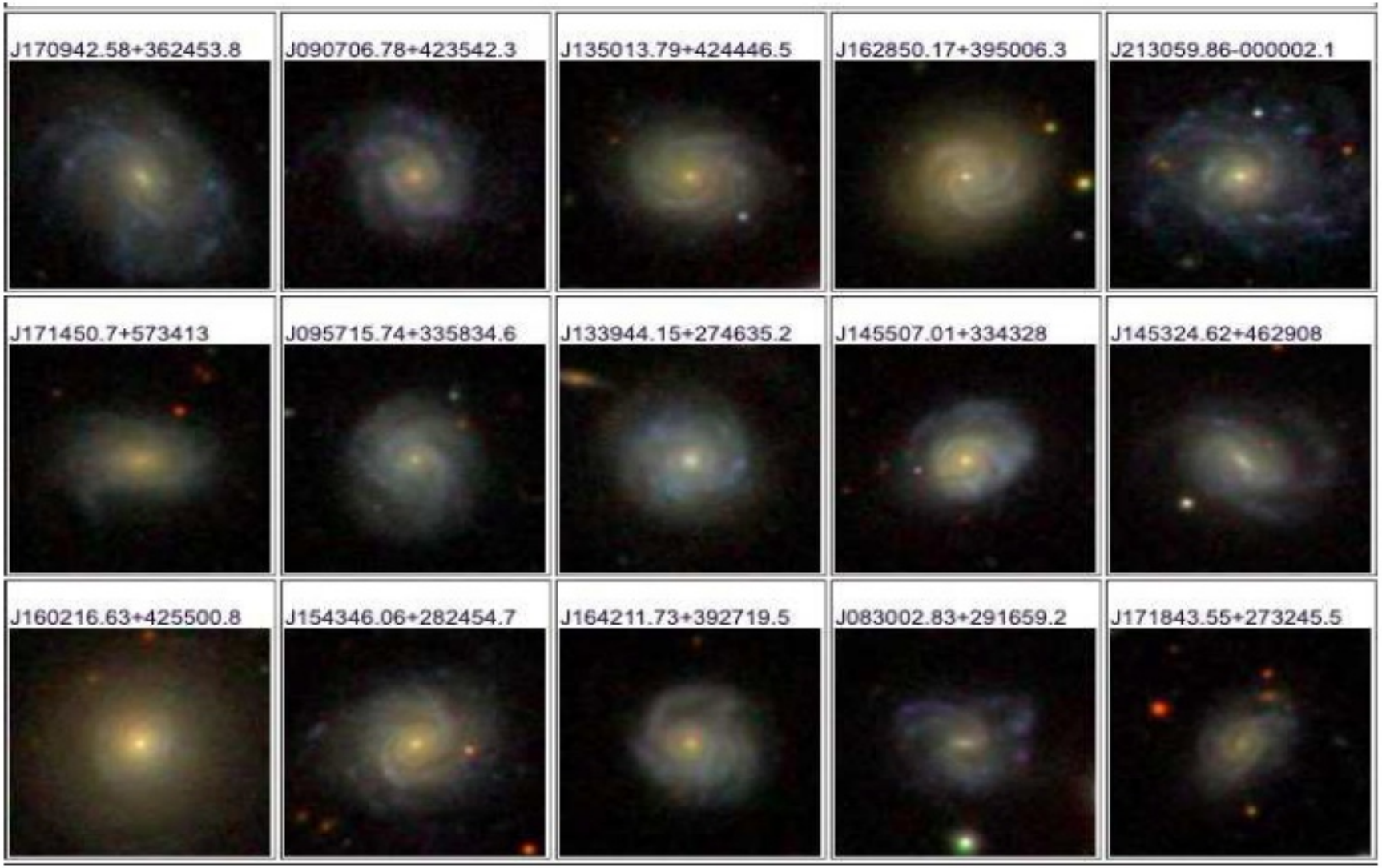


Figure 7 – *continued* SDSS g, r, i colour images of the control sample.

(i) **log Hα equivalent width:**
Outliers: 13 rising, 2 flat
Controls: 2 rising, 6 flat, 7 falling

(ii) **$D_n(4000)$:**
Outliers: 12 rising, 2 flat, 1 falling
Controls: 9 rising, 6 flat

(iii) **log Hα/Hβ:**
Outliers: 13 rising, 2 flat
Controls: 3 rising, 12 flat

(iv) **log [OIII]/[OII]:**
Outliers: 13 rising, 2 flat, median central value: -0.5
Controls: 7 rising, 7 flat, 1 falling, median central value: -0.6

(v) **Blue WR central excess:**
Outliers: 6 yes, 9 no
Controls: 3 yes, 12 no

(vi) **Red WR central excess:**
Outliers: 12 yes, 3 no
Controls: 4 yes, 11 no

Strongly centrally peaked emission (by construction)

On top of an old stellar population

Dust is centrally peaked

No hard-spectrum ionizing sources

Clear evidence for centrally peaked population of very massive young (<10^7 yr) Wolf Rayet stars

(vii) **HeII central excess:**
Outliers: 3 yes, 12 no
Controls: 3 yes, 12 no

No signature of binary star ionization

(viii) **non-Gaussian Hα central excess:**
Outliers: 1 yes, 14 no
Controls: 0 yes

Only one source with outflow signatures

(ix) **Mgb Lick index:**
Outliers: 11 rising, 4 flat, median central value: 2.5
Controls: 6 rising, 5 flat, 4 falling, median central value: 2.0

(x) **R23 index:**
Outliers: 4 rising, 4 flat, 7 falling median central value: 0.25
Controls: 2 rising, 3 flat, 10 falling, median central value: 0.0

(xi) **log [NII]/Hα:**
Outliers: 7 rising, 8 flat, median central value: -0.3
Controls: 3 rising, 12 flat, median central value: -0.5

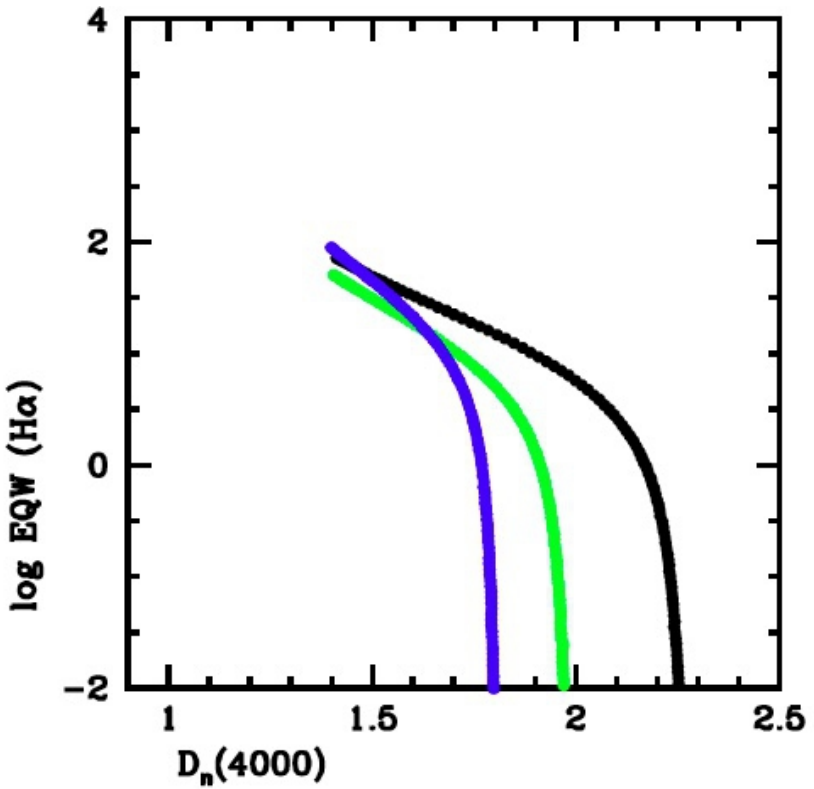
METAL RICH IONIZED GAS AND STARS

(xii) **VLA FIRST radio detection:**
Outliers: 8 yes, 7 no
Controls: no detections

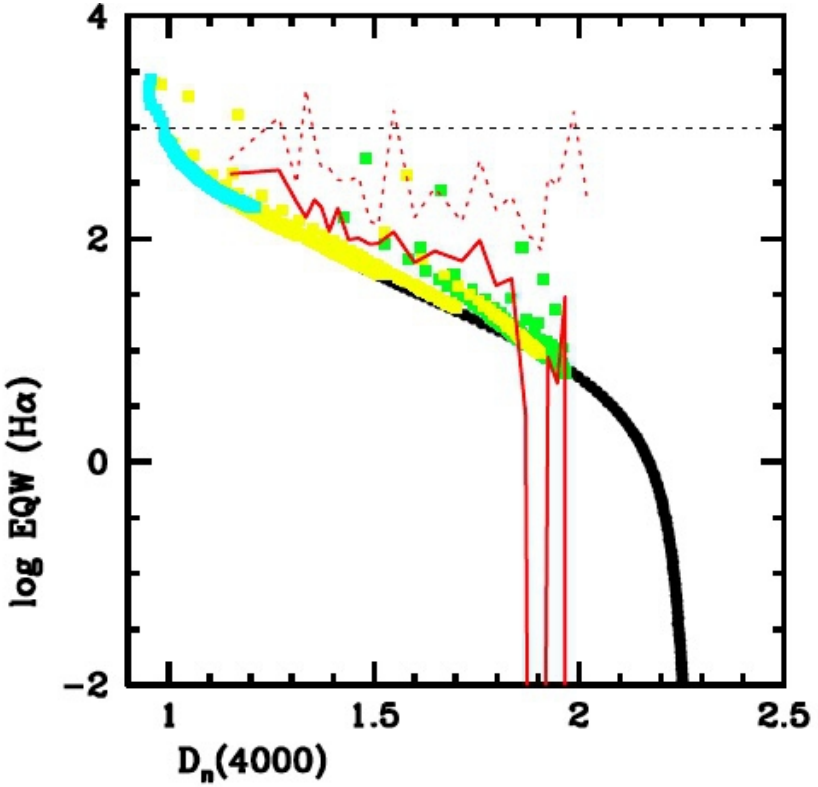
Unresolved radio components

STELLAR POPULATION SYNTHESIS AT YOUNG AGES: PLACE CONSTRAINTS ON MASS DISTRIBUTION OF YOUNG STARS

Continuous models



Models with bursts

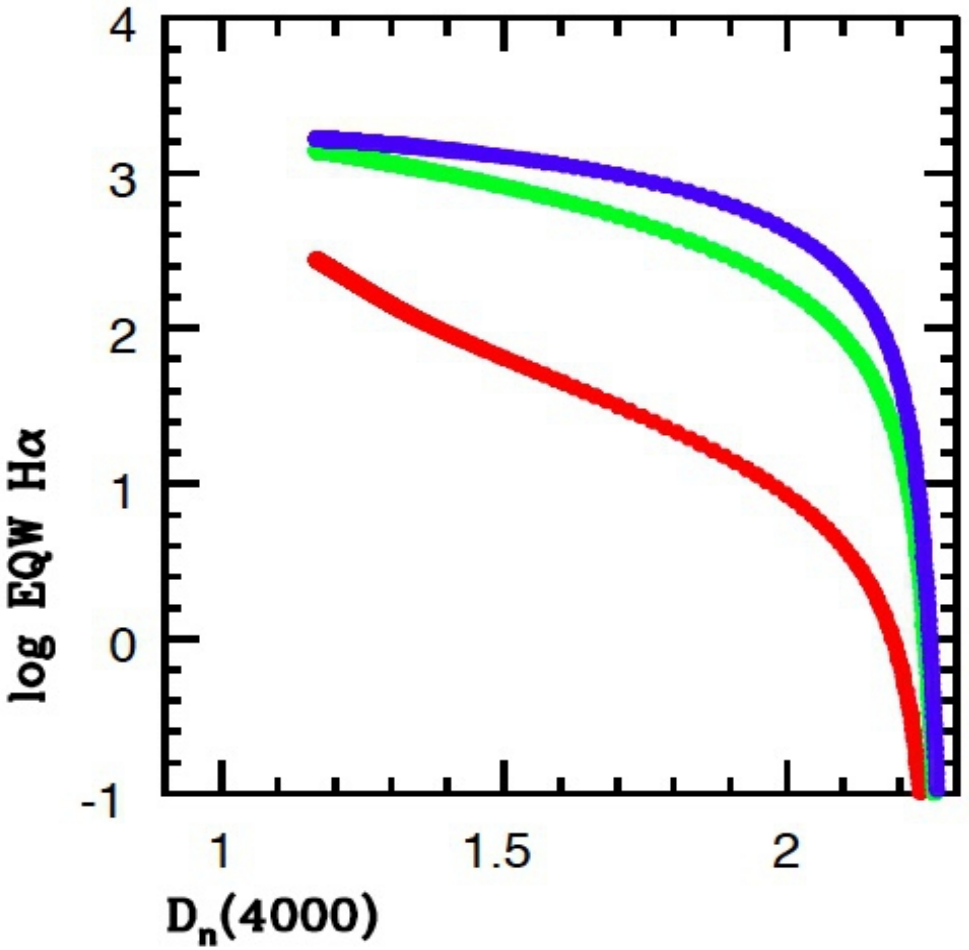


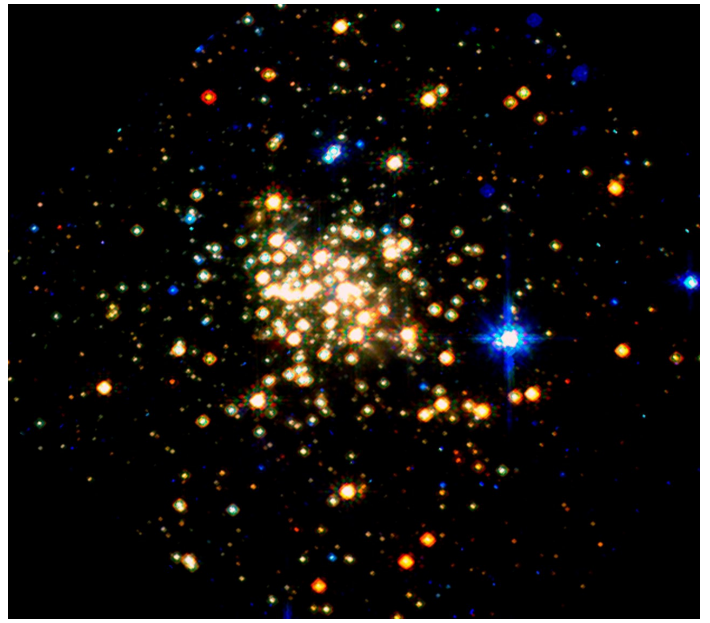
STARBURST99: fiducial initial mass function

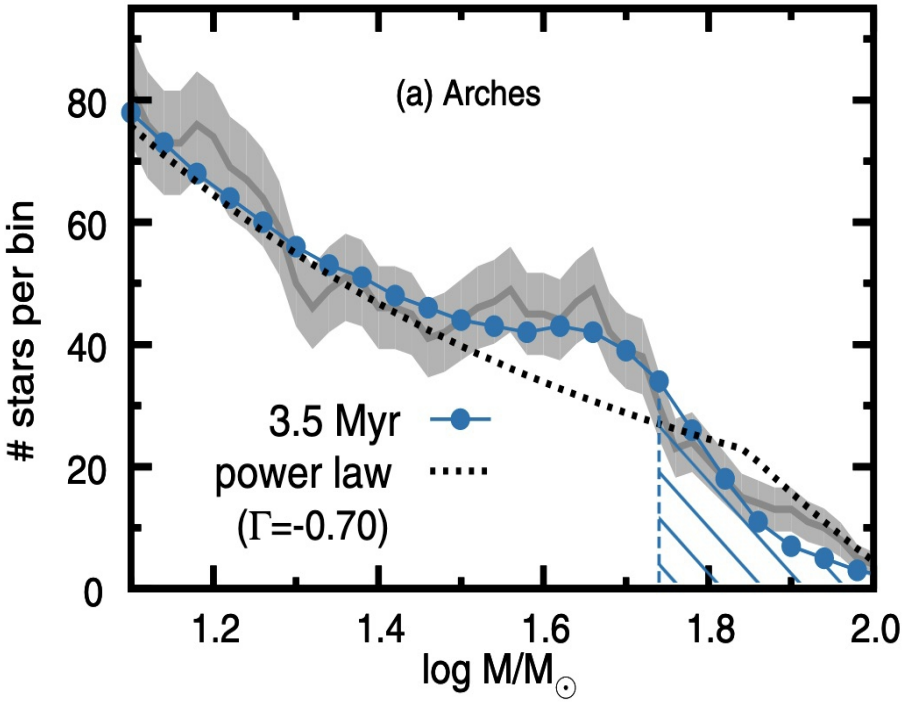
Schneider et al 2014

ARCHES

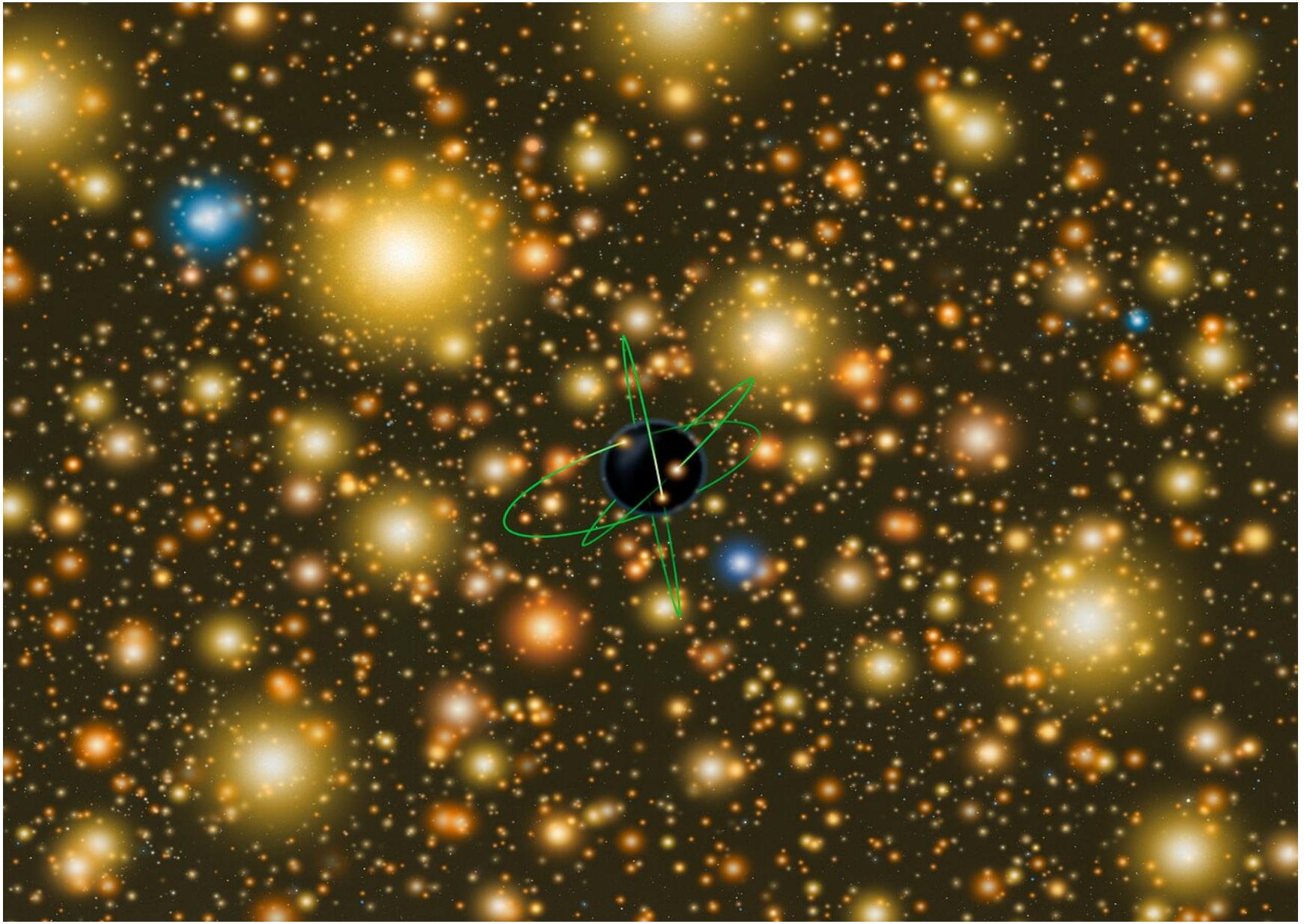
Continuous models with changes to slope of upper end of the IMF





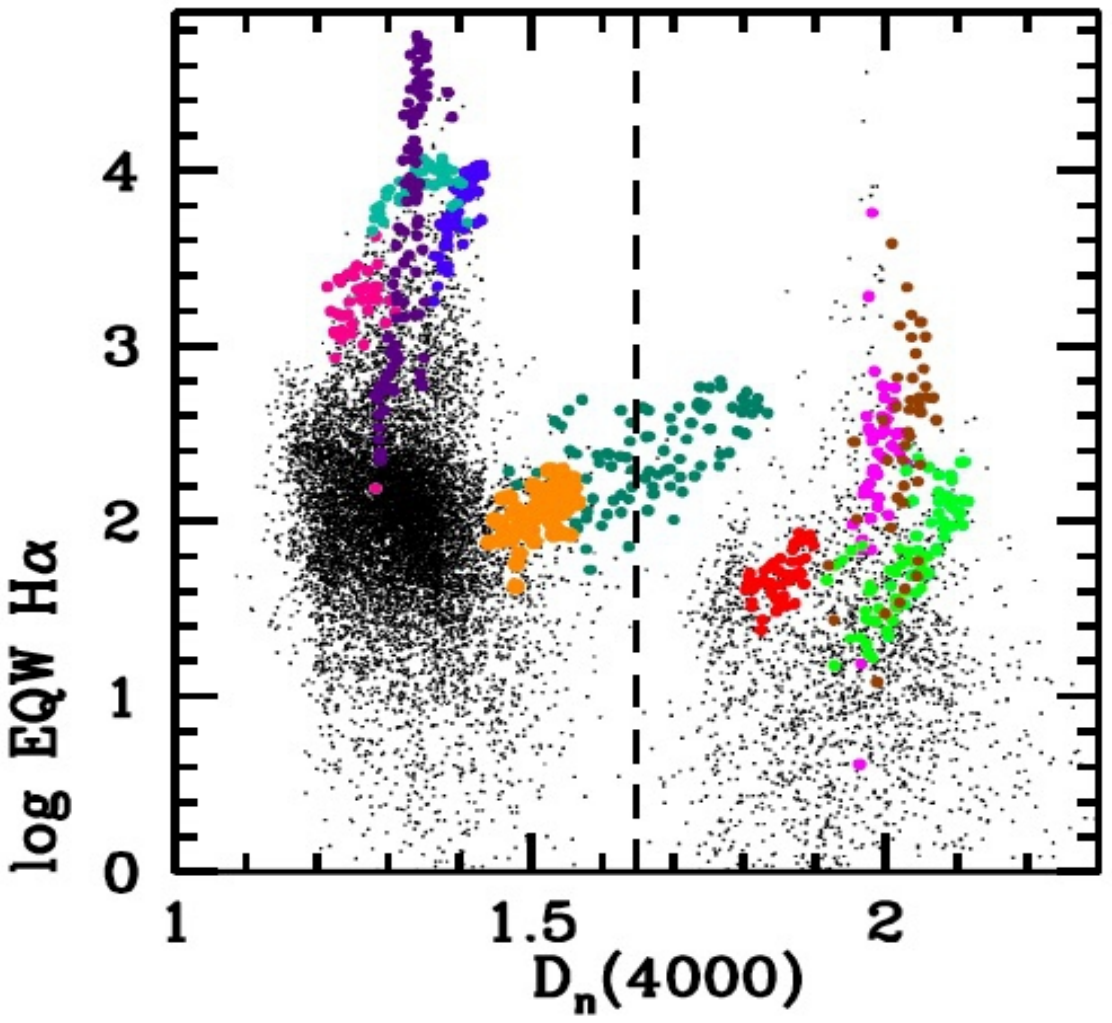


NEXT: HUNTING FOR HIDDEN BLACK HOLES



NEXT: Looking for transition objects

Blue population

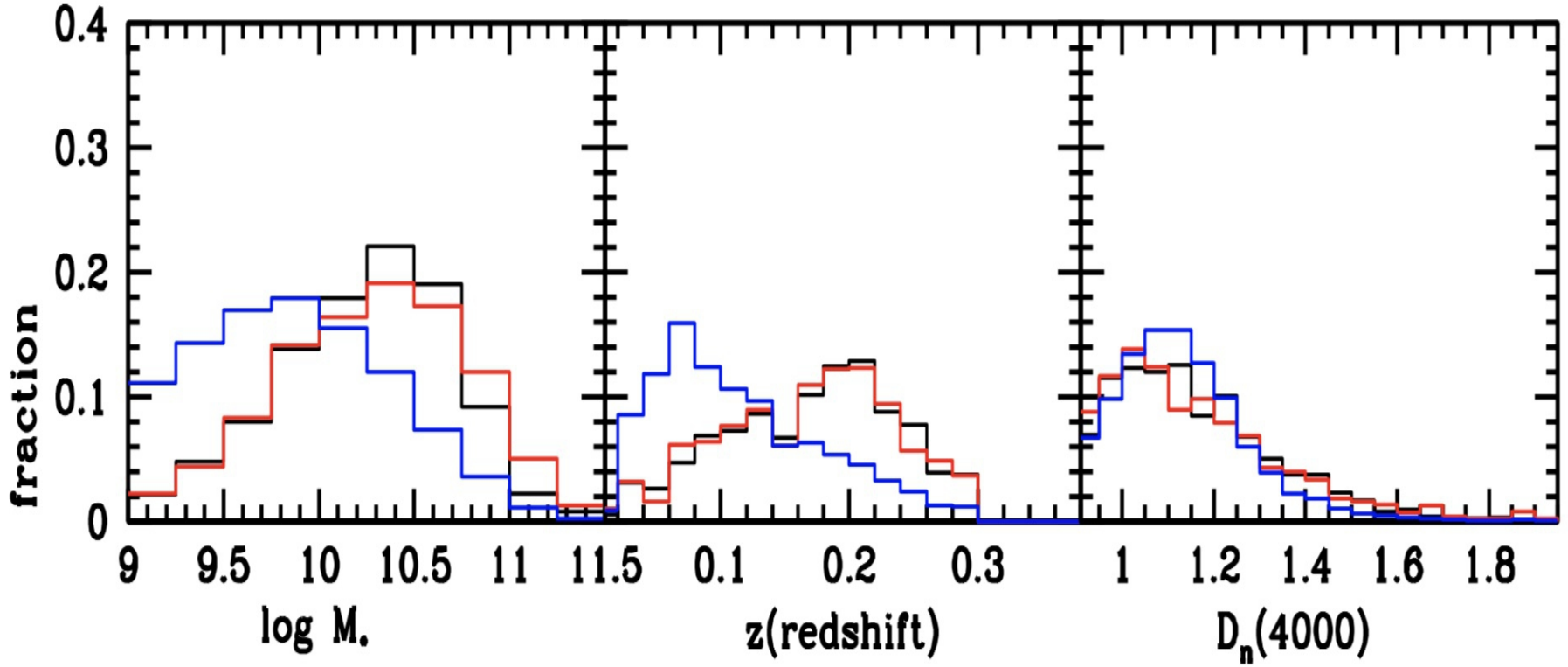


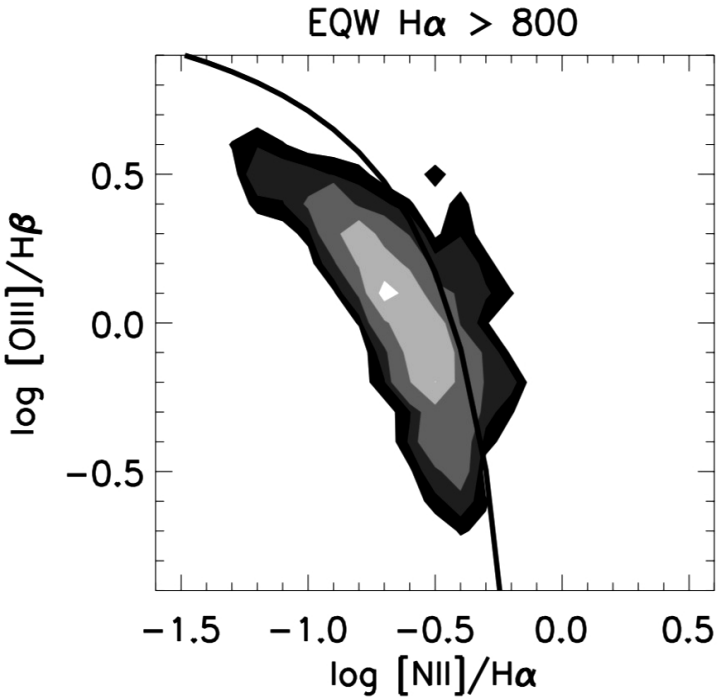
Red population

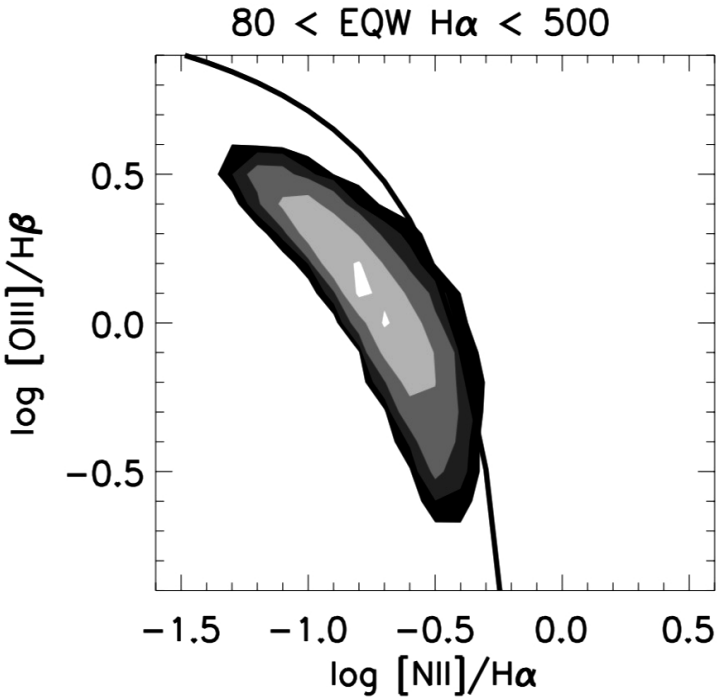
SDSS MAIN SAMPLE ANALYSIS

1076 galaxies with EQW (Halpha)> 800
(out of a total 880,000)
~10,000 galaxies with 80 < EQW (Halpha) < 300

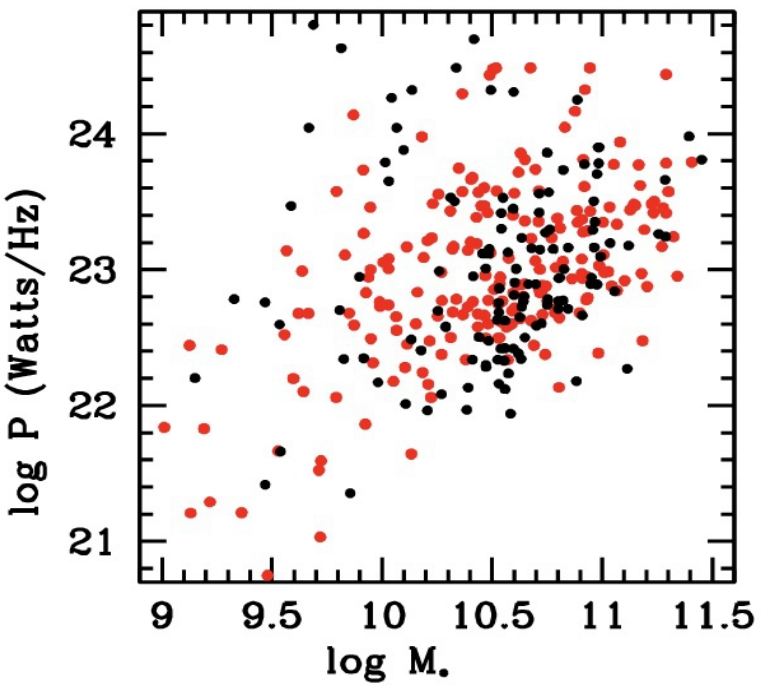
Control sample matched in mass, redshift and 4000 Angstrom break

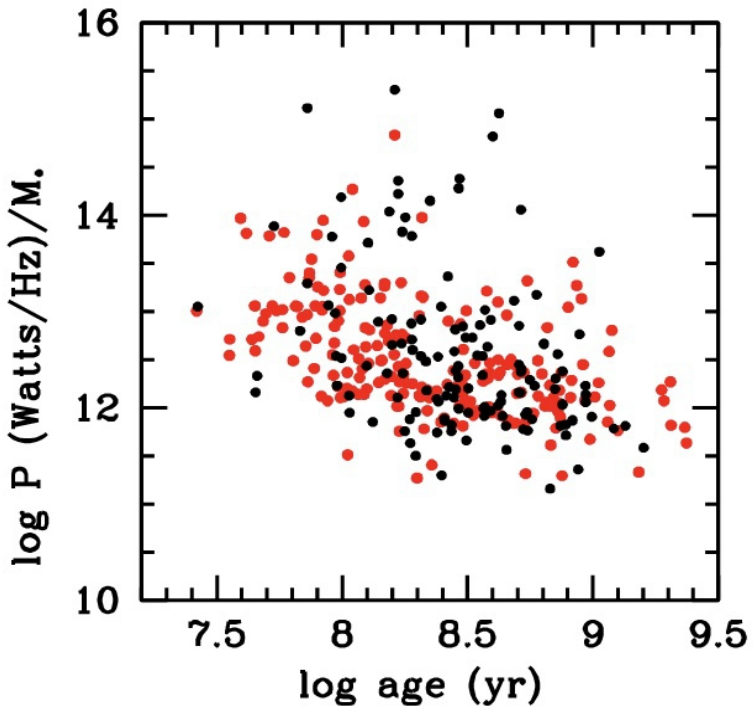






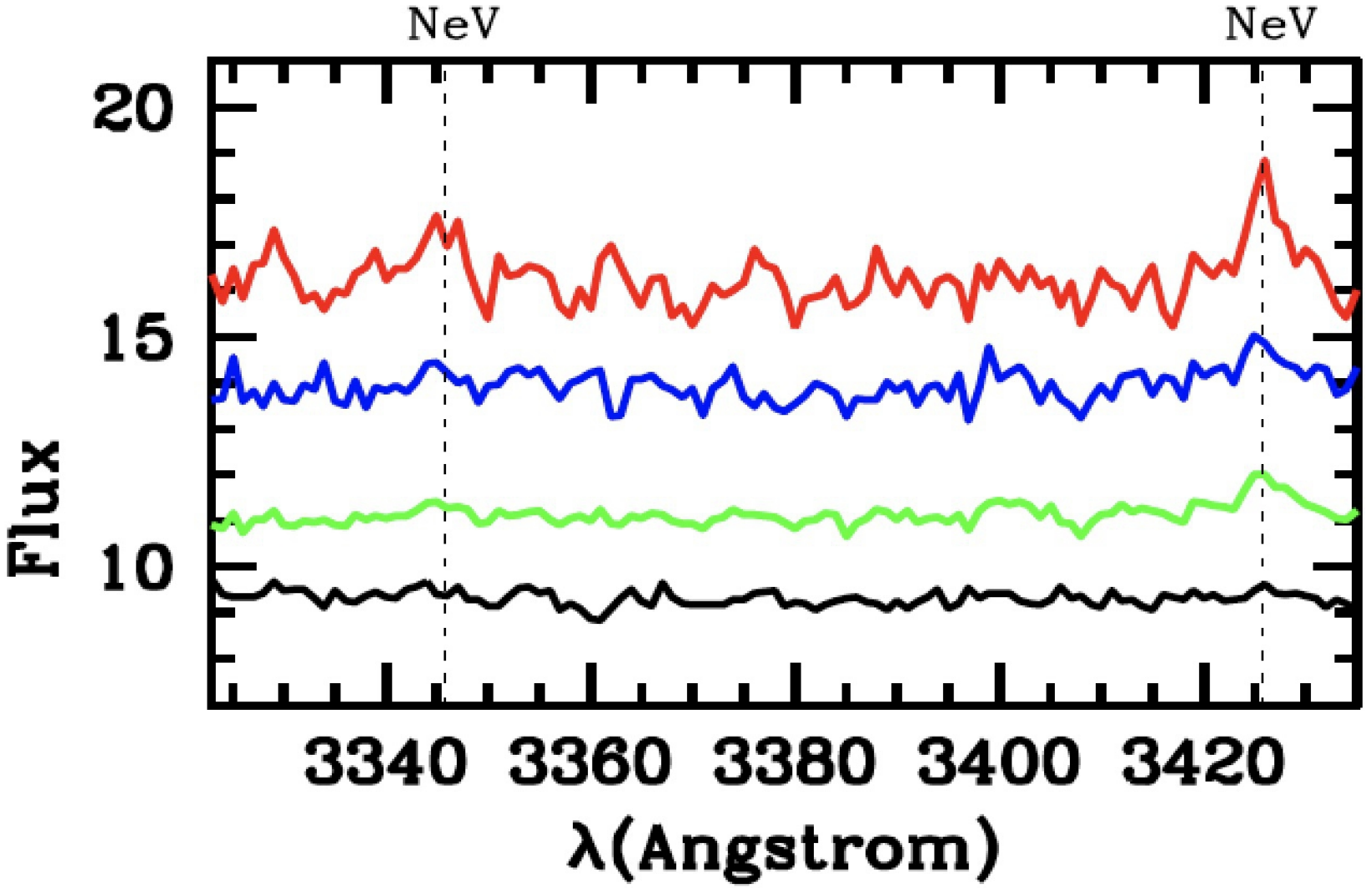
Only a few percent more objects in the composite part of the BPT diagram





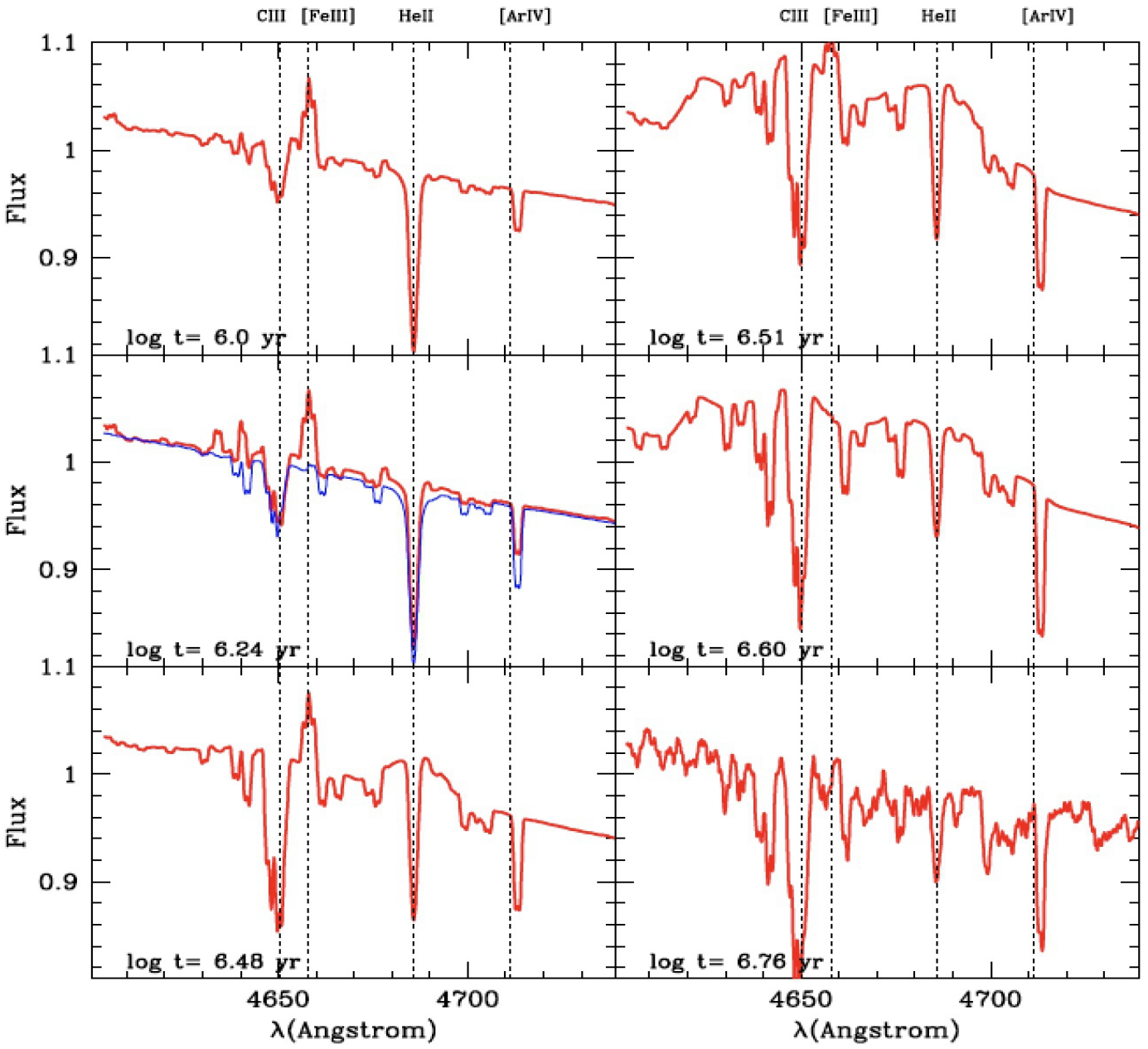
55% more likely top be detected at radio wavelengths

Spectral stacks in bins of radio luminosity



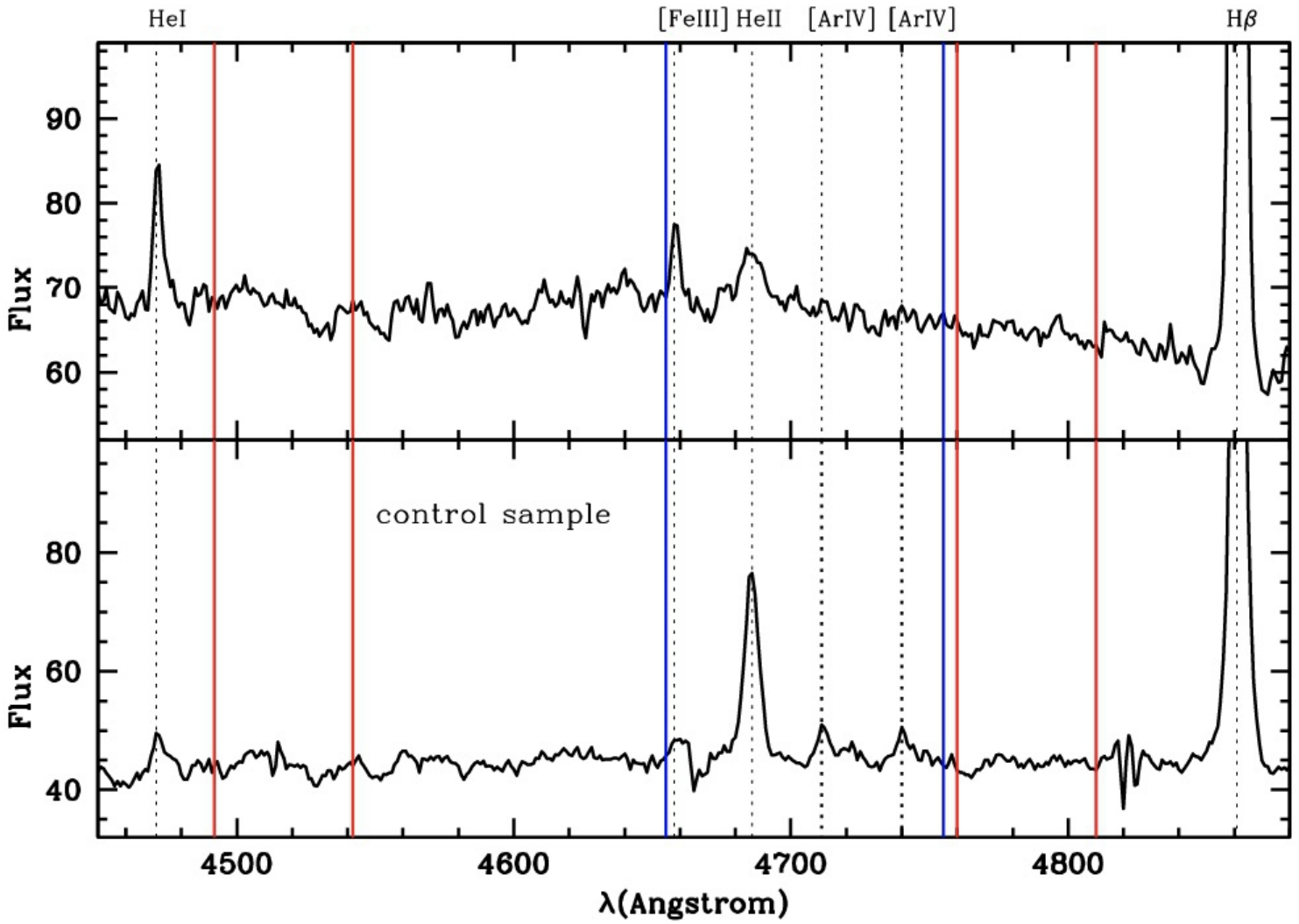
Kauffmann, Comparat, Maraston, Crowther 2022

STUDYING DIRECT SIGNATURES OF MASSIVE STARS



What is the blue bump?

(SSPs from HR-PyPOPSTAR, Millán-Irigoyen · 2021)



Halpha excess sample

Control sample

Blue bump feature much stronger than in the models

(caveats: models do not include stellar rotation or binaries!)

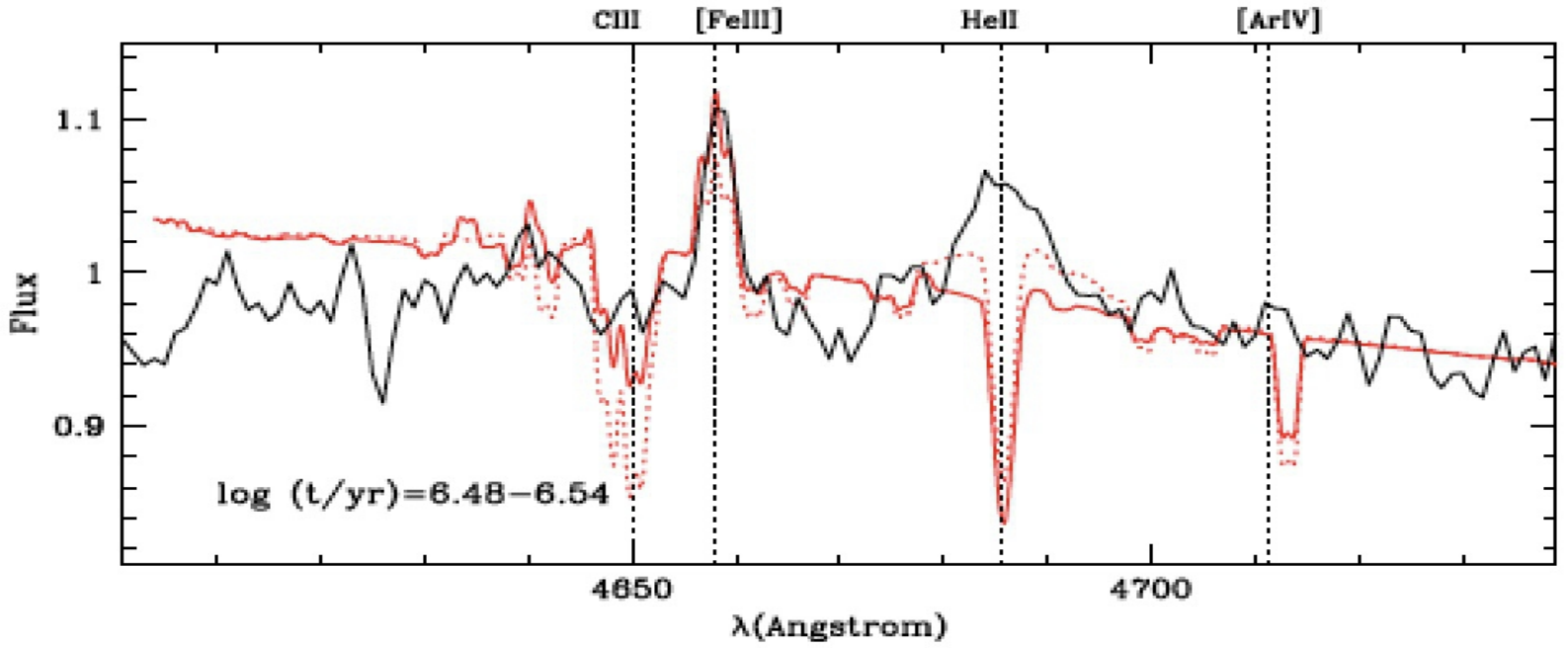


Figure 22. HR-pyPopStar solar metallicity SSPs at times $\log(t/\mathrm{yr}) = 6.48$ (red solid lines) and $\log(t/\mathrm{yr}) = 6.54$ (red dotted lines) are overplotted on the stacked spectrum from the Hα excess sample with blue bump detections (black solid lines).

Kauffmann, Comparat, Maraston, Crowther 2022

SUMMARY

1) A search for evidence of unusual stellar populations has been carried out in the dense inner regions of bulges

2) Evidence is found for excess massive stars in a small fraction of the dense star-forming regions
A variety of signatures: Halpha emission from HII regions, O and Wolf-Rayet star signatures

3) Radio emission seems to be a common feature of these unusual galaxy centres (in comparison to control samples)

4) Stacking of spectra from the radio-detected objects yields evidence of very high ionization NeV emission, often taken to be a “smoking gun” evidence of an accreting black hole