CANDELS:
The progenitors of “red nuggets”

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Why are red nuggets so important?

- Abundant population of quiescent galaxies at $z \approx 2$ (Universe 2–3 Gyr old) (Arnouts+07; Brammer+09,11; Williams+09; Ilbert+10; Whitaker+11)

- Remarkably $(x5)$ small compared to local analogs of the same stellar mass (Trujillo+07; Buitrago+08; Cassata+10; Saracco+10,11; Newman+12)
SFR $\approx M^\alpha$

- SFGs are bigger at a given mass
sSFR-M and Mass-Size

- CANDELS H-band selected catalog in GOODS-S & UDS
- Photo-z's (spec-z), stellar masses, (UV+IR) SFRs, GALFIT morphologies
sSFR-M and Mass-Size

1.4 < z < 3.0

1.4 < z < 1.8
- Quiescent
- 1.8 < z < 3.0

$\Sigma \approx M/r_e^{1.5}$

Shen et al. 2003
Newman et al. 2012

$z=0$
$z=1.75$
$z=2.25$
$1.4 < z < 3.0$
Quiescent Star forming

$1.4 < z < 3.0$
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$1.4 < z < 3.0$
$1.4 < z < 3.0$

- Quiescent
  - $1.4 < z < 1.8$
  - $1.8 < z < 3.0$

- SF

$z = 0$

- Shen et al. 2003

\[ \log(M/[M_{\odot}]) \text{ vs. } \log(\Sigma_{1.5}[M_{\odot} Kpc^{-1.5}]) \]
1.4 < z < 3.0

quench + shrink

shrink + quench

1.4 < z < 3.0

Shen et al. 2003
Nawman et al. 2012
Compact quiescent and SFGs

\[0.5<z<1.0 \quad 782\]
\[1.0<z<1.4 \quad 644\]
\[1.4<z<1.8 \quad 807\]
\[1.8<z<2.2 \quad 537\]
\[2.2<z<2.6 \quad 351\]
\[2.6<z<3.0 \quad 248\]

Log sSFR [Gyr\(^{-1}\)]

Log \(\Sigma_{1.5} [M_{\odot} Kpc^{-1.5}]\)

Compact Quiescent
Compact SF
X-ray
L_X > 10^{42-43}
L_X > 10^{43}
sersic index

0.5 < z < 1.0
1029

1.0 < z < 1.4
833

1.4 < z < 1.8
1083

1.8 < z < 2.2
701

2.2 < z < 2.6
459

2.6 < z < 3.0
357

log(n)

#
Density of compact galaxies

Looback time (Gyr)

COMPACT Quiescent
COMPACT SF

\[ n \text{ [Mpc}^{-3}] \]

\[ \Delta t = 1 \text{ Gyr} \]

\[ \Delta t = 0.3 \text{ Gyr} \]

redshift
Evolutionary paths to the red sequence

- SLOW-TRACK
  - $z < 1.8$
  - Secular processes
  - Major/minor mergers?

- FAST-TRACK
  - $z = 1-2$
  - Size growth (minor mergers?)
  - SF quenching (AGN/SF feedback?)
  - $z = 2-3$

- cSFGs formation
  - GAS-RICH
  - Major mergers, dynamical instabilities
  - AGN?
Compact SFGs $1.4 < z < 3.0$
- SFGs and quiescent galaxies follow different Mass-Size relations

Williams +2010
Mass-Size relation

- Roughly constant slope
- Zero-point shifts towards smaller radii

Newman+2011