The Ages of Passive Galaxies in a $z=1.62$ Protocluster

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Do massive cluster galaxies quench earlier?

- Rejuvenation mass and environment driven
- Formation phase self-regulated
  \[ \log \frac{M_{\text{dyn}}}{M_\odot} \approx 12.0 \]
Do massive cluster galaxies quench earlier?
IRC 0218 / Cl 0218.3-0510 / XMM-LSS J02182-05102
(Papovich+ 2010, Tanaka+ 2010)

Mass $\sim 4 - 7 \times 10^{13} M_*$
(Tanaka + 2010, Tran+ 2015)

$\sigma_{cl} \sim 250 \pm 50 \text{ km s}^{-1}$
(Tran+2015)

Still assembling
10 orbits G102, 2 orbits G141
Spectroscopic Redshifts
Passive Galaxy Selection

![Passive Galaxy Selection Diagrams](image-url)

- **Quiescent** region
- **Star Forming** region
- **IRC 0218**
- **Field**
- **DLB+17**
Mass-Dependent Quiescent Fraction

\[ \log(M/M_{\odot}) \]

- IRC 0218, z = 1.62
- Cooke+ 2016, z = 1.58
- JKCS 041, z = 1.80
- 3D-HST z = 1.6 Field

DLB+17
Mass-Dependent Quiescent Fraction

![Graph showing mass-dependent quiescent fraction with annotations]

- **No enhancement**
- **~2x enhancement w.r.t. field**

Legend:
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- 3D-HST $z = 1.6$ Field

$\log(M/M_\odot)$
Dn(4000) vs Stellar Mass

SDSS: Kauffmann+2003

DLB+17
Quenched fraction increases with mass → Enhanced quenching at high masses
Quenched fraction increases with mass

Enhanced quenching at high masses

No strong D(4000)-mass relation
Quenched fraction increases with mass

Enhanced quenching at high masses

Rapid mass-dependent quenching

No strong D(4000)-mass relation

Dry merger effects
Rapid mass-dependent quenching

Dry merger effects
Summary

Quenched fraction increases with stellar mass*
- Consistent with field at log(M) \sim 10.4
- 2x elevated at log(M) \sim 11.2
Summary

Quenched fraction increases with stellar mass*
- Consistent with field at $\log(M) \sim 10.4$
- 2x elevated at $\log(M) \sim 11.2$

No evidence for increase in age with stellar mass*
- Flat D(4000) vs stellar mass
Summary

Quenched fraction increases with stellar mass*
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Possible explanations:
- Galaxies quenched over short period of time
- Dry mergers
Summary

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