





The Morphologies of the Most Luminous Galaxies in the Universe

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Do Mergers Matter?

- Depends on the question... matter for what?
 - Contribution to cosmic star formation?



Scudder et al. 2012

Do Mergers Matter?

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Torrey et al. 2012

Do Mergers Matter?

- Depends on the question... matter for what?
 - Contribution to cosmic star formation?
 - Contribution to starburst systems?
 - Black hole growth?
 - Morphological transformation?
 - Quenching?
- How does this change over cosmic time?

Star Formation – Stellar Mass Relation



Wuyts et al. 2011

Star Formation – Stellar Mass Relation

What role do mergers play among starburst systems?



Wuyts et al. 2011

Interacting Galaxies

Hubble Space Telescope • ACS/WFC • WFPC2



NASA, ESA, the Hubble Heritage (AURA/STScI)-ESA/Hubble Collaboration, and A. Evans (University of Virginia, Charlottesville/NRAO/Stony Brook University)

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Identifying Mergers at z~2

- Low surface brightness features are hard to see
- Other causes of disturbed morphology
 - Disk instabilities?
- Minor mergers?
- Ability to identify merger signatures quantified by Hung et al. 2014



Identifying Mergers at z~2

Clear Merger Signatures

- Tidal tails
- Double nuclei
- Pairs (need redshift information!)
- Tantalizing Suggestions
 - Train wrecks (assumed to be mergers)
 - Disturbed systems
 - Slight Asymmetries (minor mergers?)
- Unclear?
 - Irregular systems / Diffuse blobs
- Post mergers?

Are High Redshift (z~2) Star Forming Galaxies Mergers?

- BzK galaxies
- Submillimeter galaxies
- Luminous Infrared Galaxies
- Early studies contained a mix of sources
- Some were mergers, some not

Are z~2 (U)LIRGs Starbursts?





At z~1....

Hung et al. 2013



GOODS- and CANDELS-Herschel

- Deep Herschel coverage of both GOODS fields and UDS + COSMOS
- PACS + SPIRE (100 500 μm) imaging
- Deep enough to reach typical star forming galaxies at z~2 (~"MS")







COSMOS – PEP +HerMES

Wide area essential for rare, most luminous sources

GOODS+CANDELS Herschel

Full Area of COSMOS



HST GO-13657

Full Herschel CANDELS+COSMOS Sample



CANDELS Visual Classification Scheme

- Classifying all CANDELS Galaxies to H<24.5
 - 4 fields complete (UDS, GOODS-S, COSMOS, GOODS-N)
 - Last one (EGS) being completed right now
 - Total of ~50,000 galaxies
- Multiple classifiers for comparison and statistical analysis
 - ~3-5 people per object
 - ~70 classifiers in total
- Automated classifications for comparison
 - GALFIT, Gini, M20, Asymemetry, etc.
- Catalogs to be made public (GOODS-S already is, Kartaltepe et al. 2015)



SFR-M* Relation



sSFR vs. Redshift



Star forming sequence line from Elbaz et

Kartaltepe et al. in prep

Disks



Edge-on Disks



SFR-M* Relation – Disks



Asymmetric Disks / Ambiguous



SFR-M* Relation - Asymmetries



Elliptical/Compact



SFR-M* Relation – Ellipticals/Compact



Interacting Pairs







SFR-M* Relation – Mergers







Summary

- Largest sample of z~2 IR galaxies with rest-frame optical morphologies
- Large numbers + dynamic range in L_{IR} needed to see trends
- Strong trend of morphologies with IR luminosity
 - Fraction of mergers increases (>50% of ULIRGs/HyLIRGs)
 - Fraction of disks decreases (from ~50% to ~5%)
 - Compact/point sources: 20-40% at high L_{IR} end
- "Starburst" systems vastly dominated by interactions and mergers, few disks