

Progress Report: Additional UMKC Efforts to Constrain the Major Merging History with CANDELS

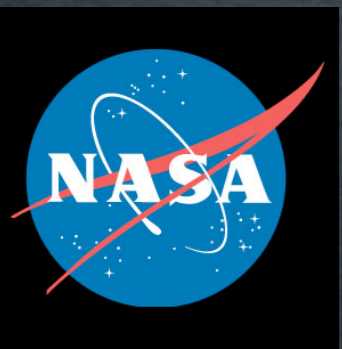
Daniel H. McIntosh

Kameswara Bharadwaj Mantha

Cody Ciaschi, Rubyet Evan, Logan Fries, Luke Landry, Scott Thompson

U. Missouri - Kansas City (UMKC)

w/ Yicheng Guo (U.Missouri) , Joel Primack (UCSC), Greg Snyder (STScI)

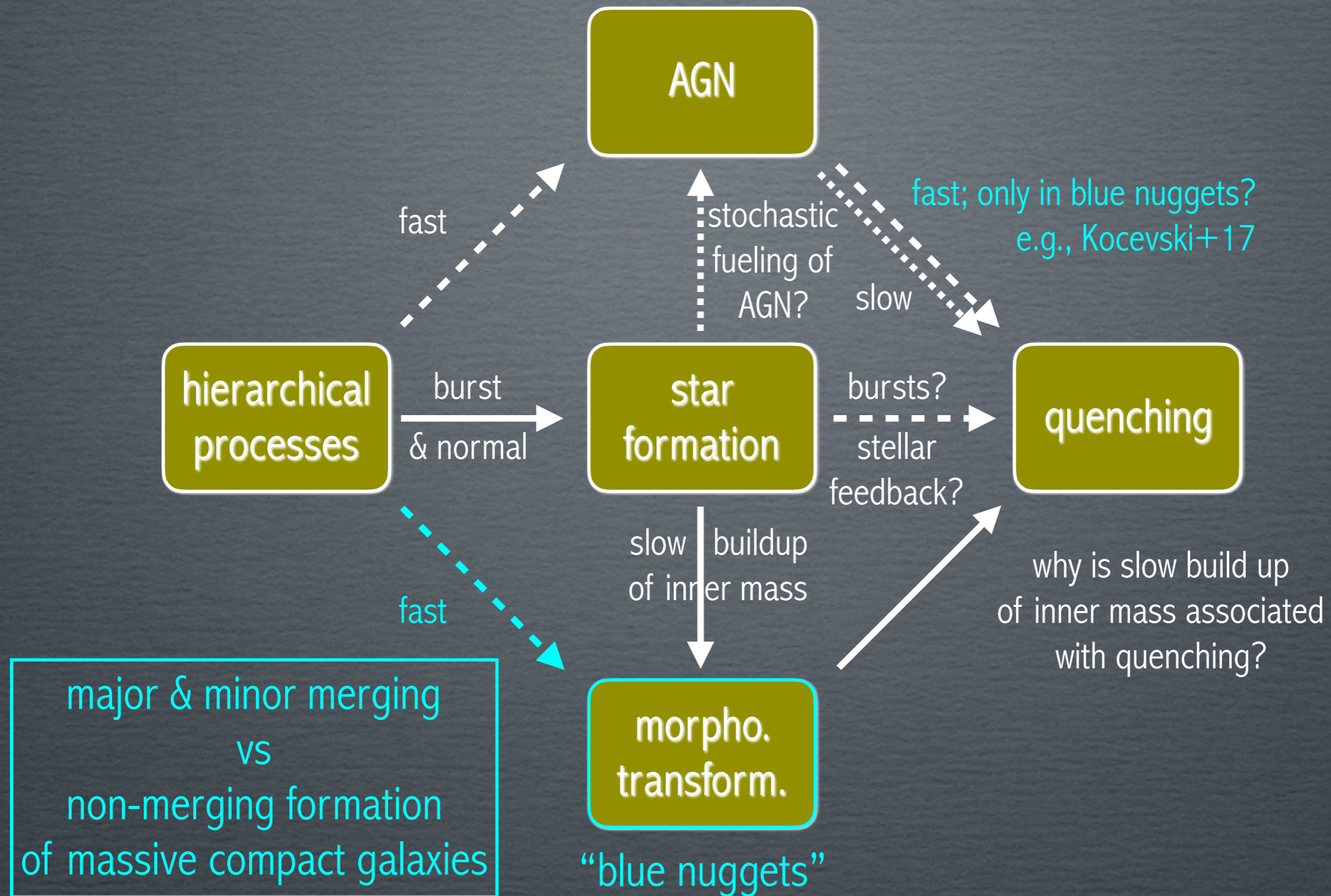


CANDELS Team Meeting
UC Santa Cruz, CA August 6, 2017



Goals: Distinguishing **Compaction Processes** & Measuring Rates

i.e., What Role Does Major Merging Really Play in the Development of Massive Galaxies at $z > 1$?



e.g., Dekel+17 predictions: 50/25/25%

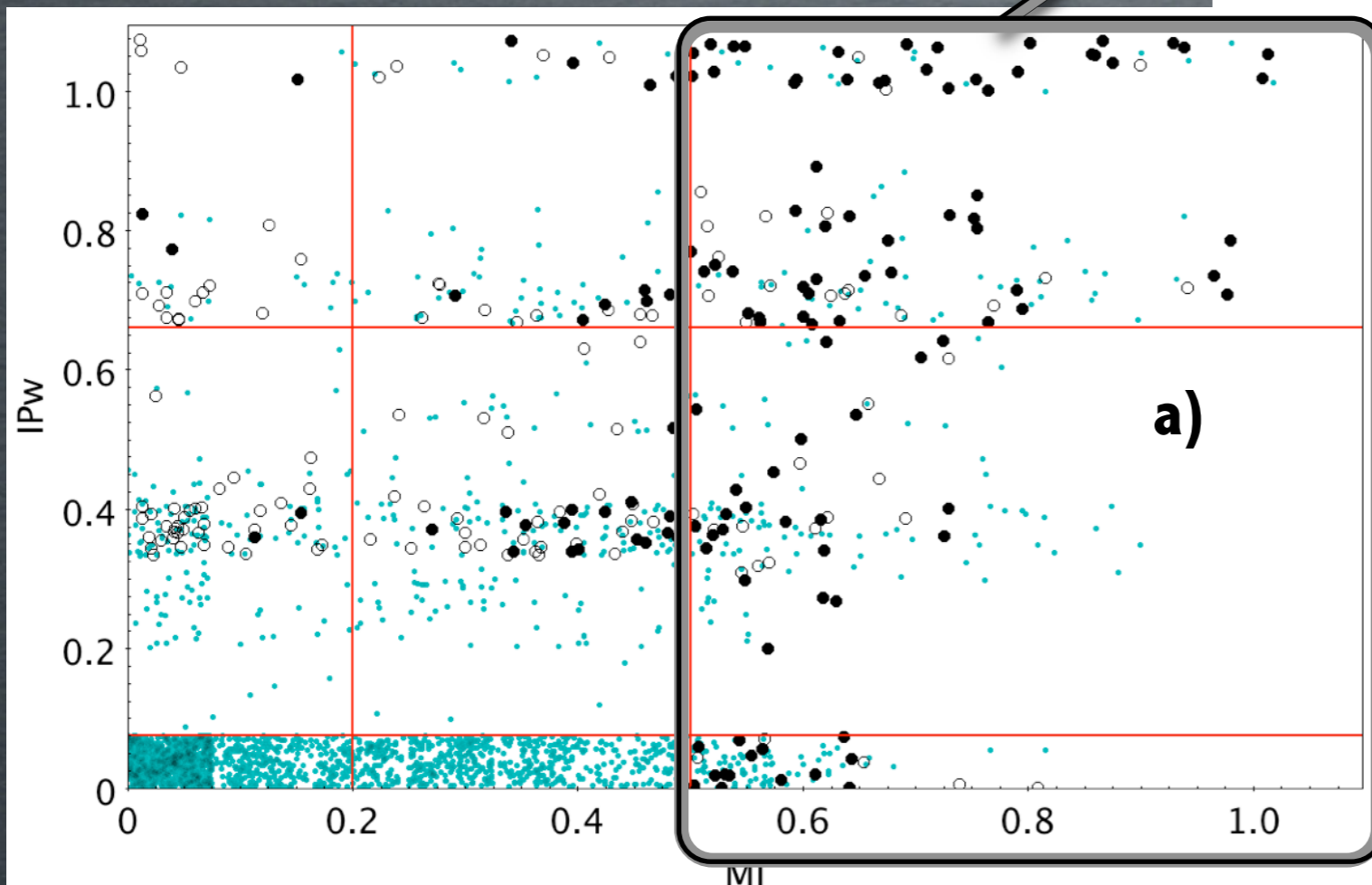
Status of Visual Selection

1. Preliminary findings with 2 visclass metrics:

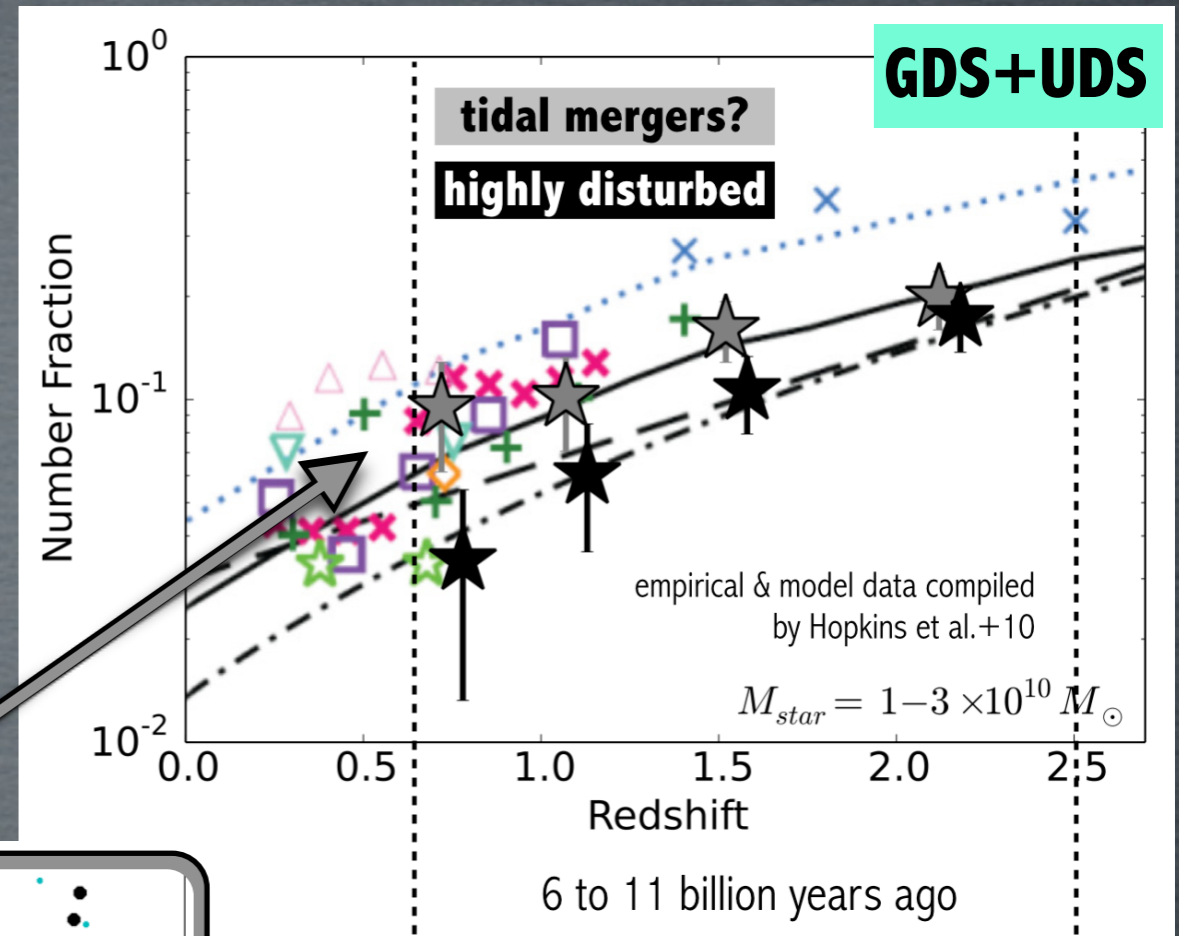
a) visclass "mergers"

based on team scheme (Kartaltepe+15)

Fraction Irr/Pec Classifications



Merger/Interaction Metric



McIntosh.02 in prep

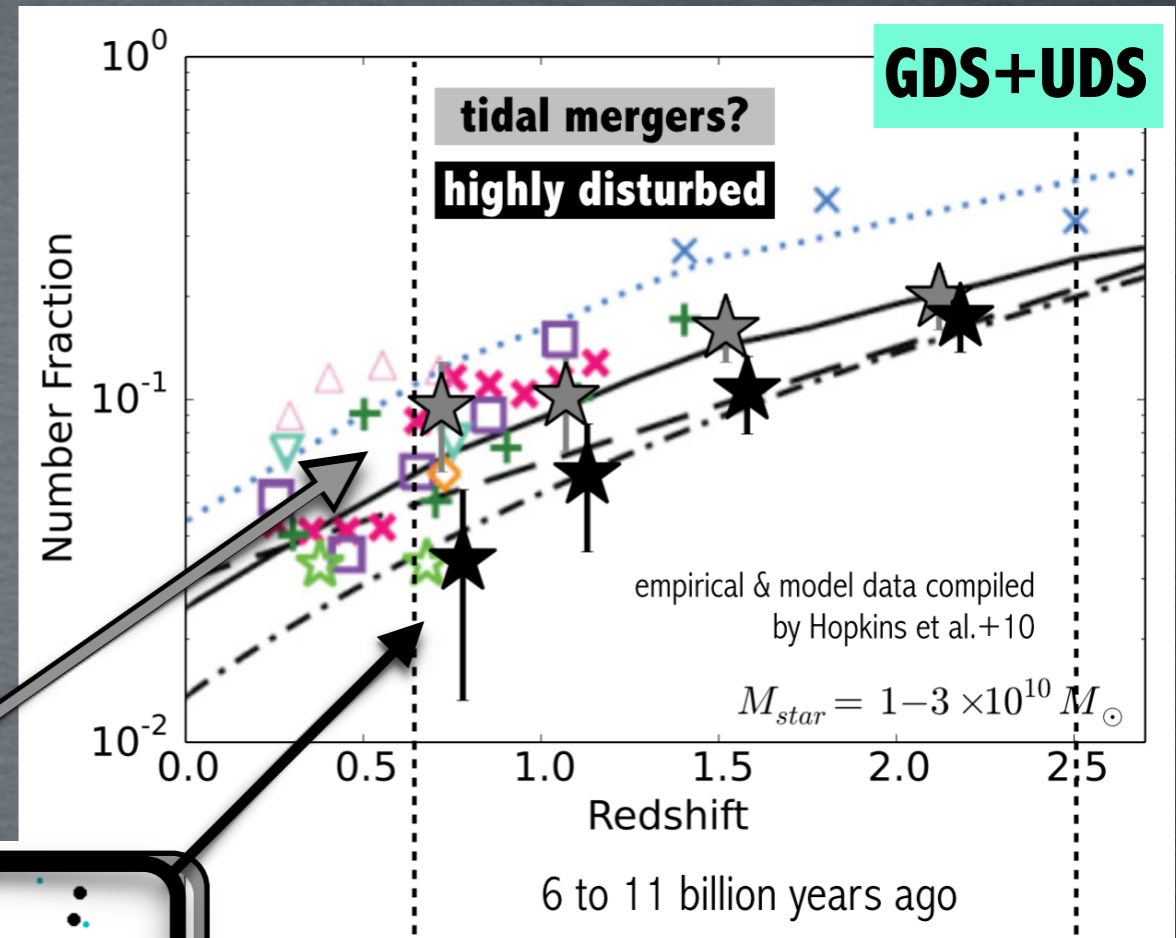
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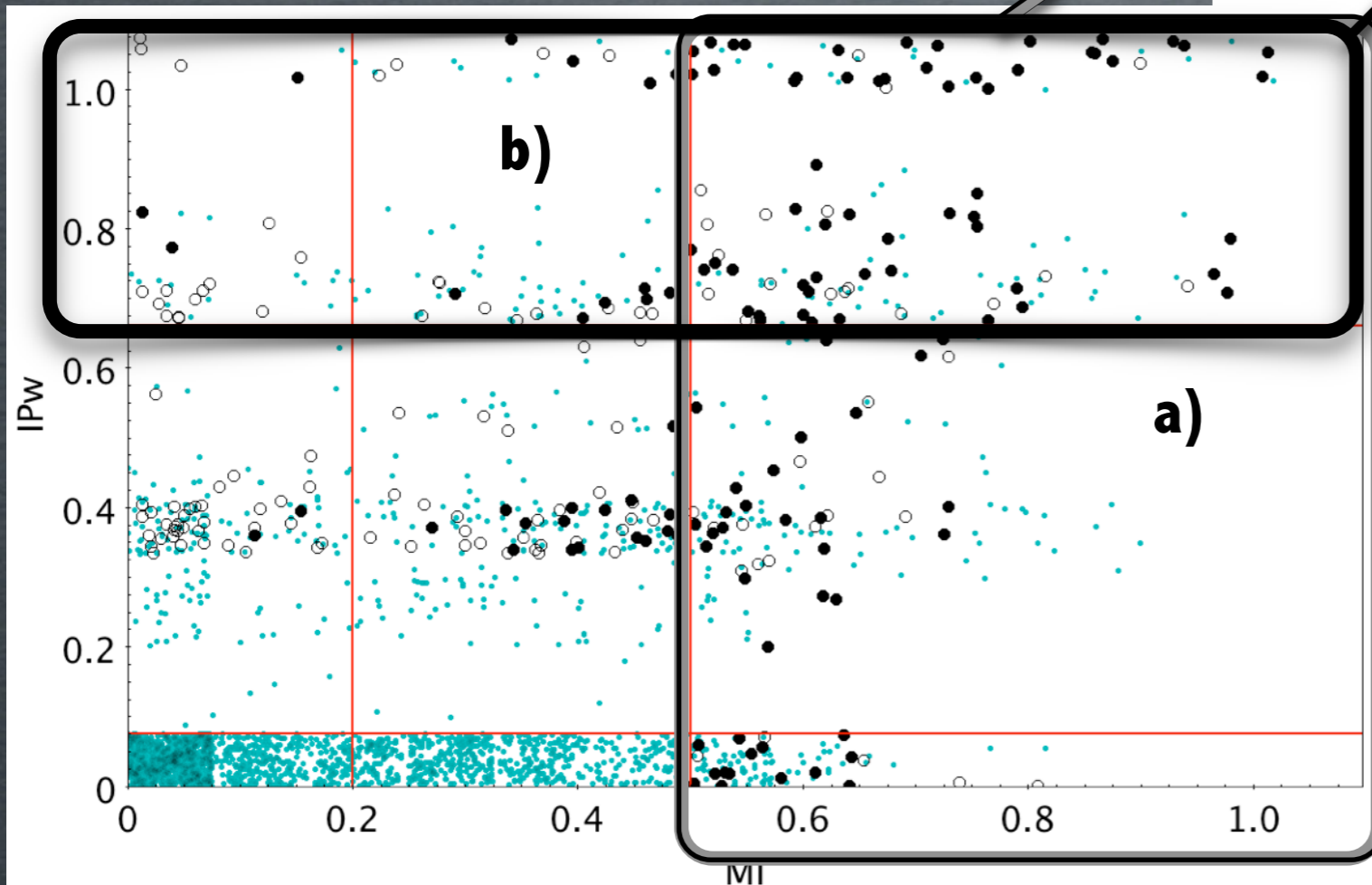
a) visclass “mergers”

b) visclass “highly disturbed”

based on team scheme (Kartaltepe+15)



Fraction Irr/Pec Classifications



Merger/Interaction Metric

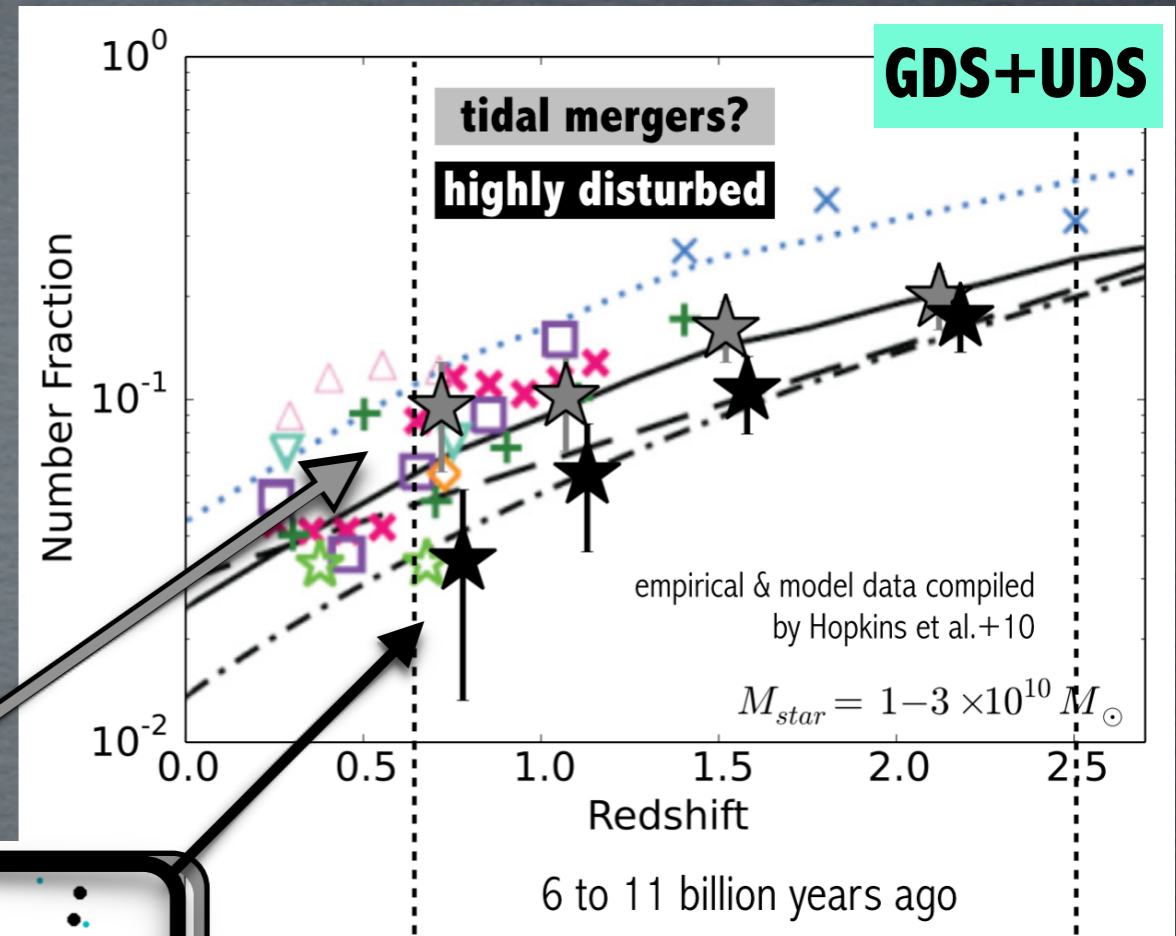
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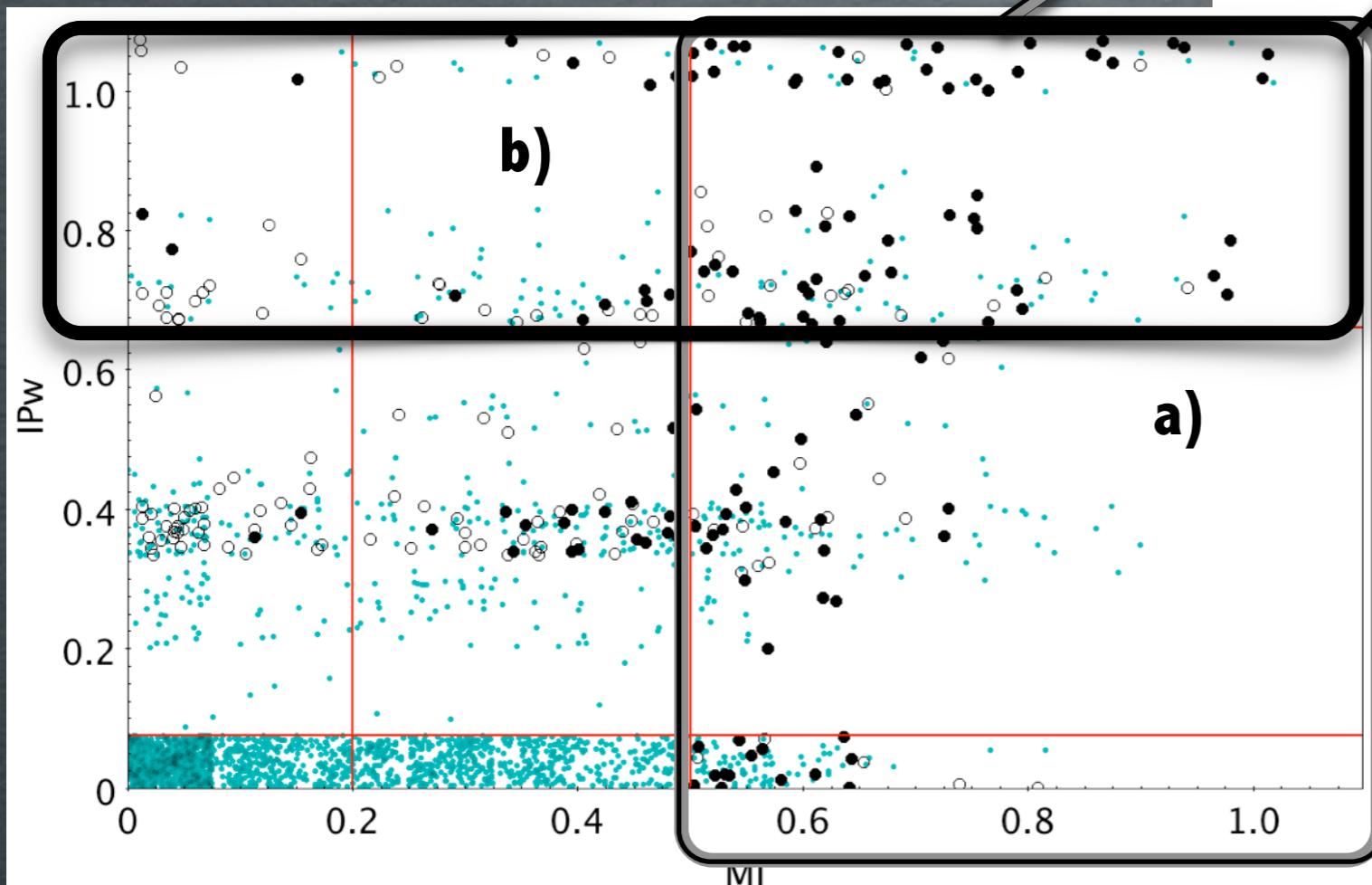
2. DHM re-inspection:

Hallmark Features (solid symbols):

- merger = "clear" tidal distortions
- interacting companion = "clear" dual asym, etc.
- double nuclei = w/in one galaxy in H-band, persists in other 3 bands; i.e., \neq blue clumps



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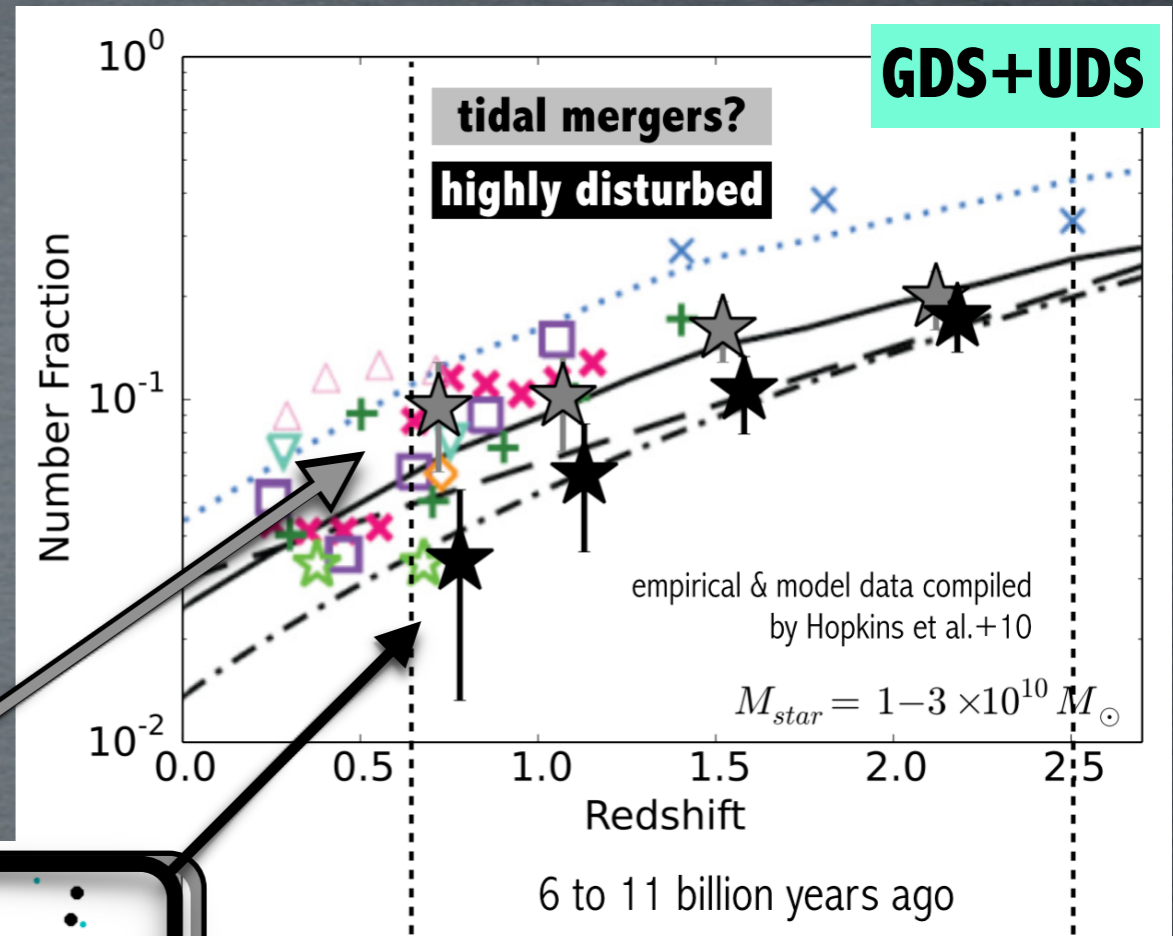
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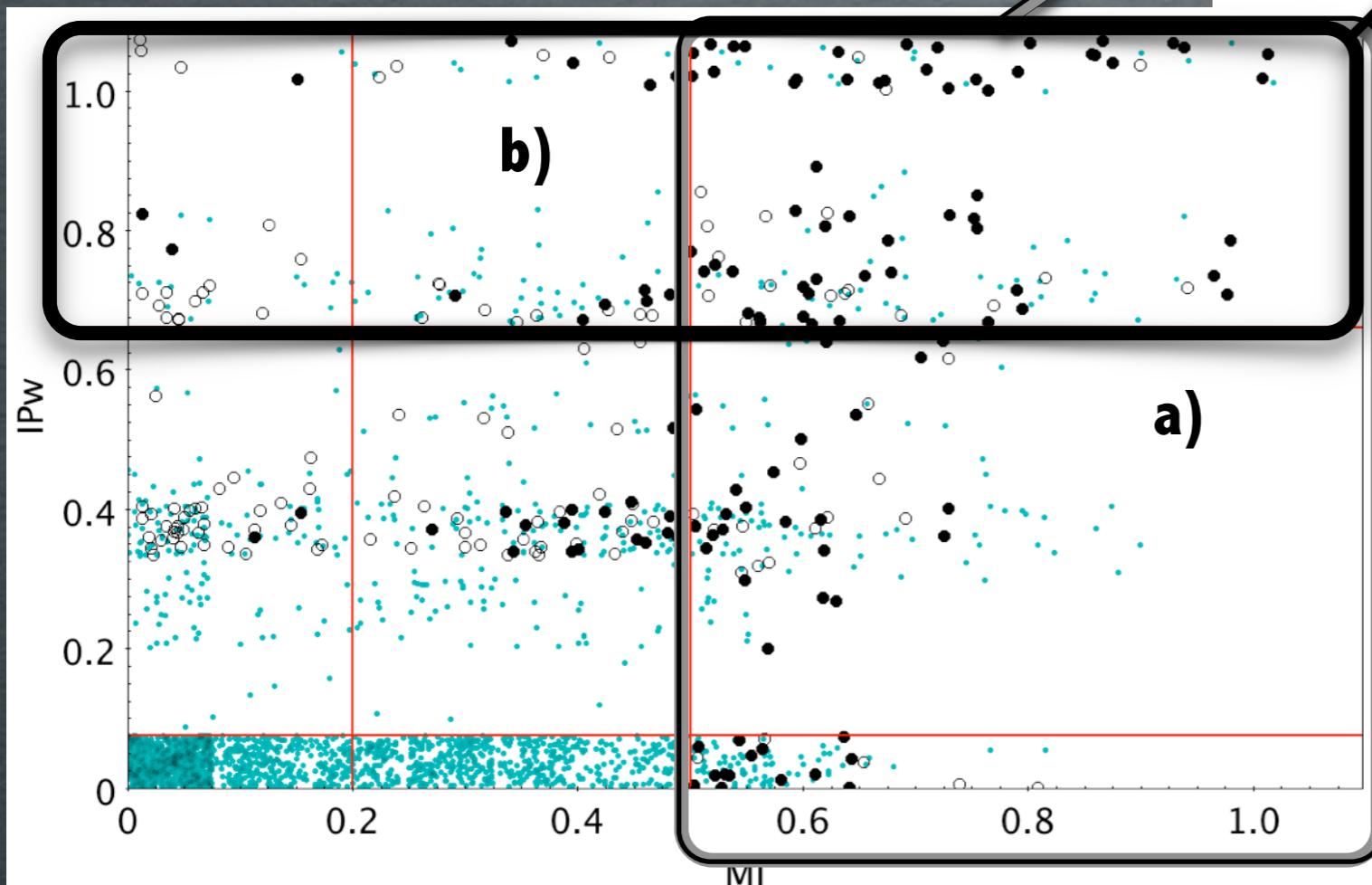
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Visclass Caveats:

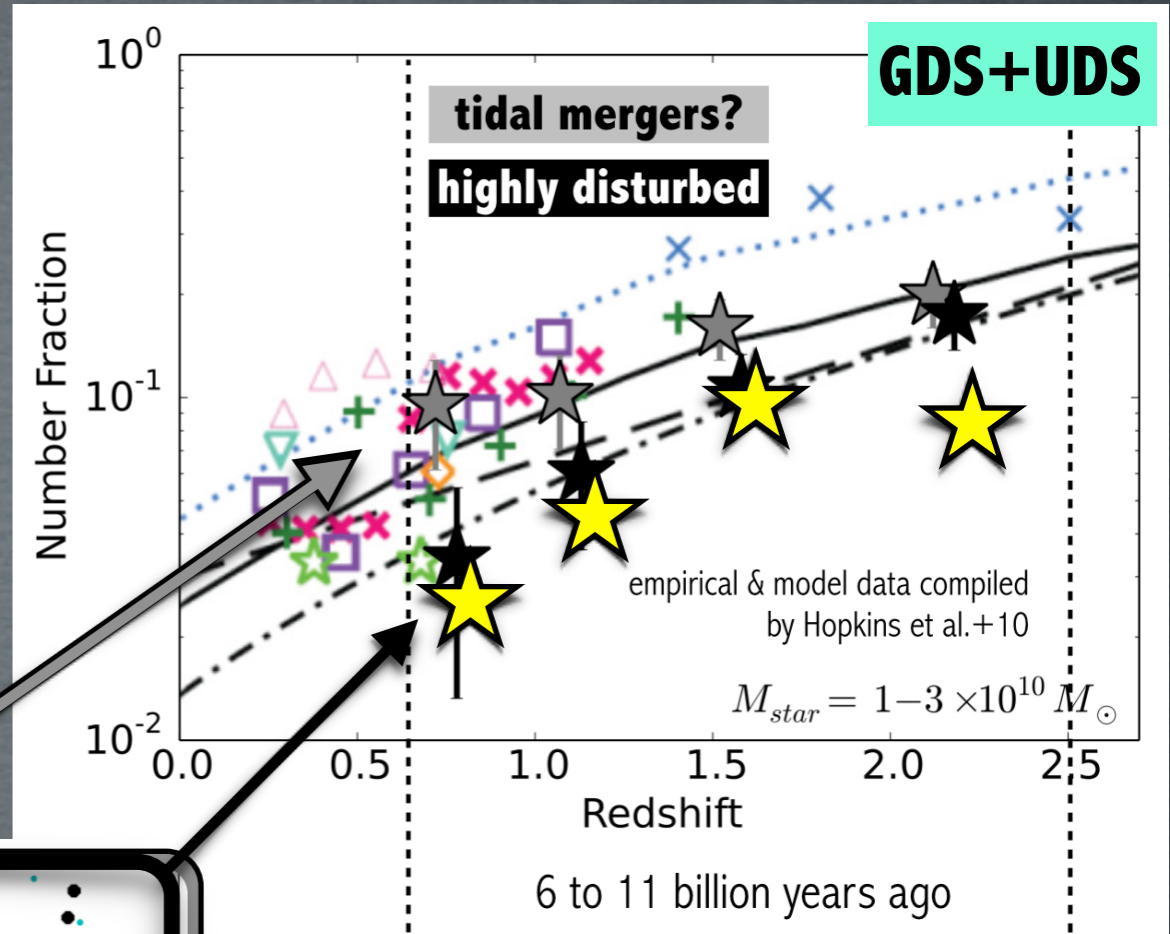
- a) does select 3/4 of hallmark, but high (75-67%) contamination
- b) only selects half of hallmark, and high (67-50%) contamination

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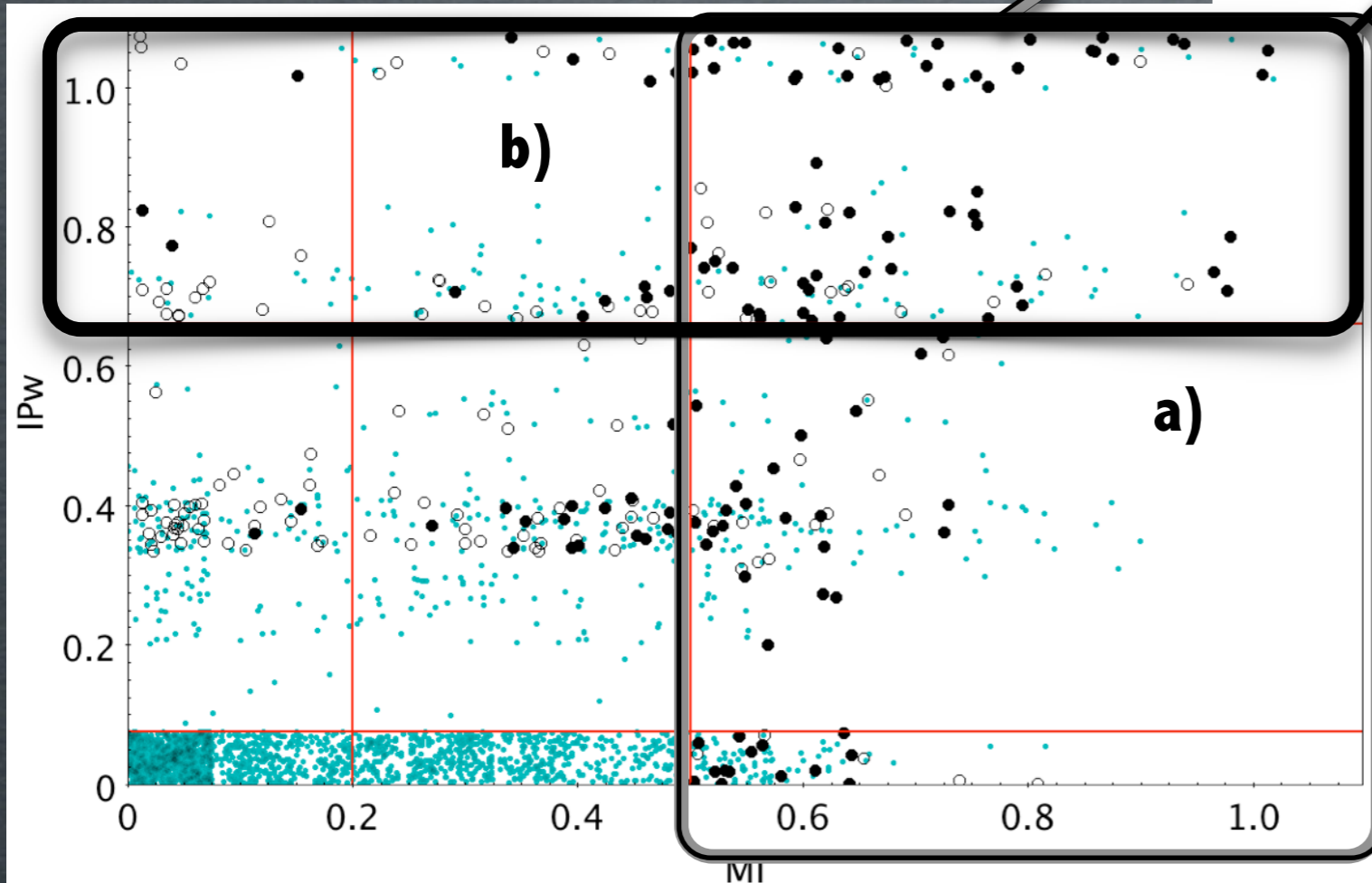
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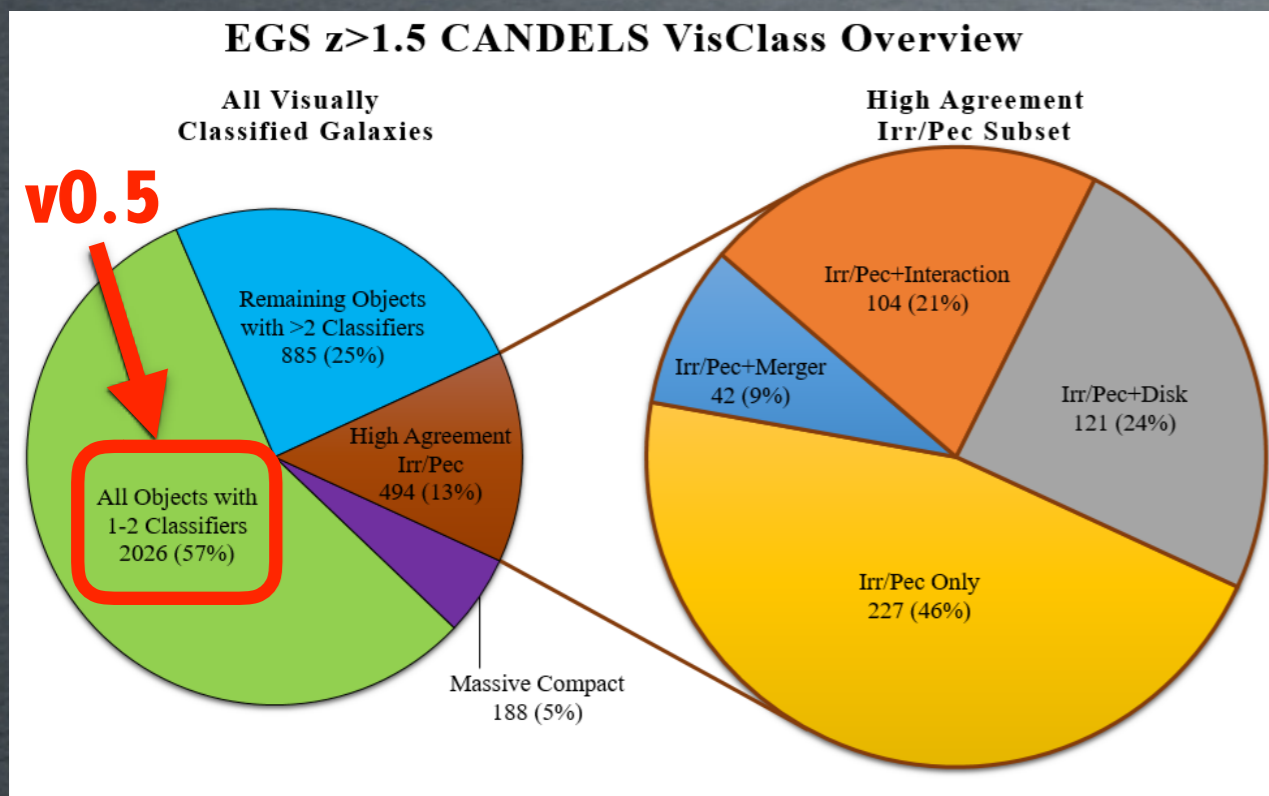
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EGS v0.5 Visclass Analysis ($z > 1.5$)

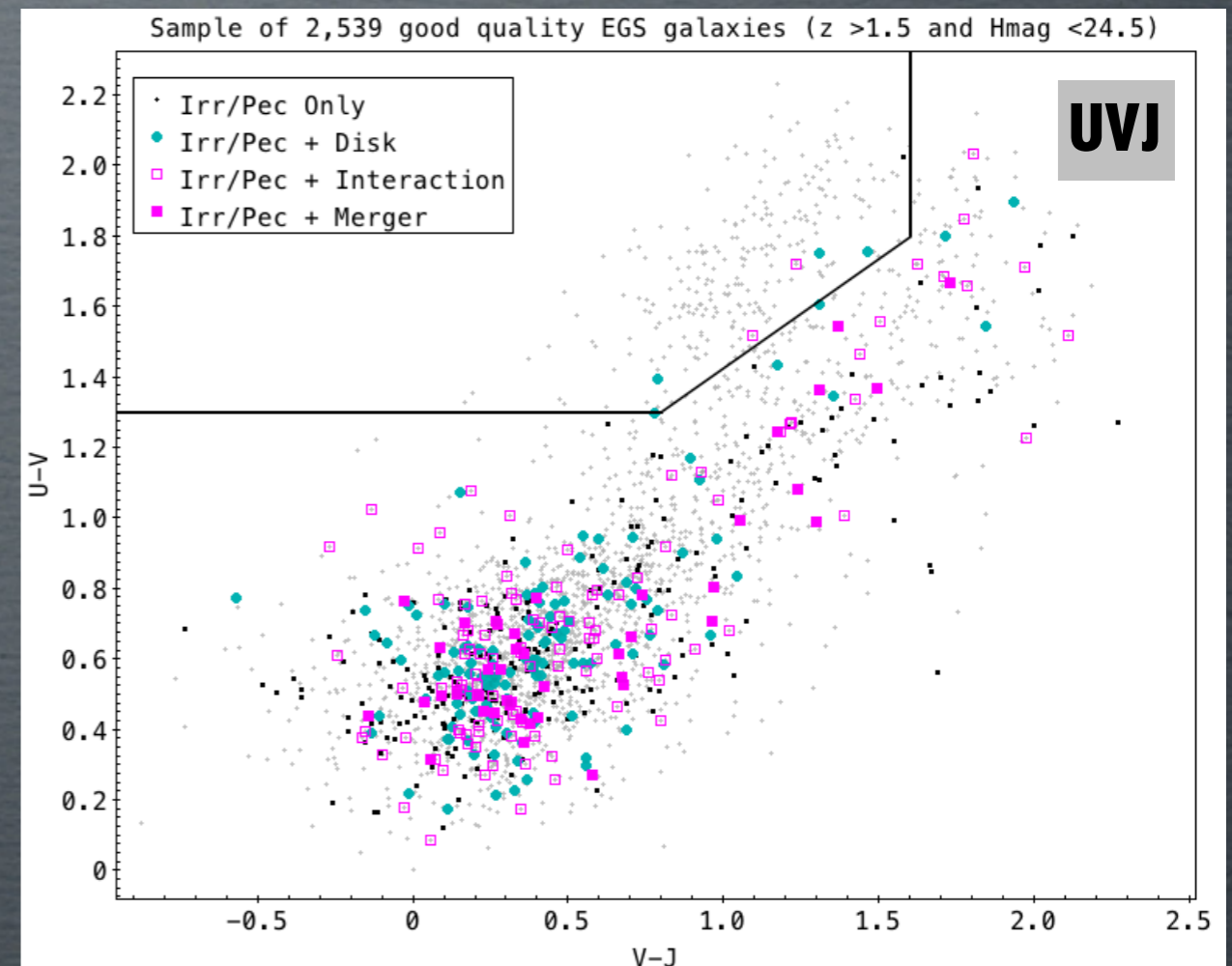
UMKC db team
preliminary catalog analysis

~25% of Irr/Pec are also disk-dominated
and non-merging/interacting



Rubyet Evan (UG, first-year, 3/4-time research intern)

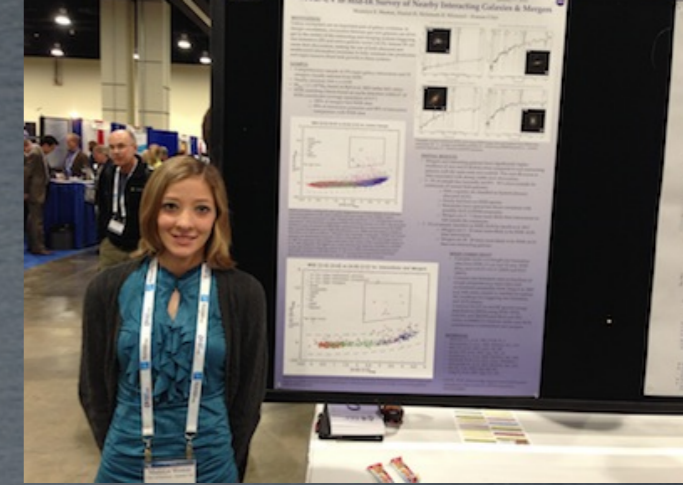
all Irr/Pec subsets are highly star-forming



Luke Landry (UG, first-year, 3/4-time research intern)

Status of Visual Classifications

1. 2014: UDS and GDS w 3/gx completed
2. Sum 2017 finished 3/gx in EGS, COS, GDN
final push by 5 UMKC students (M.Weston*, R.Evan, L.Fries,
L.Landry, S.Thompson)



*Maddie Weston (UMKC)
sustained effort award!
(>10,000 during last year)

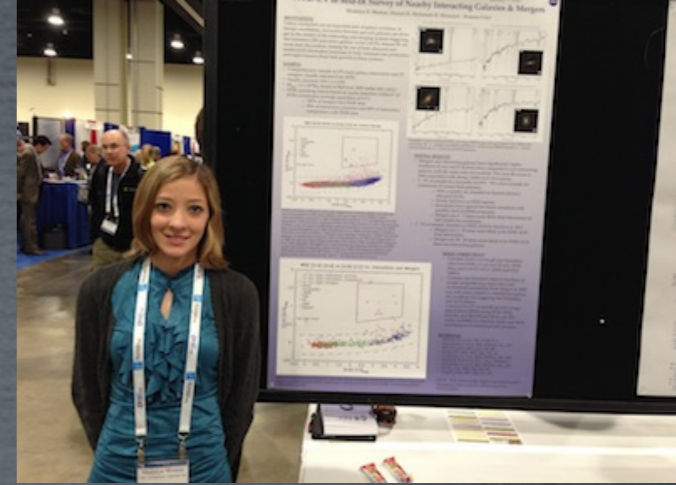
Data products

Product	Team	World
WFC3/IR, ACS images	12345	12345
WFC3/UV images	5	1 5
Photometry, photz, SED fitting, rest-frame photometry	12345	12345
Galfit sersic fits (F160W)	12345	12345
CAS/Gini/M20/MID	12345	
CANDELS Visual classifications	123	1
GalaxyZoo classifications	123	
Mock catalogs from Semi-analytical models	12345	
Photo-z probability distributions	12345	
Bulge/disk decompositions	12345	
Clump Catalogs	1	
Mock data from hydro simulations		

GOODS-N
EGS
COSMOS
UDS
GOODS-S

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UDS
GOODS-S

Sep. 2015 Summary:

- Useful info
(B/D subdivisions,
flagging peculiar galaxies)
McIntosh.01,02 in prep
- Interpretative classes are unreliable
- Extra bells'n'whistles
not well utilized

Status of Visual Classifications

3. raw EGS, COS, GDN visual classifications catalogs (Jeyhan, Fall 2017)
4. UMKC db team will produce final metrics catalogs (Fall 2017?)

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Classifying and Extracting Sersic Residual Features

Cody Ciaschi (MS) + K.Mantha, w/ Yicheng Guo, Greg Snyder & Joel Primack

Clean Residual
 Clean
 Residual

Core Residuals
 Bright Center Dark Ring Other
 Dark Center Bright Ring

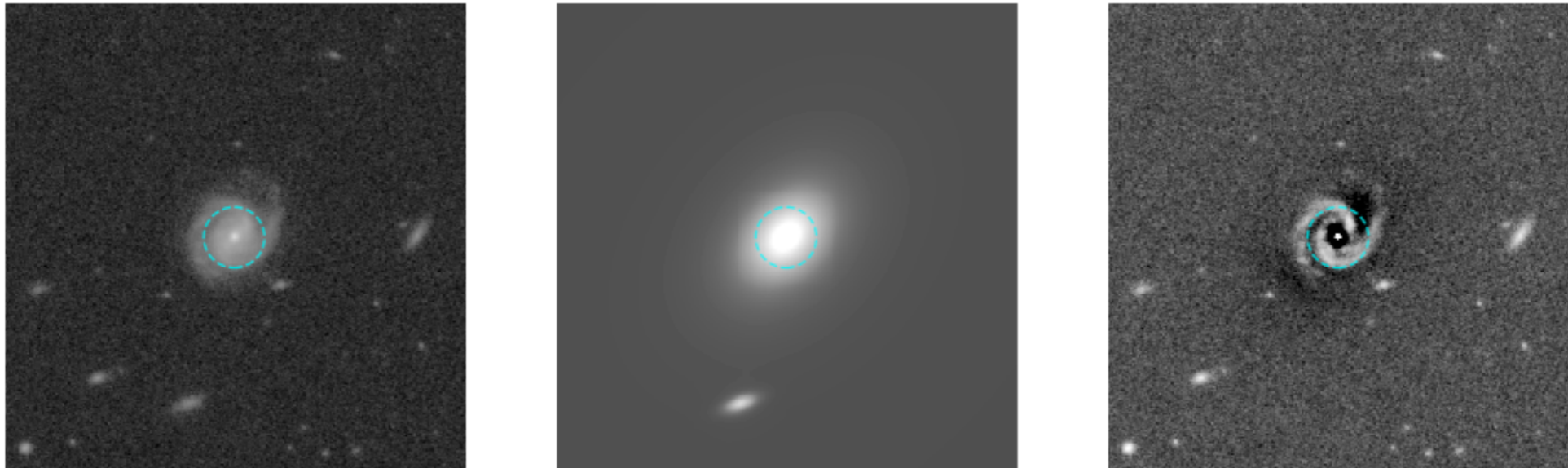
Global Residuals
 Disk Spiral Arms Other
 Bar Asymmetric

Poor-Fit Artifacts
 Diffraction Spikes Image Edge
 Unfit Close Companion

Tidal Features
 Strong Possible

Done !

F160W Sersic Model Residual



new HST-AR program to analyze existing data (vdWel+12) for 5900 $\log M > 10$, $z > 1$

Goal: “Mining CANDELS for Tidal Features to Constrain Major Merging During Cosmic Noon”

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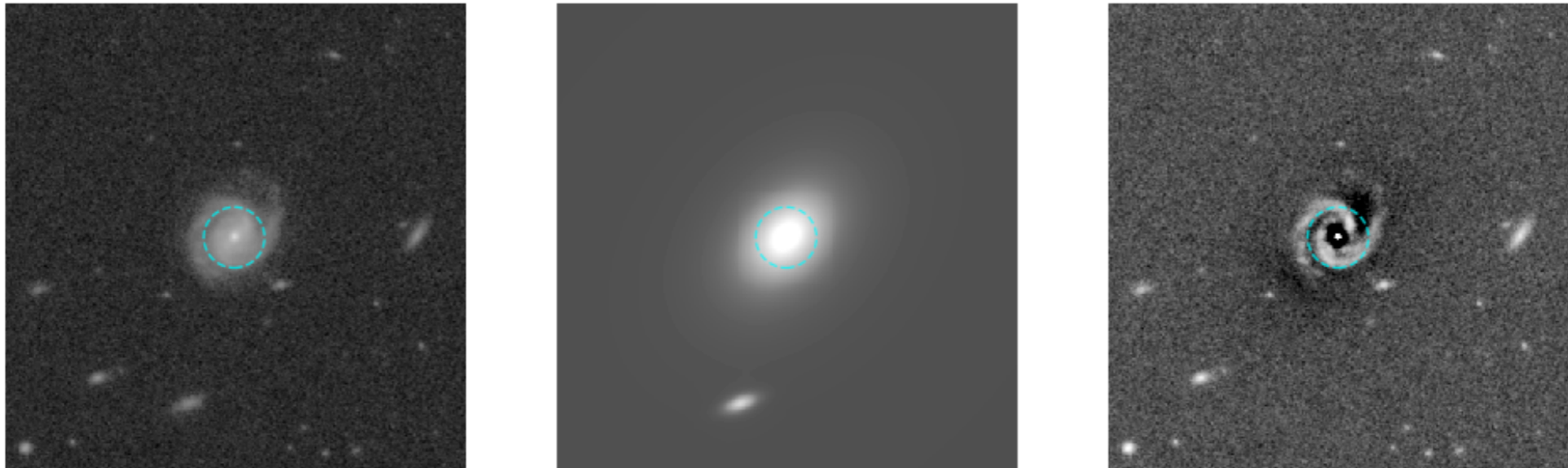
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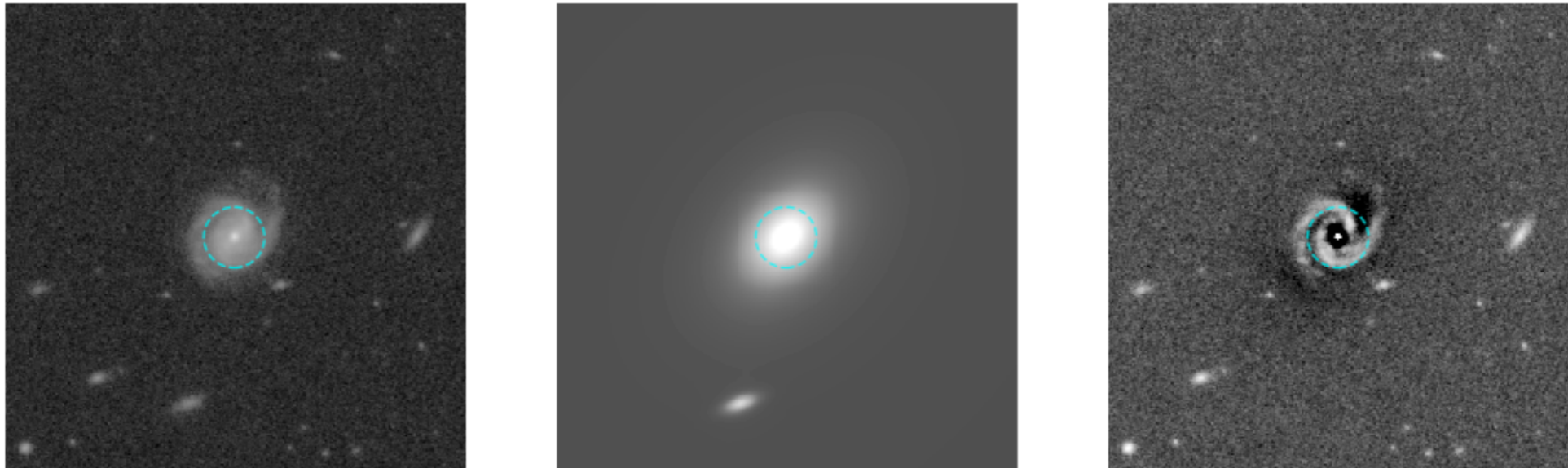
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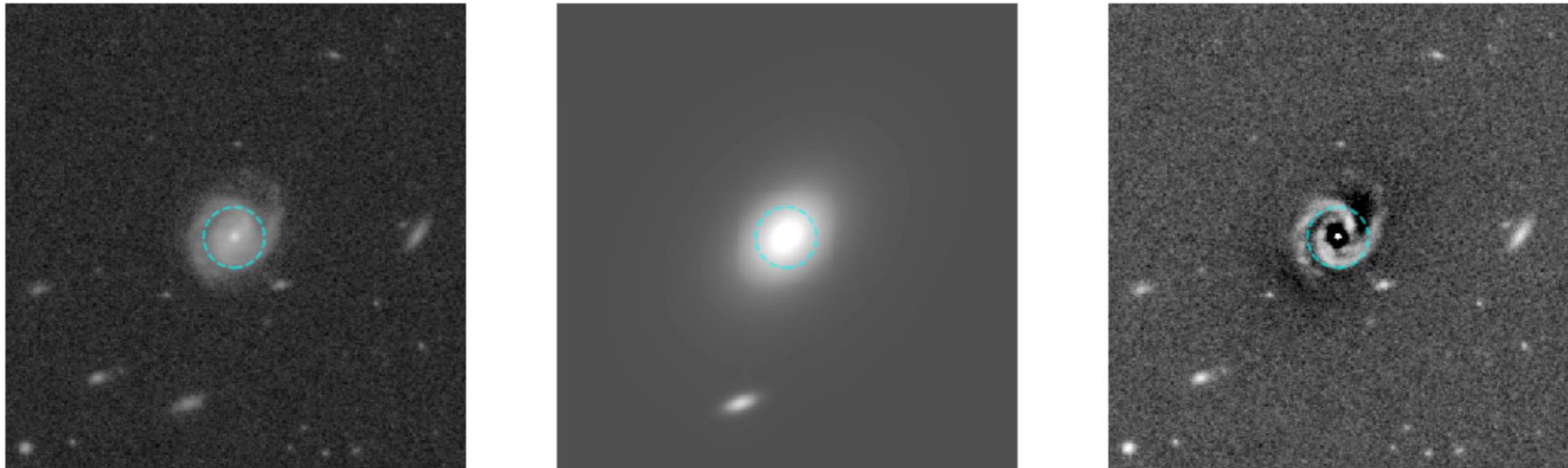
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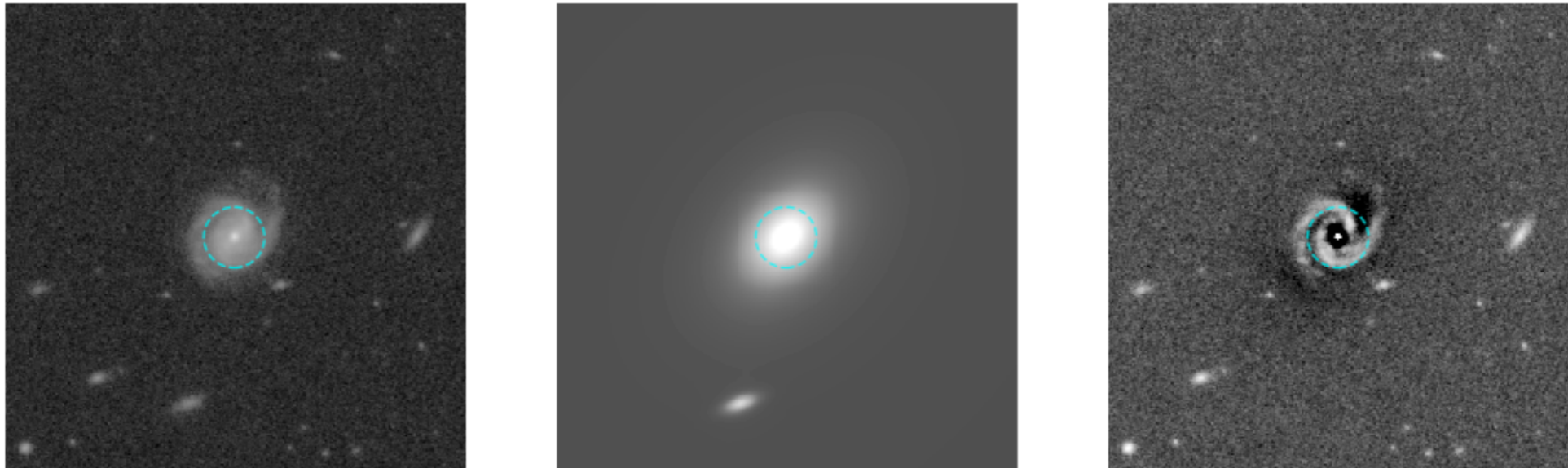
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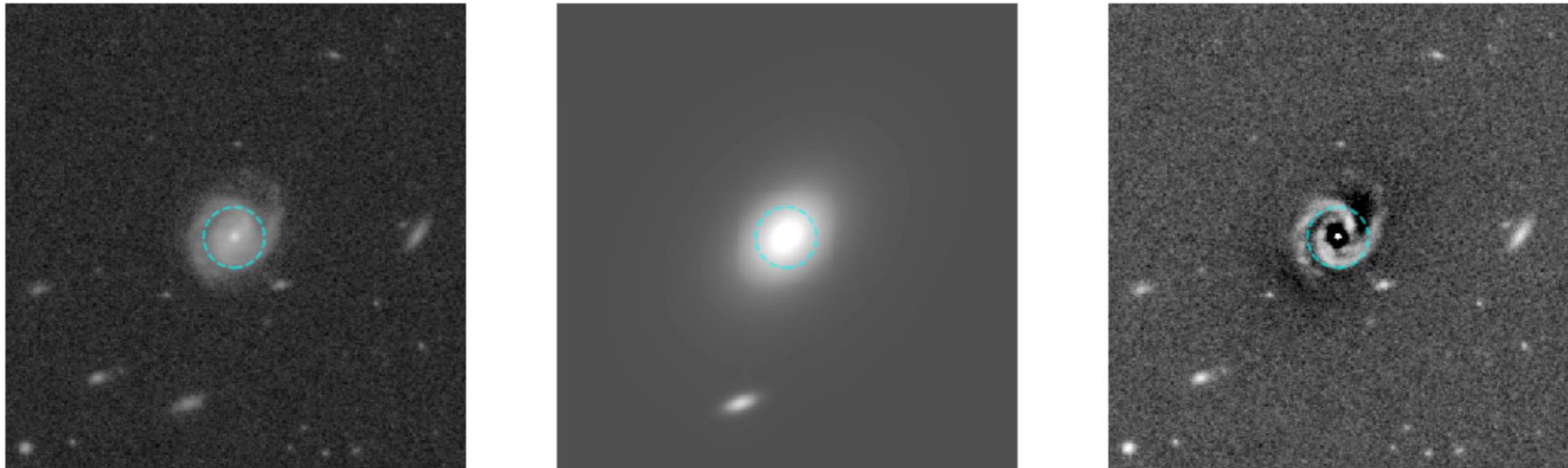
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- calibrate tidal detection & observability timescales; cosmological dimming correction

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$$R_{\text{merg,tidal}}(z) = \frac{C_{\text{merg,tidal}}(z) \times c_{\text{SB}}(z) \times f_{\text{tidal}}(z)}{T_{\text{obs,tidal}}(z)} [\text{Gyr}^{-1}], \quad (1)$$

where $T_{\text{obs,tidal}}$ is the average observability timescale for tidal features, $C_{\text{merg,tidal}} \leq 1$ corrects the estimated fraction of galaxies with tidal features f_{tidal} based on observations for contamination by asymmetric or otherwise disturbed objects *misidentified* as having tidal features, and $c_{\text{SB}} \geq 1$ accounts for incompleteness owing to cosmological surface brightness dimming. Finally, we will apply this new analysis to the existing CANDELS sample to derive $R_{\text{merg,tidal}}(z)$ with realistic and well-constrained error bars.

new HST-AR program to analyze existing data (vdWel+12) for 5900 $\log M > 10$, $z > 1$

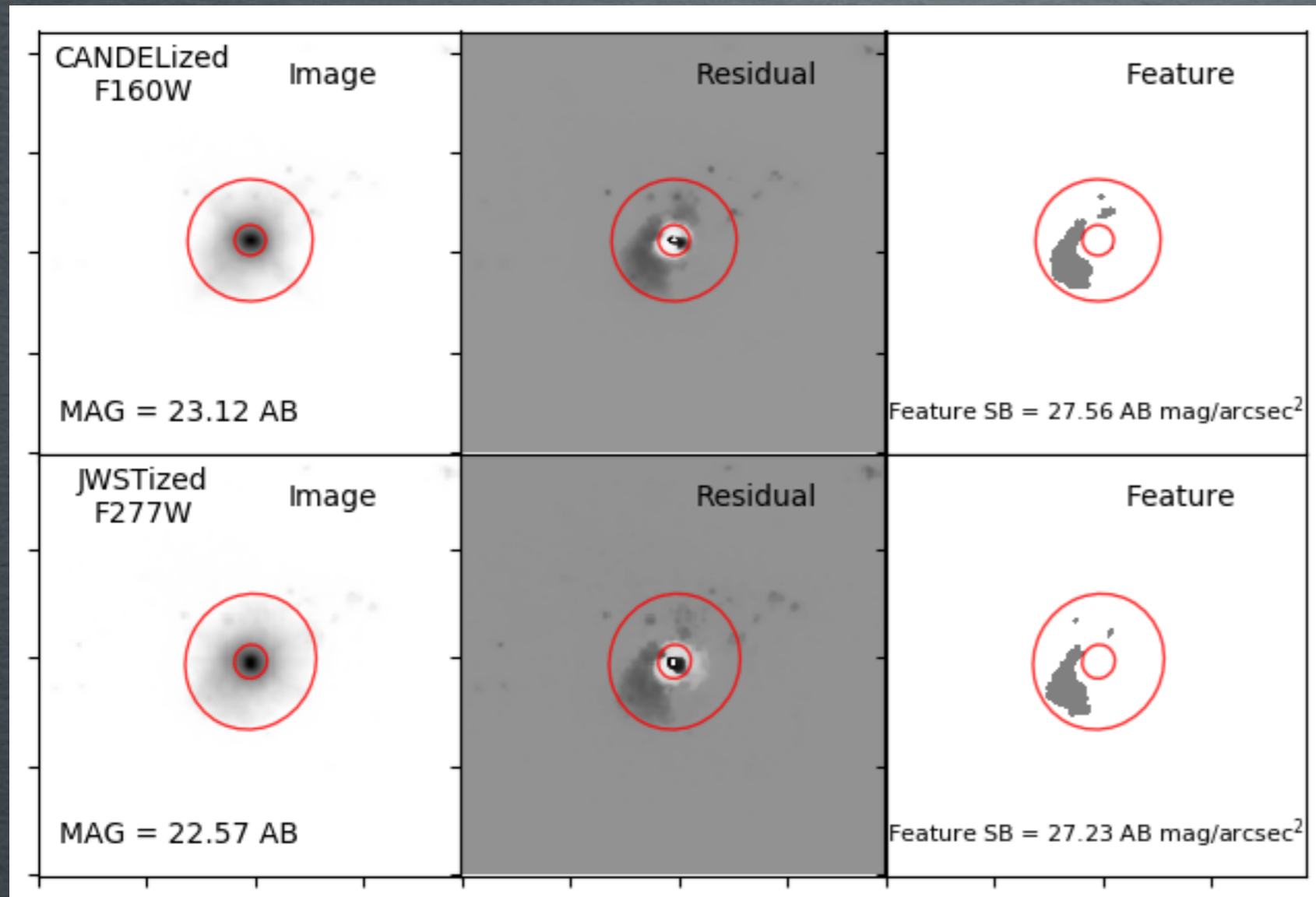
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- calibrate tidal detection & observability timescales; cosmological dimming correction
- compute tidal-based merger rates

Novel Method for Extracting/Quantifying Tidal Features*

Vela simulation post-MMerger, $z=3$

Mantha.02 in prep



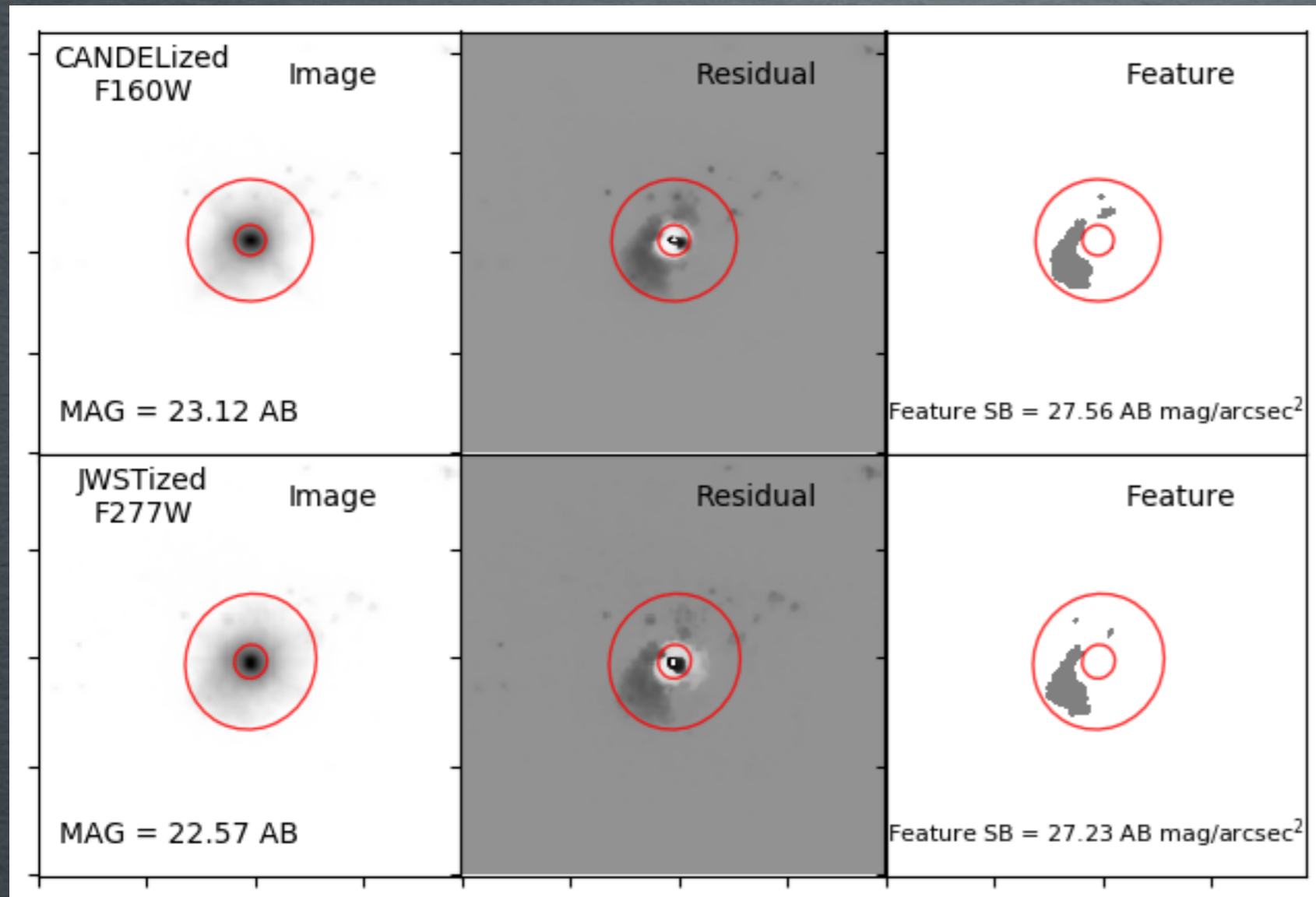
*tidal features at high- z ?

¹At $z > 1$, star-forming galaxies are dynamically 'hotter' than at low-redshift (rotation dominated but with larger velocity dispersion contribution), yet, cosmological zoom-in simulations show that low-SB *broad* tidal tails and fans form in the major merging process.

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Basic Idea:

- identify tidal features in Sersic residual
- quantify feature in an annulus

see Mantha's talk Mon.
@ Galaxy Workshop

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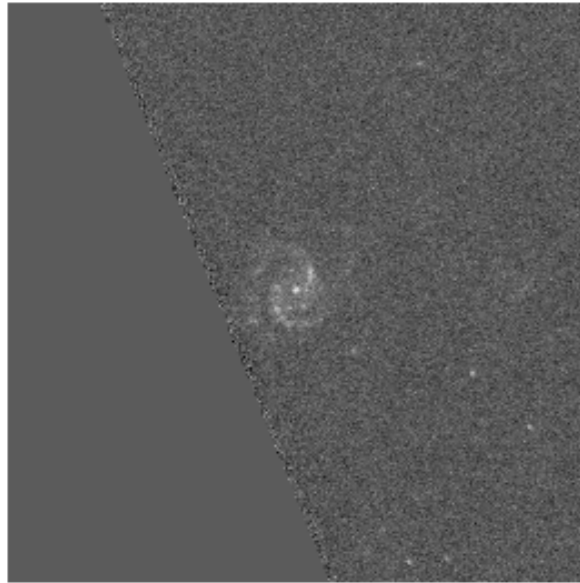
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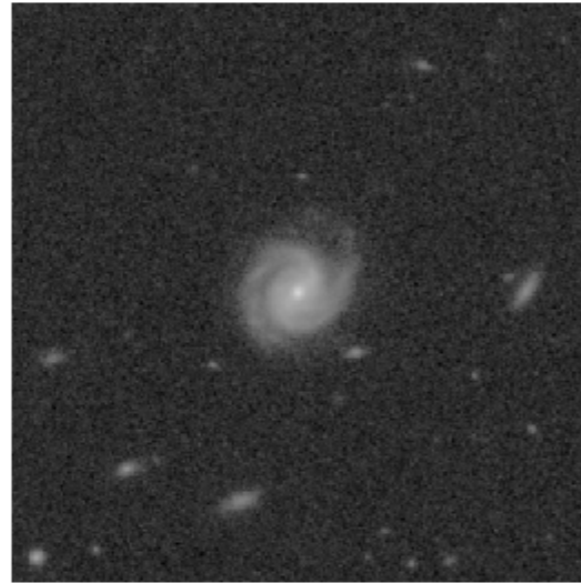
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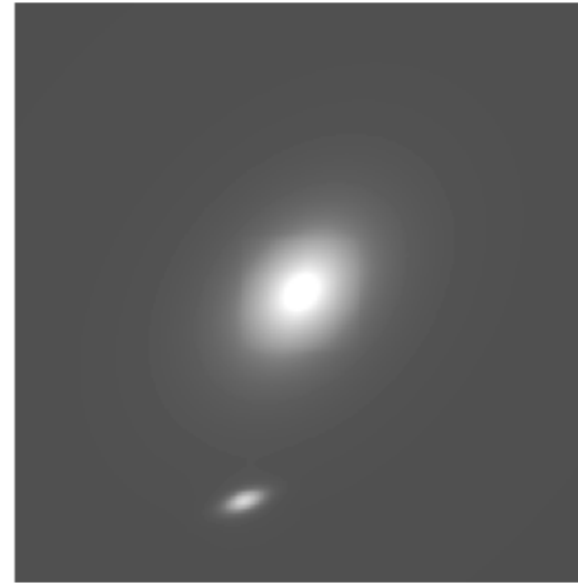
606W



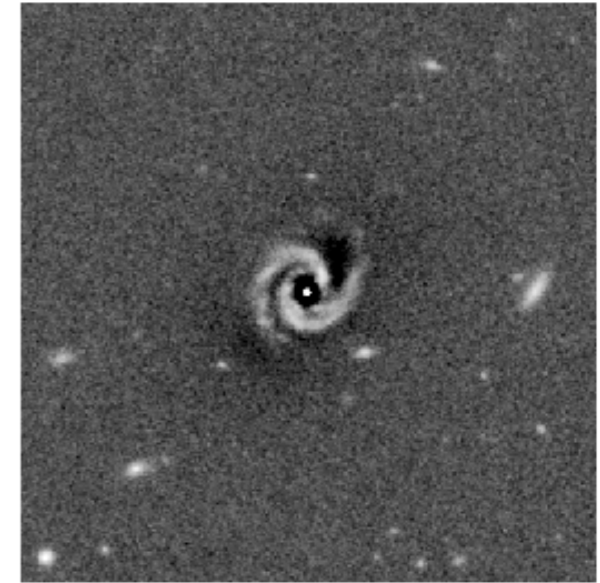
160W Original



160W Model



160W Residual



Additional Uses:

- flag poor fits to clean GALFIT-based structural analyses
- select subsamples for multi-component fitting (e.g., B+D, + nuclear pt. source)
- evolution of spiral features
- evolution of bars
- automate morphology + structure extraction from future big-data surveys (e.g., WFIRST)

Summary

1. Team visclass finally done
2. New analysis of CANDELS Sersic residuals underway
 - step#1 visual characterization of 5900 (15k) $\log M > 10$ ($\log M > 9.5$) $z > 1$ galaxies (Fall 2017)

Table 2: Work Plan Schedule & Deliverables

Category	Task	Deliverables	Investigators	Start (duration)
Management	Program administration, supervision of GRA's	performance reports	McIntosh	10/2017–finish
Data Analysis	1) Sérsic residual analysis	catalog; software	GRA#2, Mantha	10/2017 (2 mos.)
	2) clump analysis	catalogs	Guo	11/2017 (1 mo.)
	3) multi-component GALFIT	new residual maps; pipeline software	GRA#2, Guo	11/2017 (3 mos.)
	4) tidal feature analysis	source catalog; software	Mantha	11/2017 (2 mos.)
	5) automatic residual identification	machine-learning software	Mantha, Guo	01/2018 (3 mos.)
	6a) mock image analysis	source catalog	Mantha, GRA#2, Snyder, Guo	02/2018 (3 mos.)
Scientific Analysis	6b) mock image analysis	factors $C_{\text{merg,tidal}}(z)$, $T_{\text{obs,tidal}}(z)$	Mantha, GRA#2, Snyder, Primack	05/2018 (2 mos.)
	7) cosmological dimming	factors $c_{\text{SB}}(z)$	Mantha, GRA#2	07/2018 (1 mo.)
	8) merger rates; comparative analysis	$R_{\text{merg,tidal}}(z) + \text{errors}$	Mantha, Snyder, McIntosh	08/2018 (2 mos.)
Publication	Writing	manuscript	all Co-I's	06/2018– submission