Light Modeling of the "El Gordo" Galaxy Cluster

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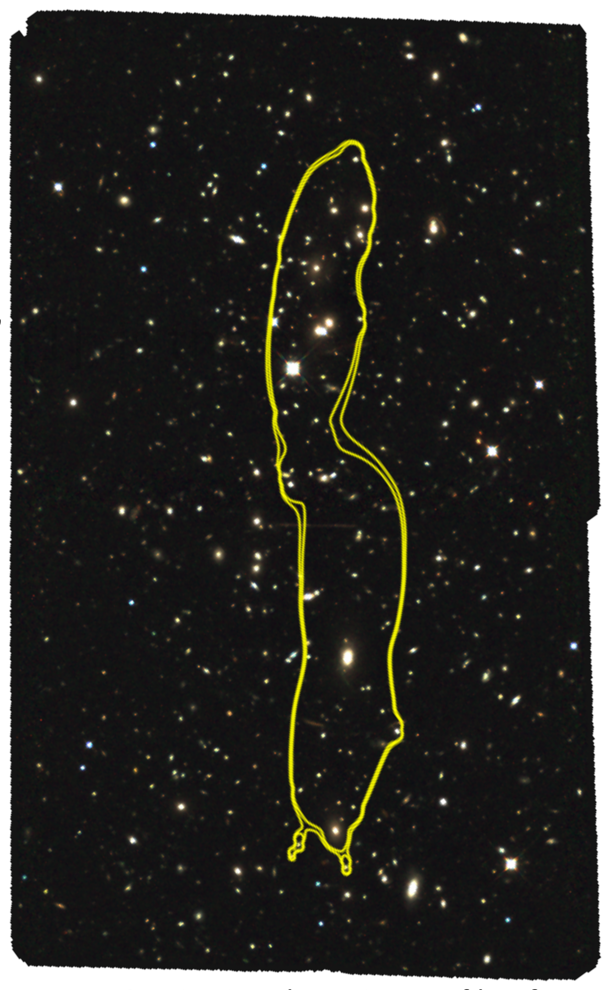
Motivation

~most massive, hottest, X-ray luminous cluster at its redshift~

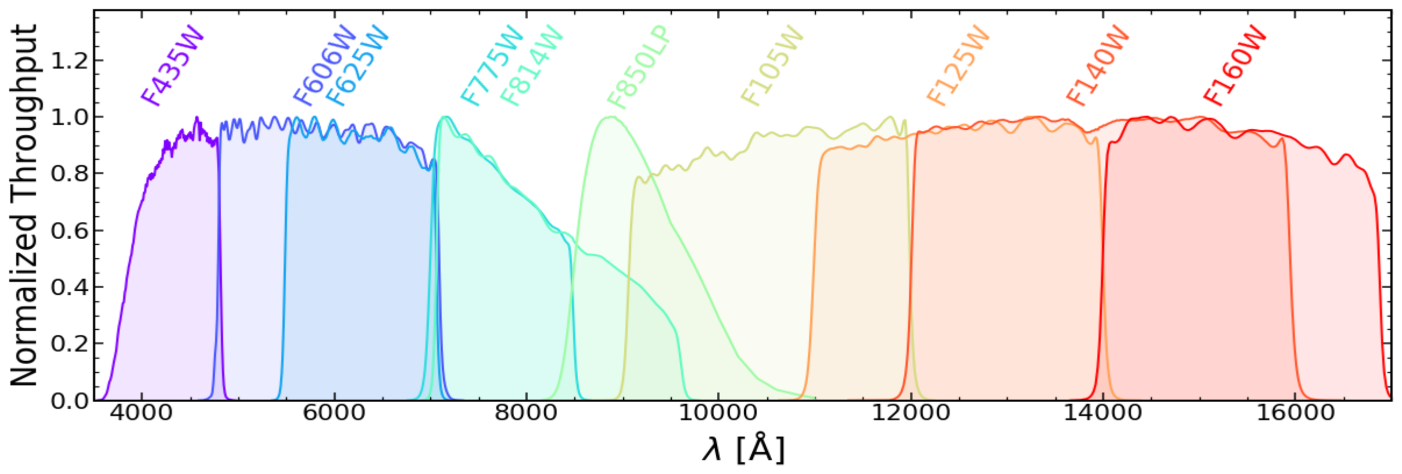
In order to exploit its potential to magnify background objects, we must understand the mass and light distribution of a galaxy cluster. The cluster ACT-CL-J0102-49151, "El Gordo" massive, hottest and X-ray luminous cluster at its redshift so it provides a unique environment to study galaxy evolution. Lower estimates for the total mass of the El Gordo Cluster are at 2.3 x 10^{15} $M_\odot$ and its redshift is 0.87 [2]. El Gordo has 89 spectroscopically confirmed member galaxies and is comprised of two smaller clusters in the process of merging [3]. Prior work has been done to map the gravitational lensing profile showing a large region of high magnification (50x) [2,4].



Gravitational Lensing Profile of El Gordo galaxy cluster shows large region of 50x Magnification contours in yellow from Zitrin, et al. 2013.

Data

~Hubble Space Telescope Optical/NIR filters~



Wide Field Camera 3 (WFC3)

- F105W
- F140W
- F125W
- F160W

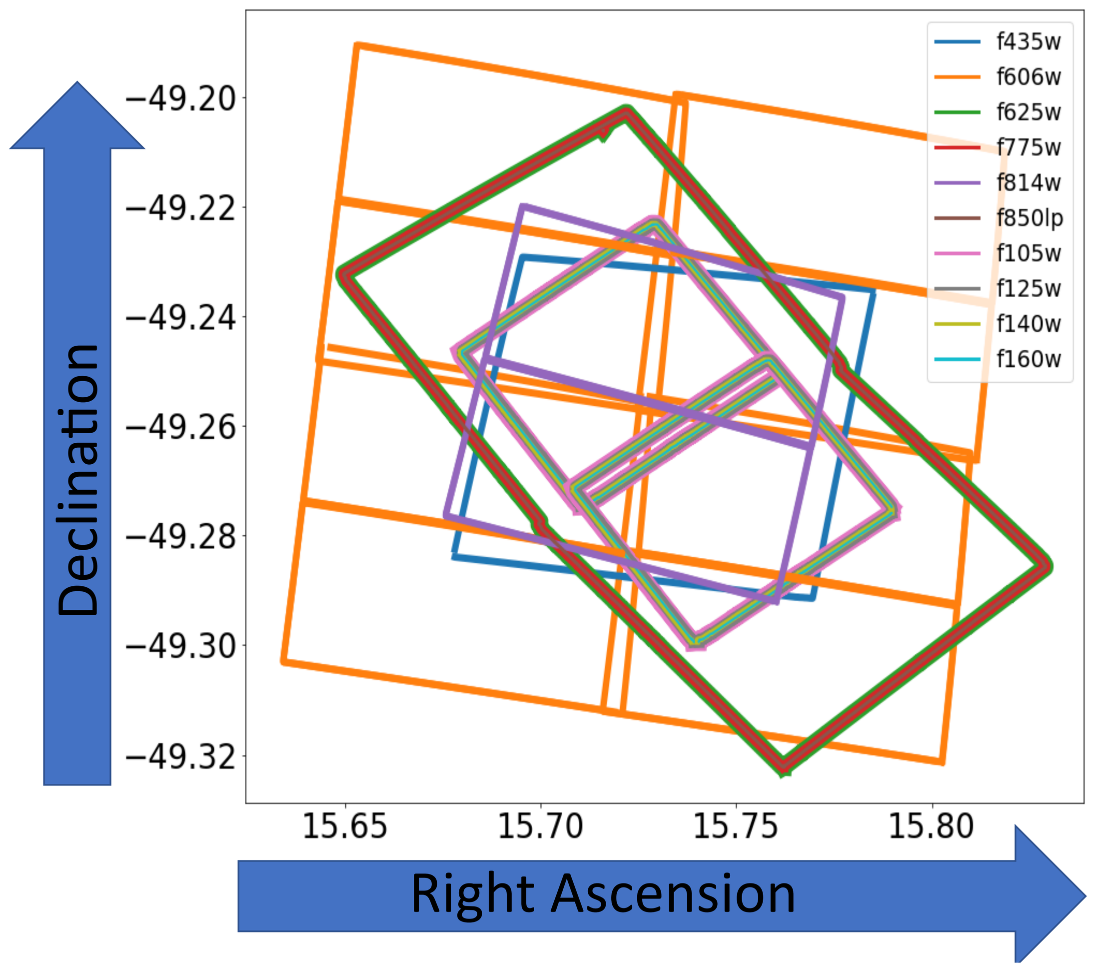
Advanced Camera for Surveys (ACS)

- F435W
- F625W
- F814W
- F606W
- F775W
- F850LP

Each filter has multiple pointings, so to combine these into one image of the cluster, per filter:

1) detect all objects with SExtractor [5]

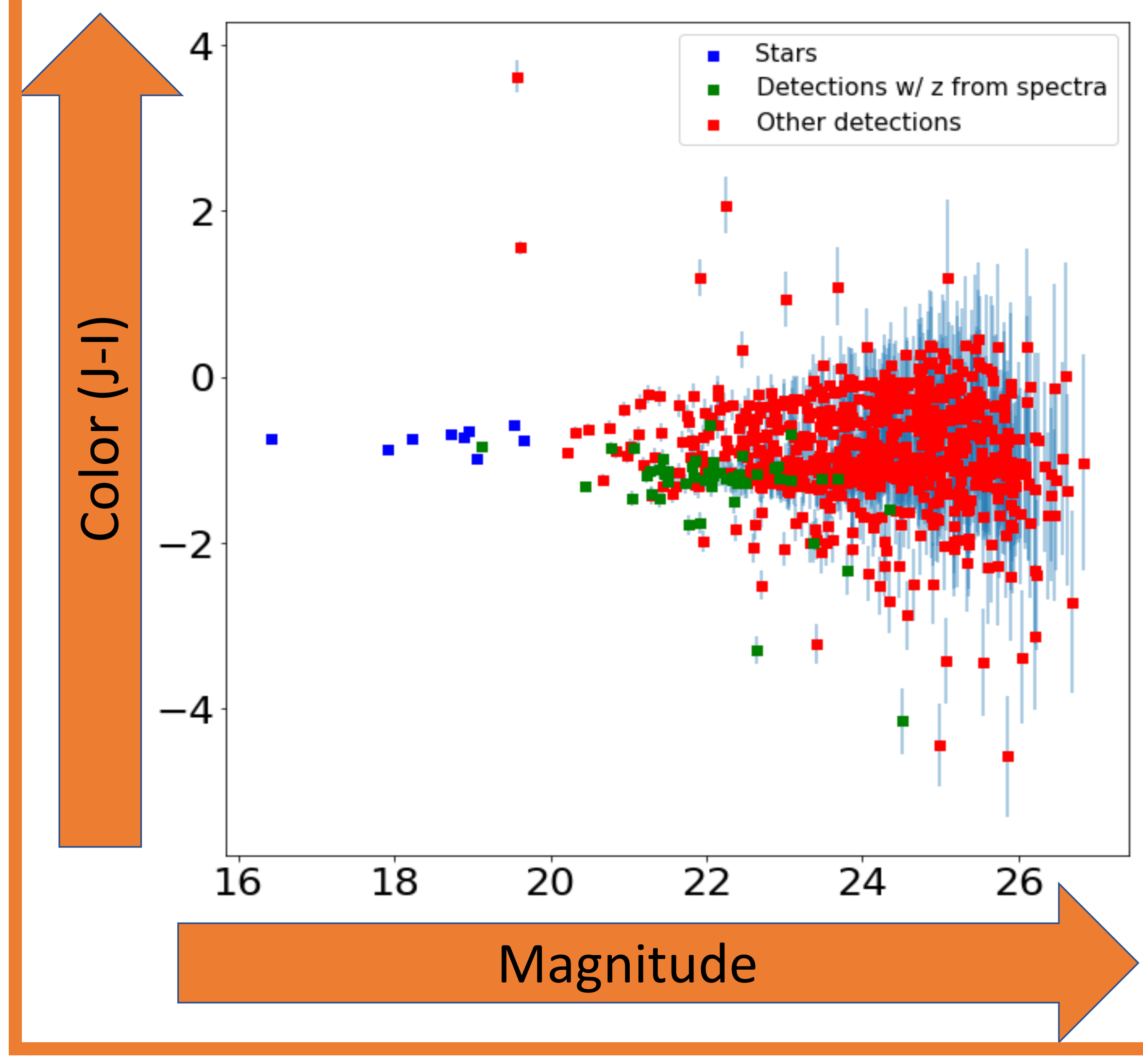
2) use SWarp [6] to align these detections & sum the flux

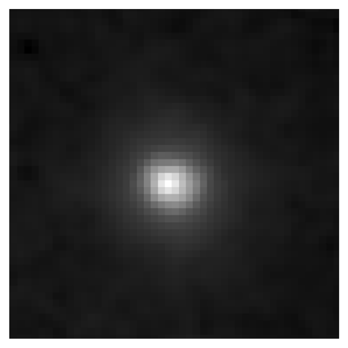


Modeling the Cluster's Galaxies

~detect and classify objects, model individual galaxies, subtract cluster model ~

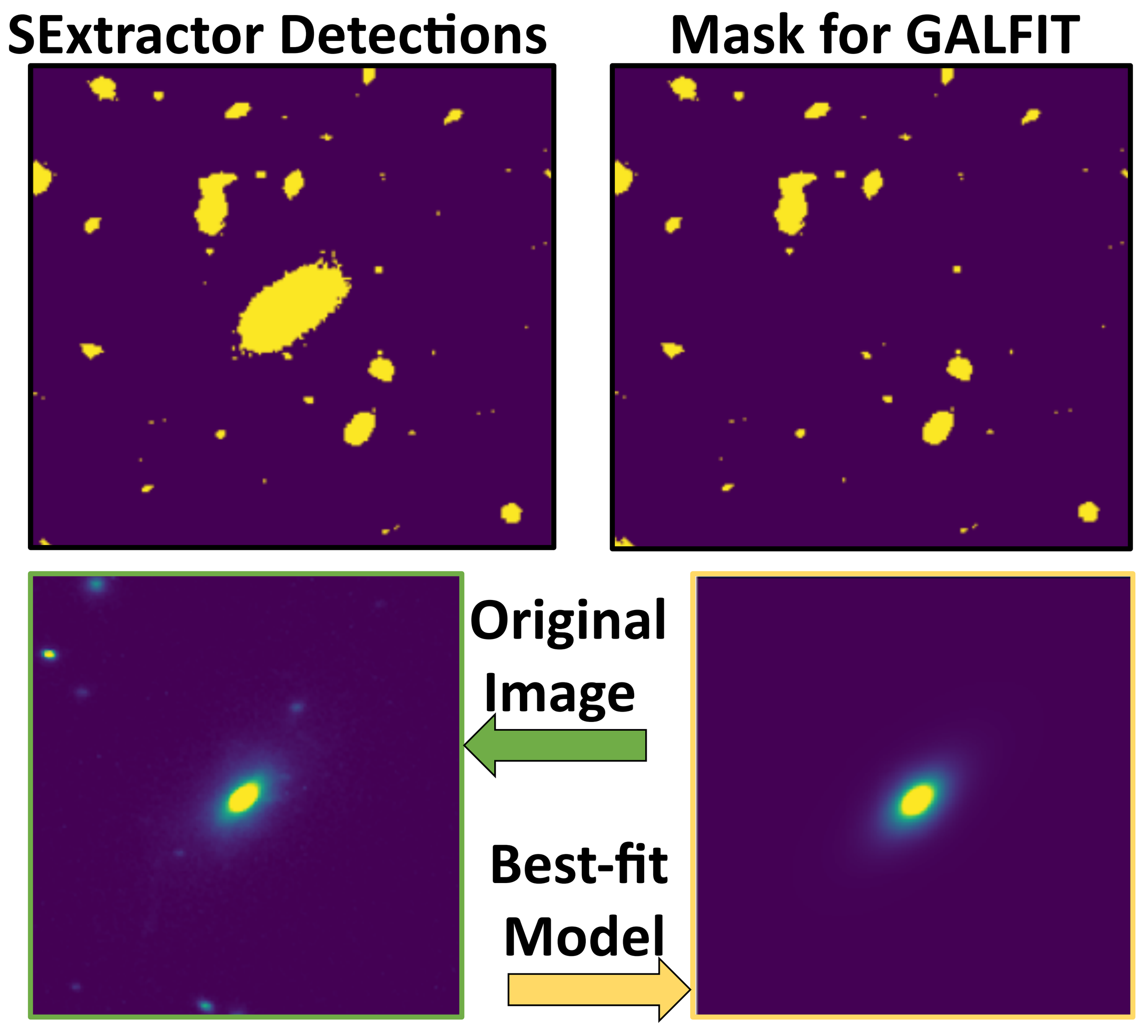
STEP ONE: Use SExtractor to detect all objects in each filter's image of the cluster and provide initial parameters. To identify foreground stars use the SExtractor stellar classifications with maximum surface brightness and magnitude. Verify stars via visual inspection and then stacked to create a point spread function (PSF) for each filter's image.

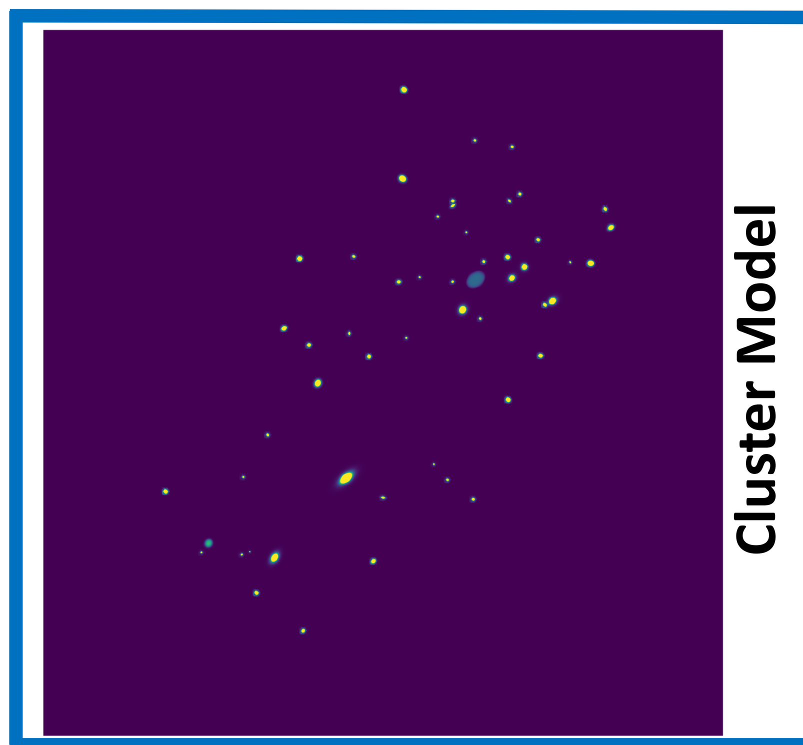




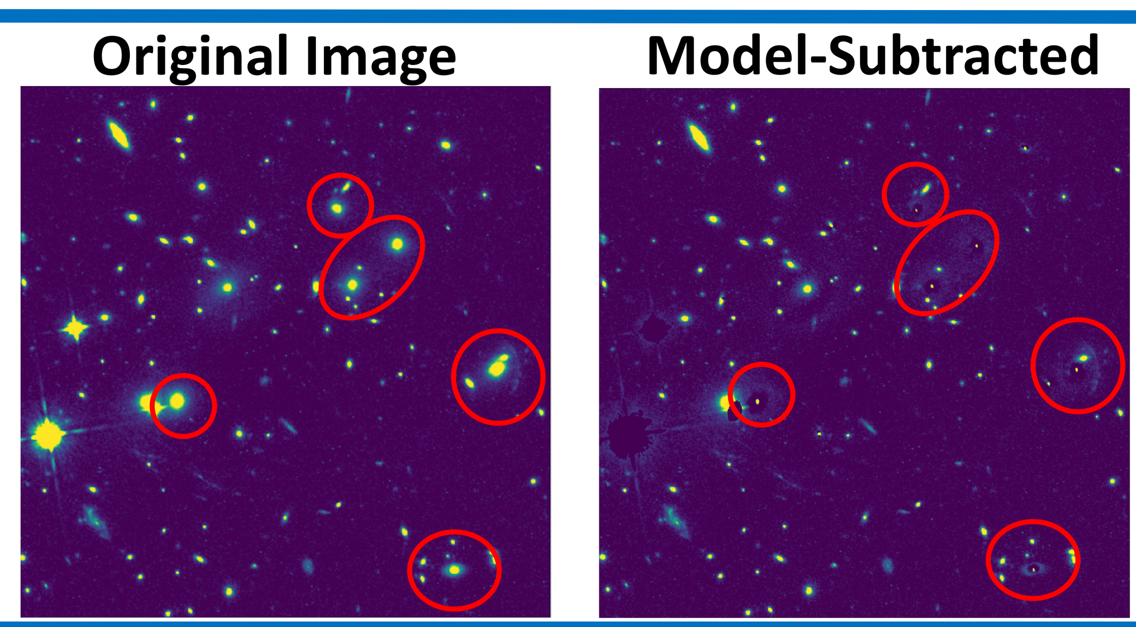
Point Spread Function (PSF) from stacked foreground stars.

STEP TWO: Mask the detections without spectroscopic information by changing SExtractor's detection values for known cluster members to match the background. Run GALFIT [7,8] on filter images of the cluster members to optimize model fit of cluster.



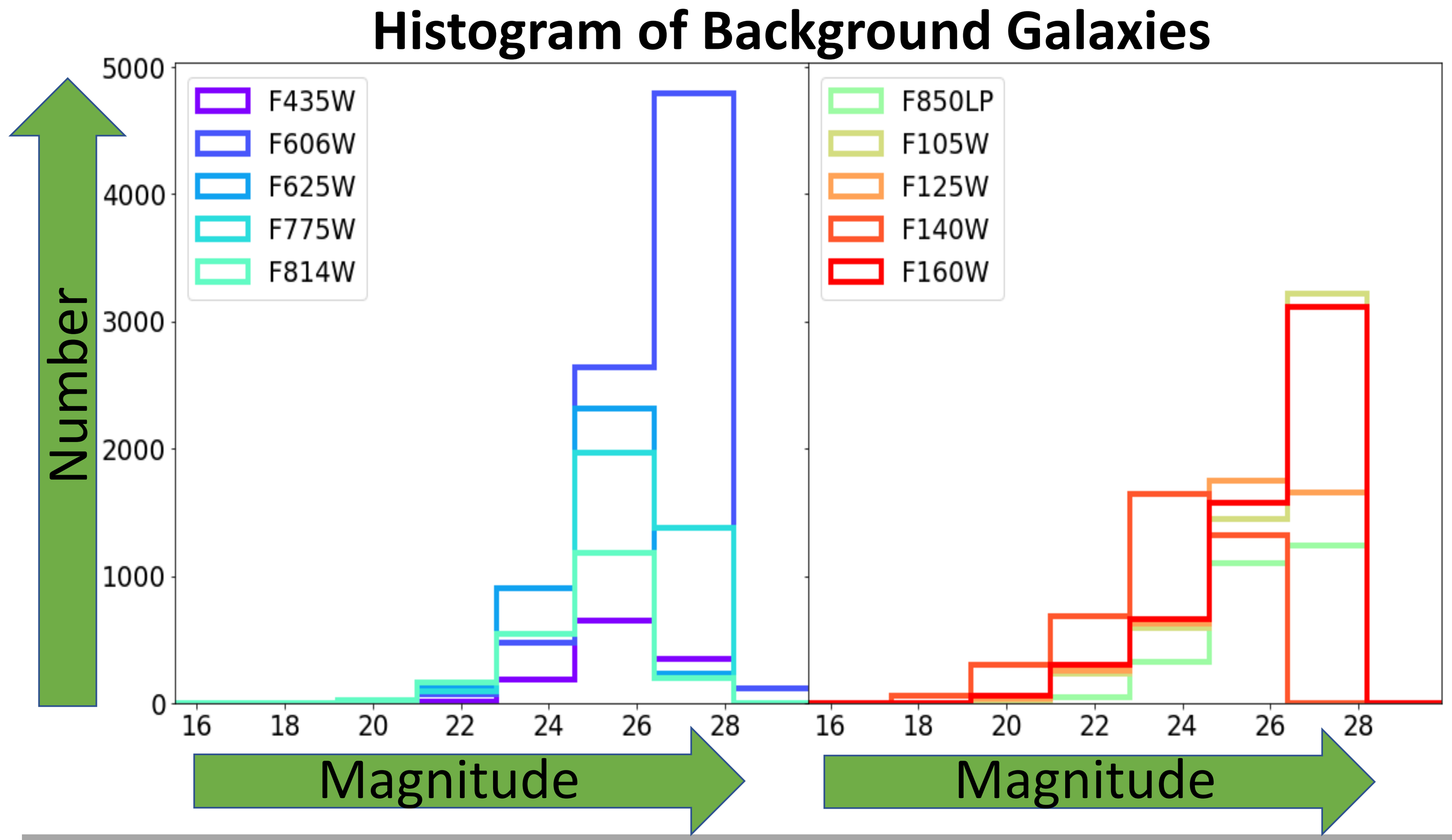


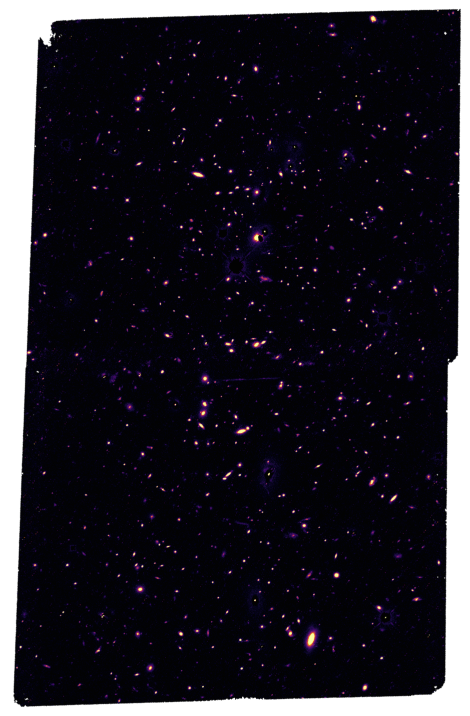
STEP THREE: Combine individual galaxy models to create a best-fit model for the cluster. Subtract this model and foreground stars from each filter's image of the cluster. Run SExtractor on the subtracted images to detected low-mass background galaxies.



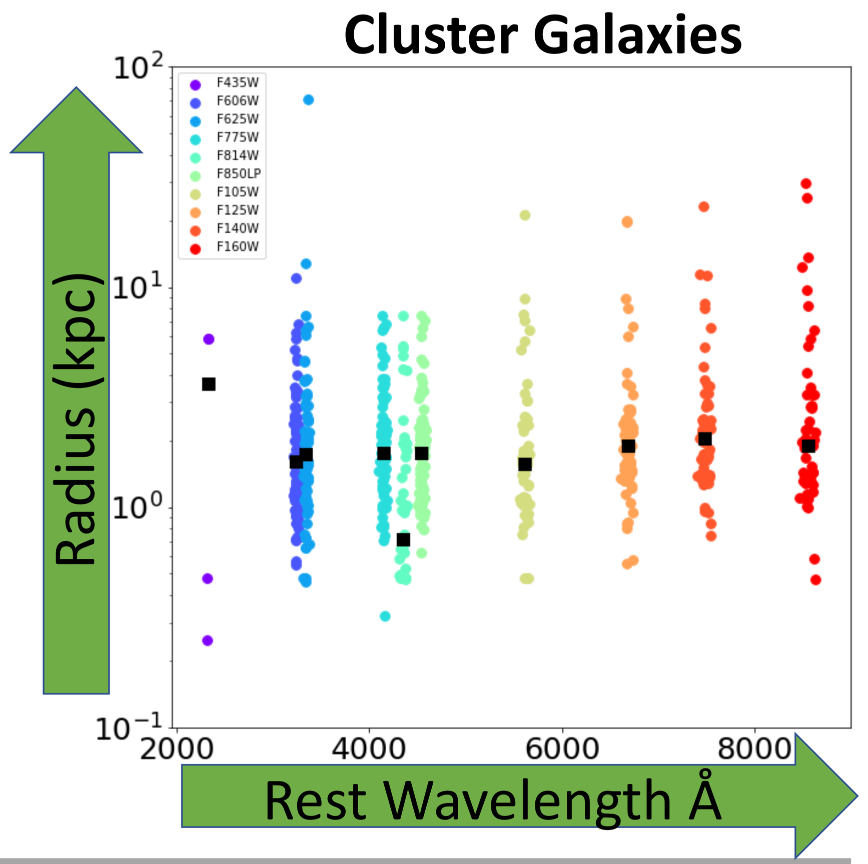
Results and Future Work

~parameter catalogs for best-fit model of cluster & background galaxies~





WFC3 F105W



Acknowledgments and References

[1] Menanteau, F., Hughes, J. P., Sifón, C., et al. 2012, ApJ, 748, 7; [2] Zitrin, A., Menanteau, F., Hughes, J. P., et al. 2013, ApJ, 770, L15; [3] Sifón, C., Menanteau, F., Hasselfield, M., et al. 2013, ApJ, 772, 25; [4] Cerny, C., Sharon, K., Andrade-Santos, F., et al. 2018, ApJ, 859, 159; [5] Bertin, E., & Arnouts, S. 1996, A&AS, 117, 393; [6] Bertin, E., Mellier, Y., Radovich, M., Missonnier, G., Didelon, P., & Morin, B. 2002, in ASP Conf. Ser. 281, Astronomical Data Analysis Software and Systems XI, ed. D. A. Bohlender, D. Durand, & T. H. Handley (San Francisco: ASP), 228; [7] Peng, C. Y., Ho, L. C., Impey, C. D., & Rix, H.-W. 2002, AJ, 124, 266; [8] Peng, C. Y., Ho, L. C., Impey, C. D., & Rix, H.-W. 2010, AJ, 139, 2097;

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