It has long been known that the conversion gas into stars in galaxies is nontrivial involving many intricacies. Some factors that have been found to be relevant towards rates of star-formation include morphology, environment, gas-phase metallicity, mass of the host dark matter halo and hydrodynamical interactions with supernovae and active galactic nuclei (AGN). Understanding star-formation histories is paramount in galaxy models used to interpret observations and make inferences about the physics underlying galaxy evolution. However, due to its complexity and our limited knowledge, star-formation histories in models are commonly simplified into smooth analytical forms. Therefore, large samples of galaxies are necessary in order to study the wide diversity of galactic star-formation histories. My research objectives are centered on improving our perspective of how galaxies form stars over cosmic time. I propose a three-fold approach to addressing this topic of research in contemporary galaxy evolution.

1) Galactic feedback mechanisms for regulating star-formation: Active galactic nuclei

High density environments (where galaxy clusters represent the extreme) are well-known for harboring an excess of passive galaxies relative to lower density environments, indicating that environment is tied to the quenching of star-formation (Blanton & Moustakas 2009, and references therein). Furthermore, results from the EDisCS survey show that proportion of quenched galaxies in clusters at $z \leq 0.8$ increases with time (De Lucia et al. 2007), illustrating that quenching is an ongoing process at these redshifts and providing an opportunity to test for various quenching mechanisms. Several contemporary studies found that active galactic nuclei (AGN) occur more frequently in clusters at higher redshifts (e.g. Eastman et al. 2007; Martini et al. 2009), suggestive of the importance of AGN feedback in quenching star-formation. However, these studies relied on selecting AGN via X-ray emission which fail to identify highly dust-obscured AGN; for example, Hickox et al. (2009) found that only 40-50% of infrared-selected AGN were detected in X-rays.

I will conduct a deep mid-infrared (mid-IR) census of nine massive galaxy clusters at ($0 < z < 1.3$) with a total of ~1500 spectroscopically confirmed member galaxies using Spitzer/IRAC photometry and established mid-IR color selection techniques (Lacy et al. 2004; Stern et al. 2005). The goal of this project will be to determine if a large population of highly obscured AGN exist in galaxy clusters that would have been missed in previous X-ray surveys. I will use standard techniques for analyzing complete subsamples within this dataset to mitigate potential biases introduced by the depth of our data. Once I've identified a sample of IR-AGN I will look into their properties including galactic morphology, position within the host galaxy cluster, luminosity and stellar mass for comparison to a control sample of normal cluster galaxies. Ultimately, I aim to answer two questions: (1) is there evidence to support that AGN are triggered as galaxies fall into clusters and (2) is the presence of AGN hosts in galaxy clusters coeval with the amount of star-formation in clusters? Saintonge et al. (2008) studied the evolution of star-formation for galaxies from this same dataset and will provide the necessary comparison for this project.

2) Tracking the net growth of stellar mass in the Universe over the past 11 billion years

Using observations from the FourStar Galaxy Evolution Survey (ZFOURGE), I plan to obtain the deepest measurement to date of the galaxy stellar mass function (SMF) at $0.2 < z < 3$. ZFOURGE provides well-constrained photometric redshifts made possible through deep medium-bandwidth imaging at 1–2μm. Combining this with Hubble Space Telescope imaging from the Cosmic Assembly Near-IR Deep Extragalactic Legacy Survey (CANDELS) will allow for the efficient selection of both blue and red galaxies down to stellar masses of $\sim 10^{9.5} M_\odot$ at $z \approx 2.5$. I will further supplement these data with the wider and shallower NEWFIRM Medium-Band Survey (NMBS) to provide stronger constraints at high masses.

Several studies at $z \leq 1.5$ have revealed a steepening of the slope at the low-mass end of the SMF, leading to an upturn at masses $<10^{10} M_{\odot}$ that is not well described by a standard single-Schechter function. However, due to the limitations of these datasets it is yet unknown if this feature exists at higher redshifts. With the dataset described above I will be able to verify this to at least $z = 2$. I will also investigate the respective SMFs of star-forming and passive galaxies to see if this low-mass steepening is the result of the superposition of these two populations. At the same time, this dataset will be the first of its kind to be able to numerically quantify the buildup of quenched dwarf galaxies, a galaxy subpopulation that is inherently the most difficult to detect in any given survey.

3) Constraining the average growth rates of galaxies (star-formation histories)

Lastly, I plan to explore the star-formation histories (SFHs) of galaxies based on the evolution of the star-formation rate stellar mass relation (SFR−M_*). Studies over the past decade have unambiguously revealed a strong correlation between galaxy star-formation rates and stellar masses, referred to as the SFR−M_* relation (e.g. Brinchmann et al. 2004; Noeske et al. 2007; Whitaker et al. 2012). The physical interpretation for the existence of this sequence is that galaxies with larger masses, and thus larger gravitational potentials, are able to accrete gas for fueling star-formation more quickly. A typical approach has been to parameterize the relation as a power law of the form: $SFR \propto M_*^{\alpha}$. The SFR−M_* relation has been shown to be remarkably consistent across a large range of redshift, evolving almost exclusively in normalization (see Speagle et al. 2014 for a review). Recent detailed studies, however, have revealed a mass-dependent slope in this relation with $\alpha = 0.9 - 1.3$ at $M_* < 10^{10} M_{\odot}$ and decreasing gradually with redshift at higher masses, interpreted as a reflection of mass-dependent quenching (Whitaker et al. 2014; Schreiber et al. 2014; Lee et al. 2015).

Again, using data from the ZFOURGE survey in combination with far-IR imaging from the *Spitzer* and *Herschel* satellites I will be able to reliably measure the SFR−M_* relation at $0.5 < z < 4$. Accurate photometric redshifts offered by ZFOURGE's medium-band imaging justify the use of narrow redshift bins (down to $\Delta z = 0.25$), leading to better constraints in the time evolution of this sequence. Adopting the parameterization of Lee et al. (2015) I plan to develop a redshift-dependent parameterization of the SFR-M_* relation to be made available for use in theoretical studies of star-formation by other teams. Assuming that individual galaxies evolve along this sequence one can extract the star-formation rate as a function of time (i.e. star-formation histories). Integrating these profiles will yield stellar mass growth histories for galaxies which can be compared to independent predictions from abundance matching.

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