SCIENTIFIC JUSTIFICATION

The intermediate Palomar Transient Factory (iPTF) is undertaking the Census of the Local Universe (CLU) project to complete our survey of galaxies out to 200 Mpc ($z \sim 0.05$). CLU deploys four wavelength-adjacent, narrowband filters to search for extended, emission-line (Hα) sources across 15,000 square degrees of the sky. The estimated 5σ limiting Hα line flux is 6×10^{-16} erg s^{-1} cm^{2}, which corresponds to a star formation rate (SFR) of 10^{-3} M$_\odot$ yr^{-1} at a distance of 50 Mpc. An analysis of 4 preliminary iPTF pointings suggests that **the final CLU galaxy catalog will capture 92% of the Hα luminosity out to 200 Mpc resulting in an estimated ~100,000 newly discovered galaxies in all iPTF pointings**.

CLU assists the discovery of transients by providing a secure host-galaxy redshift to prioritize follow-up. For example, if a candidate transient is spatially coincident with a CLU galaxy, we could infer its luminosity and hence, distinguish a rare, young supernova from an old, more distant supernova. In addition, the **CLU galaxy catalog will be used by aLIGO follow-up programs to help search for electromagnetic counterparts** (Kasliwal et al., 2016). Nearby galaxies occupy less than 1% of the area on the sky. Thus, when searching for electromagnetic counterparts for gravitational wave triggers (aLIGO) in coarse localizations of hundreds of square degrees, CLU can promptly narrow-down the list of candidate counterparts by over two orders of magnitude.

CLU will also advance our understanding of galaxy evolution by providing a more accurate anchor point for the local SFR density (ρ). Emission line studies of nearby and high redshift galaxies have found that ρ increases with redshift until z$\sim 2-3$ and then plateaus or decreases (Lilly et al., 1996). A major source of scatter on this relationship derives from cosmic variance in studies probing small volumes of space (Stroe & Sobral, 2015). **The CLU local SFR density measurement will be derived from the largest area on the sky yet studied**, thus providing a robust anchor point for the relationship between cosmic SFR density and redshift.

Furthermore, **matching CLU Hα and GALEX UV sources will help to solve a discrepancy between Hα and UV-derived SFR indicators in low-SFR galaxies** (Lee et al., 2009; Meurer et al., 2009). This discrepancy suggests that low-SFR, dwarf galaxies are systematically deficient in ionizing fluxes, and hence contain fewer high mass stars compared to their more massive counterparts. Several interpretations have been put forth to explain this discrepancy ranging from stochastically sampling of the stellar IMF (e.g., Fumagalli et al., 2011), to bursty star formation histories (e.g., Weisz et al., 2012), to a variable IMF (e.g., Pflamm-Altenburg et al., 2009). However, it is difficult to discriminate between the predictions of these theories due to the low number statistics of low-SFR galaxies (log SFR $< 10^{-2}$ M$_\odot$ yr^{-1}). Given the SFR sensitivity of the iPTF narrowband survey, the CLU galaxy catalog will help to distinguish between these theories by adding an order of magnitude more low-SFR galaxies. The ramifications of this study will be wide-spread on the star formation process and will impact the stellar IMF, stellar population models, and luminosity-derived physical properties of galaxies.

In addition, we anticipate contamination ($< 7\%$) from strong [OIII](4959,5007 Å) galaxies located at z~0.3 redshifted into our Hα filters. Galaxies with a strong enough [OIII] emission lines to be identified as potential candidates in our study will be low metallicity galaxies with high SFR. These galaxies are rare in the local Universe and are analogs for high redshift ($z > 6$) dwarf galaxies. *In the course of quantifying our contamination fraction, we can also characterize these high redshift dwarf galaxy analogs which will be detectable with JWST and WFIRST infrared telescopes.*

Proposed SDSS Future Spectroscopic Survey

We propose for an ambitious spectroscopic survey of all ~100,000 CLU galaxy candidates using the BOSS multi-fiber spectrograph. The iPTF Hα project surveys 1/3$^{\rm rd}$

of the sky ($\sim 15,000$ deg^2) with a declination limit of > -20 and is on schedule to be completed at the end of 2016 in all 4 Hα filters. Analysis of only 4 iPTF pointings with SDSS overlap shows that our candidate selection criteria successfully identifies $> 90\%$ of known galaxies with an Hα EW$\sim$tens Å, and have less than 7% contamination from higher redshift galaxies.

For each preliminary iPTF field, we find ~ 35 galaxy candidates in addition to SDSS galaxies with existing spectra (Fig. 1). However, we consider this estimate to be a lower limit since roughly half of the area covered by our survey is outside the SDSS footprint and we will likely more than double the number of new galaxies found in fields without SDSS coverage. Given the ~ 2000 iPTF fields total, we expect to discover $\sim 35,000$ and $\sim 70,000$ new galaxies in fields inside and outside the SDSS footprint, respectively, totaling $\sim 100,000$ newly discovered galaxies.

The BOSS spectrograph on the 2.5m telescope at APO is ideal for such a large undertaking due to its multi-fiber capabilities where each plate subtends 3 degrees on the sky (i.e., ~ 7 deg^2). Visual inspection of galaxy candidates over an additional 30 iPTF fields (7.9 deg^2 per field) suggests that the number of candidates in each field will have a range of 10s to $\sim$100 candidates per fiber plate. The number of projected CLU targets per BOSS plate leaves a large fraction of fibers free for other galaxies and high-z quasars identified in other large area surveys (e.g., Pan-STARRS, LSST, etc.).

The 5σ detection limit for a point source in our Hα images is 19.5$\pm$0.5 AB mag which is similar to the limit in previous SDSS galaxy spectroscopic surveys (i.e., i$\sim$20 mag; Strauss et al., 2002; White et al., 2011). Hence, we propose for similar exposure times of 45 minutes per plate (see Strauss et al., 2002) used by previous SDSS galaxy projects with the same spectral resolution (R$\sim$2000) and wavelength coverage (3600 to 10,400Å). This instrument setup and exposure time have proven ideal to measure, not only Hα emission lines for redshift determination, but Balmer lines for internal dust corrections and [OIII] lines for metallicity.

The spectra obtained with this ambitious survey will provide redshifts, star formation rates, dust content, and metallicities for the most complete sample of galaxies in the local Universe (D <200 Mpc). The scientific ramifications of this uniform data set for our closest neighbors will affect many areas of astrophysics: linking aLIGO events to an electromagnetic counter part, help prioritize transient discoveries, disentangle star formation theories in low-SFR galaxies, and galaxy evolution models.

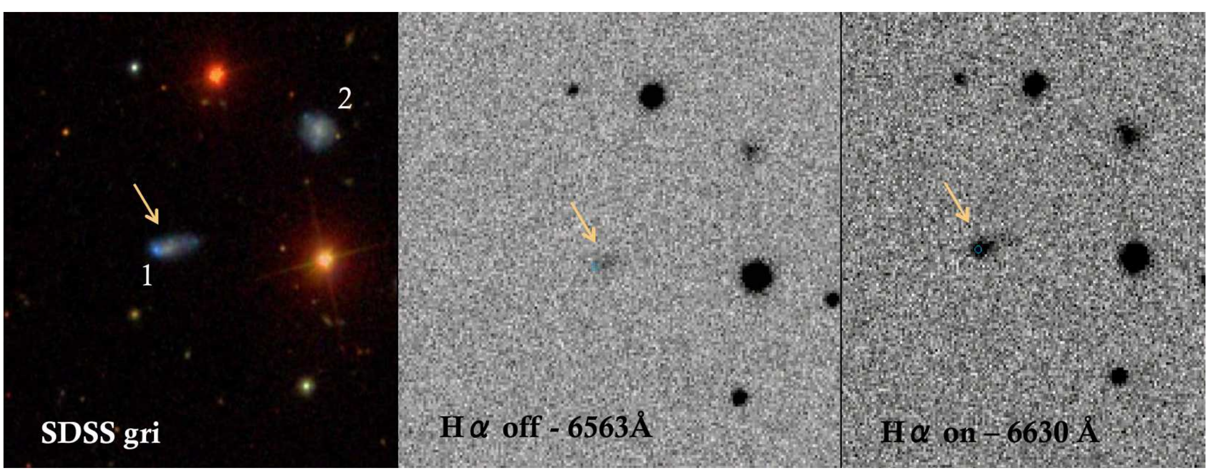

Figure 1: Two CLU galaxy candidates where one has been spectroscopically confirmed with the BOSS spectrograph (#1) and the other has yet to be confirmed (#2). Shown above (left-to-right) is the SDSS gri color composite, the iPTF Hα-off image (z$\sim$0, 6564Å), and the iPTF Hα-on image (z$\sim$0.01, 6630Å). The galaxy marked with an arrow was spectroscopically confirmed to be at z=0.015 with SDSS/BOSS. CLU will uncover $\sim 100,000$ nearby galaxies out to z=0.05 using a four filter narrow-band survey with iPTF.

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