Burst and Quench?

The Life Story of Low Surface Brightness Galaxies

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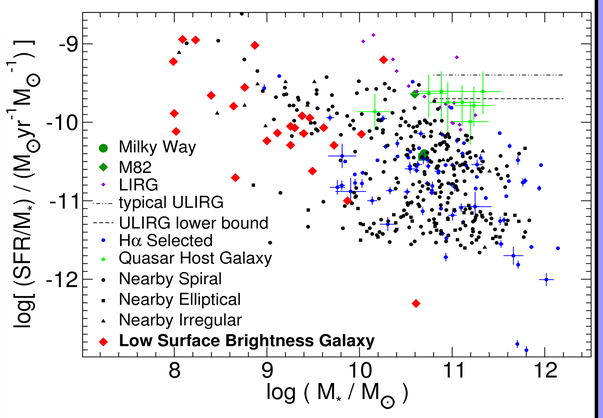
Motivation:

Low Surface Brightness (LSB) galaxies bracket the lower envelop of star-forming disk galaxies. As extreme examples of late-type galaxies, they are an excellent test-bed for our understanding of the triggering, regulation, and feedback of star formation in disks.



Stellar mass-specific star-formation rate vs. stellar mass for a variety of galaxies; the LSB galaxies are on the lower envelope of the distribution, but are not a distinct class, and span a range of stellar masses and specific star-formation rates.

Sources: LSB galaxies (Kuzio de Naray & Spekkens 2011 and Kim 2007), quasar host galaxies (Young et al. 2013), nearby galaxies (Gil de Paz et al. 2009), LIRGs (Lehmer et al. 2010), the Milky Way (Hammer et al. 2007; McKee & Williams 1997), M82 (Heckman et al. 1990), Hα-selected galaxies (Young et al. in preparation)

The Paradox

- Low Surface Brightness (LSB) galaxies are HI rich but have putative stellar populations $\mu_0 > 21.5$ mag/□”
- Optical colors are blue but star-formation rates are low.
- No extensive old stellar population (they are not fading starbursts), but red UV colors (not entirely composed of young stars).

The Solution(s)?

Although the colors of LSB galaxies do not match simple model star-formation histories (such as constant or exponentially decaying star-formation rates), some authors suggest that a burst and quench history may fit. Broad band colors alone, however, are insufficient to test such models – with optical spectra we hope to do just that.

Strategy:

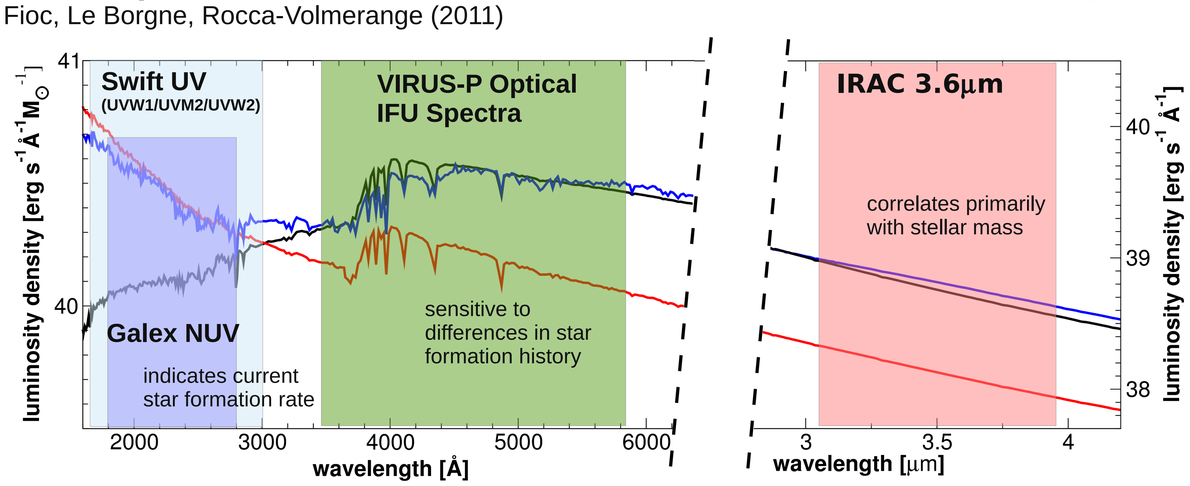
We aim to break degeneracies between candidate star formation histories with a multi-wavelength approach.

Right: SEDs of three star-formation histories. UV photometry correlates with current star-formation rate, Spitzer IR correlates with stellar mass, and optical spectra reveal subtle differences in continuum shape.

We plan to run different candidate star formation histories (burst & quench) against optical IFU spectra anchored at the red end with archival Spitzer observations and at the blue end with Swift and Galex observations using SED fitting code.

Model spectra for different star-formation histories; created using PÉGASE

Fioc, Le Borgne, Rocca-Volmerange (2011)



6.5 x10^{10}M$_\odot$ forming stars at an exponentially decaying rate, currently 0.5 M$_\odot$ yr^{-1}
1.0 x10^{10}M$_\odot$ forming stars at an constant rate of 0.5 M$_\odot$ yr^{-1} for the past 3 Gyr
6.5 x10^{11}M$_\odot$ 3 Gyr after an instantaneous burst

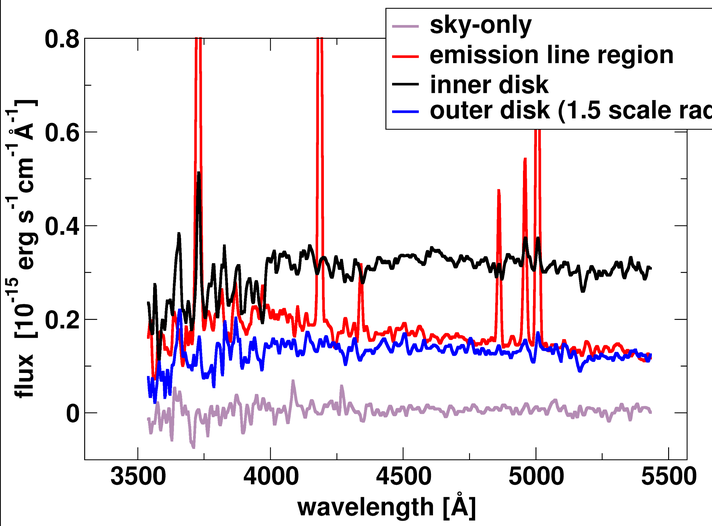
Our First Target: UGC 628

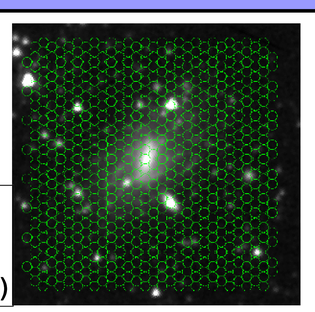
- distance ~75 Mpc
- log(M$_*$) ≈ 10.8
- B = 15.6 mag
- μ_0 = 22.5 mag/□”
- archival Spitzer IRAC 3.6μm and 4.5μm images
- observed with VIRUS-P in Nov.
  - spatially resolved IFU spectra from 3500-5800Å
- observed with Swift UVOT

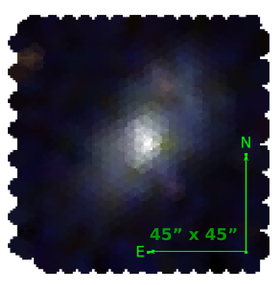
- stellar continuum detected in the disk and core
  - the shape will constrain star formation histories
- [OII]3727, [OIII]5007 and Hβ lines detected in the core and spiral arms
  - unexpected!
  - secondary measures of star formation rates

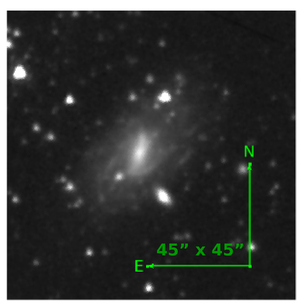
IFU Spectra of UGC 628

Each spectrum below corresponds to a 4.″2 fiber in the VIRUS-P integral field unit (see right). The spectra have been sky subtracted and redshift corrected. The 246 fibers provide us with a unique star formation history for each location.









UGC 628; Spitzer 3.6μm

What is an IFU?

The 246 fibers of the VIRUS-P Integral Field Unit each sample the spectrum of UGC 628 **(left)** at different positions **(top left)**, giving us spatially resolved star-formation histories.
Top Right: The IFU spectra have been passed through V, B, and U filters to create this RGB image.