The Cosmic Skidmark: witnessing galaxy transformation at $z = 0.19$

David N. A. Murphy
Instituto de Astrofísica, Facultad de Física,
Pontificia Universidad Católica de Chile
email: dmurphy@astro.puc.cl

Abstract. We present an early-look analysis of the “Cosmic Skidmark”. Discovered following visual inspection of the Geach, Murphy & Bower (2011) SDSS Stripe 82 cluster catalogue generated by ORCA (an automated cluster algorithm searching for red-sequences; Murphy, Geach & Bower 2012), this $z = 0.19$ 1.4$L^\star$ galaxy appears to have been caught in the rare act of transformation while accreting onto an estimated $10^{11} - 10^{12} h^{-1} M_\odot$-mass galaxy group. SDSS spectroscopy reveals clear signatures of star formation whilst deep optical imaging reveals a pronounced 50 kpc cometary tail. Pending completion of our ALMA Cycle 2 and IFU observations, we show here preliminary analysis of this target.

Keywords. galaxies: evolution - galaxies: clusters: general

1. Introduction

Study of galaxy populations reveal clearly bimodal properties such as morphology, the colour-magnitude distribution (CMD) and star formation rates (see e.g. Kauffmann et al. 2006). The origin of this dichotomy appears to be driven mainly by galaxy environment; compared to those in the low-density field, spiral galaxies in clusters exhibit suppressed star formation, smaller cold-gas reservoirs and truncation of their gaseous disks (Boselli & Gavazzi 2006). The evolution of the CMD into a progressively pronounced “red sequence” (Bower, Lucey & Ellis 1992) at early times, indications of a transitional CM “green valley” and a lack of high-mass blue spirals point to the transformation of late-type spirals into early-type ellipticals within cluster environments. Examples of such transformations (most recently Jáchym et al. 2014) are valuable case-studies that deepen our understanding of galaxy evolution. To this end, we present a preliminary look at the “Cosmic Skidmark” - an example of galaxy transformation in action.

2. Data

The Cosmic Skidmark investigation consists of three datasets. The first is with deep (7hr) griz-band SOAR Adaptive Module (SAM; Tokovinin et al. 2008) photometry (shown in Figure 1 left). We compliment this with 14hrs of VLT/VIMOS IFU data covering a 27”x27” FOV over 3837Å–7430Å rest-frame at a spaxel resolution of 0.67”x0.67”. Finally, we await completion of a 3hr ALMA Band 3 scan to measure tracers of neutral gas from reservoirs potentially fuelling the sites of strong star-formation. The latter two datasets are partially complete. The $z=0.19$ redshifting of spectral features permits IFU measurement of [OII] line emission in addition to ALMA mapping of CO(1-0) and CN(1-0) over one pointing covering the target galaxy, group members and environs to a 3σ CO line sensitivity of 0.34mJy.
3. Preliminary findings and outlook

Figure 1 (centre) shows a datacube for the high-resolution VPH blue VLT/VIMOS grism centred on the wavelength corresponding to observed-frame [OII] line emission. Spectra for the numbered spaxels can also be found in Figure 1 (right). With three key spectral indicators ([OII],[OIII],Hβ) we find clear indications of star formation in the galaxy core (spaxel 4), in agreement with SDSS fiber spectroscopy. Star formation, evident throughout the cometary plume, traces out the dual-tail structure (spaxels 2,3) alluded to in optical imaging. We find evidence for line emission out to 50 kpc from the galaxy core (spaxel 1). Inspection of deep g-band SAM imaging near this spaxel reveals a number of small galaxies and clumps clustered downstream at the tail-end of the plume. With g-r colours consistent with the group red-sequence suggesting a similar redshift to the Cosmic Skidmark, they may possibly have been disturbed by it’s passage through the group. Future work will focus on probing this site, in particular two diffuse (g~25.2mag/arcsec²) tidal dwarf-scale sources seen stretching between two brighter sources. VIMOS star-formation maps can be connected to ALMA CO(1-0), CN(1-0) and SiO(3-2) line emission mapping of molecular gas reservoirs and will permit measurement of the star formation efficiency, kinematical differences between the star-forming and cold-gas, gas depletion timescales and outflow signatures. A detailed analysis of this target will appear in Murphy et al. (2014, in preparation).

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References