Novel HST Imaging of OVI Emission from z~0.25 starburst galaxies

Abstract: The importance of feedback to the evolution of the galaxies and the IGM cannot be overstated. Strong starbursts drive massive galactic superwind, the cumulative effect of which acts to modify the observed luminosity function of galaxies and the star-forming main mass function. Furthermore, feedback from star formation (supernovae and stellar winds) evacuates metals from galaxies to perturb the CGM ([6]. In low-mass (M<10^10 M☉) galaxies, the effects of stellar feedback are particularly important in the CGM ([3] and the outflow rate of dark galaxies may reproduce in a major way the feedback therein ([5,6]). Future studies of star-forming dwarf galaxies, e.g. with JWST, will necessarily rely on diagnostics calibrated for their low-redshift analogs. We present recent efforts to characterize feedback in low-redshift starbursts via HST observations of the warm, OVI-boundary winds. Combining UV/optical ground and space-based imaging and spectroscopy we present the results of a first census of the OVI luminosity, halo morphology, and physical properties of five low-redshift starburst galaxies.

Figure 1: Synthesized OVI Narrowband — Applying a narrowband methodology first used to study Lyα Lyα in low-redshift galaxies in the LARG survey ([10,11,12]), we combine SDSS long-slit of (above) plus models to synthesize a narrowband sensitive to OVI & Lyα. Subtracting the underlying [NII] emission, we filtered the F125LP data to images and map the full spatial profile of the O VI spatial (velocity) distribution.

Figure 2: Sample Selection — For a pilot survey ([17] we searched the SDSS catalog for objects that satisfy strong OVI absorption (EW(OVI)>2000Å) and restricted to a small aperture. This allows us to set a limiting magnitude on the OVI detection from the O VI narrowband image. With SFR = 35 M☉/yr, we require SFR = 35 M☉/yr, and the OVI narrowband surface brightness map (lower right). Within a circular annulus measured 10<r<30 kpc from the galaxy core, we reproduce the measured OVI emission to the northwest of J1247+1558 (above left). We then tentatively report a detection of OVI emission within ~30kpc.

Figure 3: Observations — In Cycle 2, we obtained ~35k with the F125LP narrowband F125LP imaging of ~4s at UCSC/UW, broadband ACS narrowband imaging, and ~2k with COS for the first time—replicating the narrowband observation. COS FUV spectroscopy (right) is critical for confirming the O VI detection, while blue-shifted O VI absorption in the outflow, with velocity ~3500.

Figure 4: Physical Properties of the OVI Halo: —In contrast, blue Pl. models (fixed β per pixel) indicate significant OVI emission to the northwest of J1247+1558 (above left). The F125LP synthetic narrowband surface brightness map (lower right). Within a circular annular measured 10<r<30 kpc from the galaxy core, we measure a ~5.7x10^6 erg/cm^2/s.

References

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Figure 5: Possible High-Redshift OVI Emission — After subtracting the O VI narrowband contamination, we identify O VI emission. Lyα(COS) is an excellent candidate detection; perhaps unsurprising considering its expected velocity, halo morphology. COS spectroscopy can be useful for constraining the wind geometry in this system.

Figure 6: Surface Brightness Profiles — Production of the OVI emission line map is a multistep process that we outline here. First, identify candidate O VI emitters using F125LP and F435W imaging maps as a power law, then select SFR using the F140LP and F555W imaging maps as a power law, and finally select O VI emitters using the F125LP narrowband imaging maps. With proposed X-ray observations, combined with these O VI and optical cooling observations, we can further constrain the underlying wind geometry in this system.

Conclusions and Future Work
In this paper, we presented a novel method using HST ACS/SBC to image the O VI halo in five low-redshift starburst galaxies. The success of this O VI narrowband imaging program demonstrates that it is now possible to detect O VI emission for the first time at high redshift (z<0.05). Future observations for those starbursts with significant F125LP halos would be useful for confirming our detection.

Figure 7: Future Observations — Complete Census of CGM metals: Analysis of these galaxies’ optical spectroscopy, in conjunction with forthcoming UV spectroscopy, will be necessary to determine the total halo and cooling losses in the warm phase. For reference, we calculate the 10% metallicity of the O VI emission. Lyα(COS) is an excellent candidate for a redshift that could scatter to larger radii and it may potentially contaminate our measurement. CO3 spectroscopy will be used to determine the strengths of these lines. For J1156+0503, ~0.25x~0.25x~0.25x, and the recombination line imaging indicates that the neutral scattering medium was compact relative to the O VI halo. In the CO3 program, we do not obtain Lyα and this may provide future observations for those starbursts with significant F125LP halos would be useful for confirming our detection.

Figure 8: Final OVI Emission Map — Highlighting the full mult phase medium to feedback: The success of this O VI narrowband imaging program demonstrates that it is now possible to directly characterize the cooling of the galactic superwind in low-redshift starbursts. With proposed X-ray observations, combined with these O VI and optical cooling observations, we can further constrain the underlying wind geometry in this system.

Figure 9: Final OVI Emission Map — Highlighting the full mult phase medium to feedback: The success of this O VI narrowband imaging program demonstrates that it is now possible to directly characterize the cooling of the galactic superwind in low-redshift starbursts. With proposed X-ray observations, combined with these O VI and optical cooling observations, we can further constrain the underlying wind geometry in this system.