Mapping Interstellar Reddening and Attenuation in Overlapping Galaxy Pair VV 191

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Overview

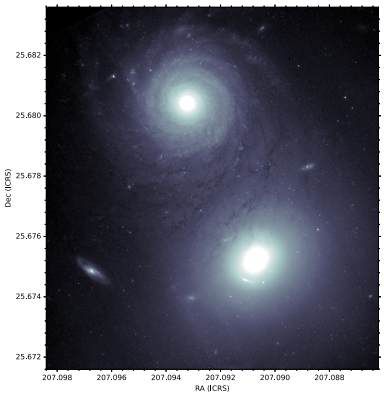
The combination of extinction and scattering combined (i.e., attenuation) due to dust grains remain a critical uncertainty in all branches of astrophysics. A prior function of how the optical properties of interstellar matter depend on wavelength and its dependence on the galaxy environment would be invaluable. This is achieved with an attenuation law, the relation between reddening and dimming by dust between stars, typically adopted to characterize the effect interstellar dust has on light from stars. It is needed to model the star formation, stellar mass, and stellar age distribution for galaxies over cosmic time.

However, the differences demonstrated in different sightlines (such as Magellanic Clouds and the Milky Way) show that there is a wide variety of attenuation laws for the interstellar medium (ISM). It is still an issue for galaxy-wide, galaxy- population, and distance measurements throughout astronomy and cosmology. It is still an unknown with how reddening and attenuation differs in smaller, condensed galaxies compared to larger ones.

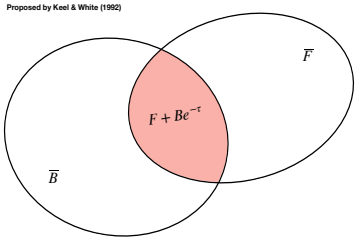
A technique to obtain extra-galactic spatially-resolved attenuation measurements is to use overlapping galaxy pairs: an astrophysical experiment in the optical properties of the interstellar medium that models the light of both galaxies and infers the missing light in the regions of overlap.

A pixel-by-pixel analysis of separately derived attenuation laws for this pair will give a statistical encyclopedia of reddening and attenuation slopes that will include a mean attenuation law for arbitrary regions in this galaxy pair and variance throughout the spiral foreground galaxy that will give detailed insight on the dust distribution and symmetries of VV 191b.

F090W Image

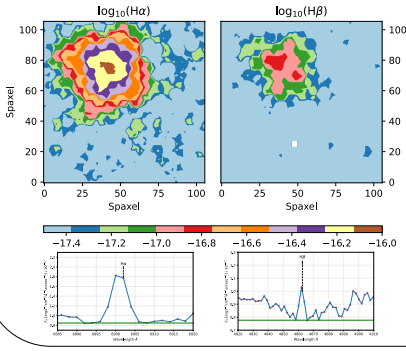


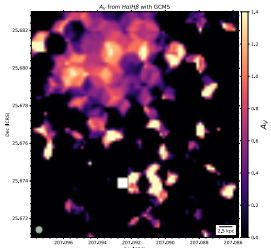
Methodology

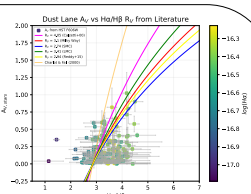


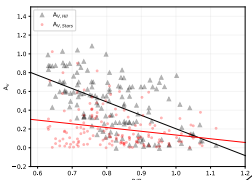
$$A_\lambda = 1.086 \times \tau = -1.086 \times ln\left[\frac{(F + Be^{-\tau}) - F}{B}\right]$$

Ground-Based Balmer Decrement







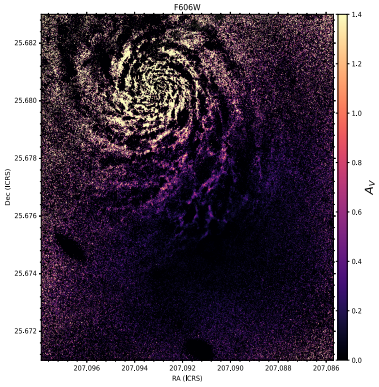


$$E(B-V)^{HII} = \frac{2.5}{k_{H\beta} - k_{H\alpha}} log\left(\frac{H\alpha}{H\beta} / 2.86\right)$$

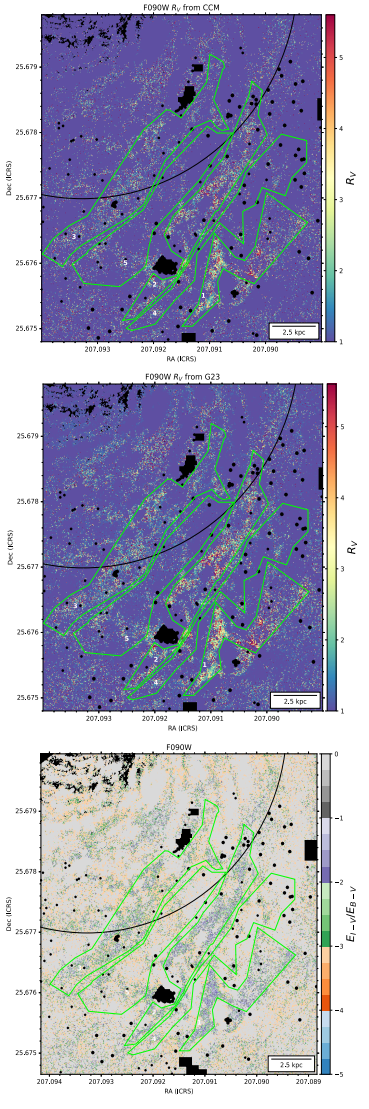
Data

HST: Wide Field Camera 3 as part of SNAPSHOT (PI B. Holwerda) in the F606W and F336W wide camera filters
JWST: NIRCam as part of PEARLS (PI R. Windhorst) in F090W, F150W, F356W, and F444W wide camera filters
GCMS: Ground-based IFU spectra from the George & Cynthia Mitchell Spectrograph in the McDonald Observatory at the University of Texas

Attenuation Maps



R_V Maps



References

- Robertson, Clayton et al. 2024. "Ground- and Space-Based Dust Observations of VV 191 Overlapping Galaxy Pair." The Astronomical Journal 167(6): 263. doi:10.3847/1538-3881/ad39c4.
- Keel, W. C. et al. 2023. "JWST's PEARLS: Dust Attenuation and Gravitational Lensing in the Backlit-galaxy System VV 191." The Astronomical Journal, 165(4), 166. https://doi.org/10.3847/1538-3881/acbdff
- Robertson, Clayton et al. 2024. in prep