VLA Imaging of Atomic Hydrogen-Bearing Ultra-Diffuse Galaxies and the HI Size-Mass Relation

Lexi Gault
lexi.gault@valpo.edu

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What is an ultra-diffuse galaxy?
- A galaxy that has a star content similar to that of dwarf galaxies but a radius similar to that of a large spiral galaxy.

Our Question: Why are UDGs so diffuse?
- Are there other characteristics of these galaxies that could explain their diffuseness?
- Could the galaxies’ motions explain their diffuseness?

What is HI gas and how do we observe it?
- We can observe gas in the galaxy in radio wavelengths.
- HI gas is atomic hydrogen that emits at a wavelength of 21 cm.
- All data in our sample of 12 UDGs was taken with the Very Large Array (VLA), an array of radio telescopes that allows for high resolution radio images.

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Lexi Gault and Luke Leisman
Valparaiso University Department of Physics and Astronomy

Main Points
- We observed ultra-diffuse galaxies (UDGs) with the VLA in order to understand their characteristics and motions.
- Hydrogen gas in UDGs appears undisturbed and normal.
- UDGs have ordered velocity fields.
- UDGs are rotating at slower rates than expected.
- Hydrogen gas in UDGs is not ultra-diffuse.

What are characteristics of these UDGs?
- Gas in the galaxies extends past the stars.
- HI gas in the galaxies is more reliable in measuring inclination.
- Galaxies are bluer in color which is indicative of star formation.
- Galaxies have irregular and clumpy star morphologies.
- Clear velocity gradient shows galaxies are rotating (darker colors are moving away and lighter are moving toward us).

How do these UDGs’ radii compare to typical galaxies?
- HI diameter is proportional to the HI mass for regular galaxies (all sizes).
- UDGs fall on the relation, which means:
  ○ UDGs have a similar average HI surface density as typical galaxies.
  ○ Though the stars in UDGs are ultra-diffuse, the HI gas in these galaxies is not.
- Since the gas is normal, it is likely that the star formation is normal; their diffuseness cannot be explained by lack of new stars.

Future Work
- Take observations in a higher resolution of the largest and brightest UDGs from this sample.
- Create detailed rotation curves for those galaxies.
- Rotation curves will reveal the dark matter content of these galaxies, which can then be compared to typical galaxies.

Acknowledgements and References
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Mannura Pita et al (submitted)
Wang et al 2016

Figure 1. This figure shows optical images in the left hand panel and velocity maps in the right hand panel of galaxies AGC 749290 and AGC 238764. These images are plotted on a color scale to show the variation in redshift across the galaxies in units of km/s.

Figure 2. This figure shows the Baryonic Tully Fisher Relation in Mancera Pita et al (submitted). The y-axis is plotting the baryonic mass (total mass of gas and stars), and the x-axis is plotting the rotational velocity in km/s.

Figure 3. This plot shows our sample of UDGs plotted over the Wang et al. 2016 HI size-mass relation. The y-axis plots the HI diameter and the x-axis plots the HI mass. The red solid line represents the fit of the Wang et al. 2016 data, and the red dashed lines show the scatter in the relation to 3σ.