The Arecibo Pisces-Perseus Supercluster Survey: Exploring the Large Scale Structure in the Local Universe

Olivia Jo Dickinson
Providence College

Follow this and additional works at: https://digitalcommons.providence.edu/eps_students

Part of the Engineering Commons

https://digitalcommons.providence.edu/eps_students/3

This Poster is brought to you for free and open access by the Engineering & Physics at DigitalCommons@Providence. It has been accepted for inclusion in Engineering & Physics Student Scholarship by an authorized administrator of DigitalCommons@Providence. For more information, please contact dps@providence.edu.
**The Arecibo Pisces-Perseus Supercluster Survey:**

**Exploring the Large Scale Structure of the Local Universe**

*Olivia Jo Dickinson¹, J. Ribaudo¹, M. Haynes², R. Koopmann³, APPSS Team, Undergraduate ALFALFA Team, ALFALFA Team*

¹Providence College, ²Cornell University, ³Union College

---

**Abstract**

The Pisces-Perseus Supercluster is one of the most massive and cosmologically significant structures in the local universe. The *Arecibo Pisces-Perseus Supercluster Survey (APPSS)* will provide observational constraints as to the mass-infall rate onto the main filament of the Supercluster through a detailed analysis of the mass and motion of galaxies within and around the cluster. The APPSS galaxy sample consists of over 2,000 galaxies detected during the ALFALFA survey (a blind, HI 21-cm emission line survey of the local universe) combined with galaxies identified through our recent targeted observing campaign - designed to probe below the HI mass cutoff of the ALFALFA survey. These APPSS-candidates were observed using the L-band Wide receiver at the Arecibo Observatory over the last 4 years; to date the APPSS targeted observing has led to an HI 21-cm emission line detection rate of ~70% - corresponding to ~500 galaxies with cz < 9,000 km/s. Combining these new observations with the ALFALFA galaxies gives a total of ~2,500 galaxies in the current APPSS sample. Here, we describe and demonstrate the methods used by the APPSS team to reduce and analyze these targeted observations and explore the properties of the entire APPSS galaxy sample (while comparing the properties of the ALFALFA galaxies with the detections from the APPSS targeted observing campaign).

This work has been supported by NSF AST-1637339.

---

**APPSS Targeted Observations**

Figure 1 (left) is an optical image of one of the APPSS targets taken from the Sloan Digital Sky Survey (SDSS). The APPSS targeted observing campaign leveraged photometry from SDSS and the Galaxy Evolution Explorer (GALEX) telescope to identify likely HI-rich galaxies to observe with the L-band Wide (LBW) receiver at the Arecibo Observatory. The targeted observations consist of 5-minute, On/Off exposures providing significantly higher sensitivity to HI emission when compared to the blind, ~50 sec. exposures of the ALFALFA survey observations.

Figure 2 (above) shows the initial LBW spectrum of a targeted observation after minimal processing, with the observed flux density plotted as a function of frequency. The LBW observations are broken into four boards, with overlapping frequency coverage at the edges. The board in the top right shows a characteristic emission profile at ~1391 MHz, corresponding to HI in the targeted galaxy.

---

**APPSS Reduction and Analysis**

Figure 3 (above, left) and Figure 4 (above, right) show the process of normalizing the spectrum by setting the baseline. In this case, the blue indicates the region used to produce a polynomial fit that sets the baseline. Notice that only noise is included in the region to fit the baseline, the region in red is the emission line region which is avoided, along with any RFI that appears in the board.

Figure 5 (above, left) shows the selection window in red of the HI-signal to be analyzed. There are two fit options to measure the emission-line properties: gaussian or 2-horned profile. In this case, the emission feature is 2-horned in nature. From the fit shown in Figure 6 (above, right) various properties of the emission are estimated, including the velocity centroid, the width of the line, and the integrated flux density. These properties will be combined with optical observations to constrain the distance to the galaxy from the Baryonic Tully-Fisher Relation.

Figure 7 (above) shows the distribution of galaxies on the sky in the region of the PPS. The grey symbols are galaxies identified from the ALFALFA survey while the orange and blue symbols correspond to the subset of targeted APPSS observations reduced and analyzed for this project (with orange representing a non-detection, and blue representing a detection, of HI 21-cm emission). Figure 8 (below) shows the distribution of galaxies on the sky in the region of the PPS, now with the systemic velocity plotted on the vertical axis. Again the grey symbols are galaxies identified from the ALFALFA survey, while the red symbols are galaxies identified during our targeted APPSS observing campaign and the blue symbols are galaxies identified during the reduction and analysis done for this project. Note the prominent structure at ~5000 km/s – the main filament of the PPS.

---

**Up Next for APPSS**

The next phase of the APPSS project is to leverage the Baryonic Tully-Fisher Relation to estimate distances to these APPSS galaxies. For more information regarding APPSS and the next steps of the project, see the following posters:

279.04 The Arecibo Pisces-Perseus Supercluster Survey: Characteristics of the APPSS Galaxy Population, B. Montalbo
279.05 The Arecibo Pisces-Perseus Supercluster Survey: Applying the Baryonic Tully-Fisher Relation, R. Ramirez
279.11 Data Reduction Integrated Python Protocol for the Arecibo Pisces-Perseus Supercluster Survey, C. Dye
279.17 Density and Velocity Profiles for Large-scale Cosmological Filaments, T. Viscardi

---

Presented at the 234th Meeting of the American Astronomical Society
Honolulu, Hawaii, January 2020