The Possible New Local Group Member AGC 198606 (Friend of Leo T) and the Search for Optical Counterparts to ALFALFA–Detected UCHVCs

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WIYN onedegreeimager

Overview

The ALFALFA neutral hydrogen (HI) survey has detected a sample of isolated ultra-compact high velocity clouds (UCHVCs) that have HI properties similar to nearby dwarf galaxies like Leo T (at 1 Mpc, HI masses of ~10^5-10^6 M_{sun}, HI diameters of ~2-3 kpc, and dynamical masses of ~10^7-10^8 M_{sun}), but do not have optical counterparts in existing surveys. Detecting these object's stellar populations and determining their distances requires deep optical imaging.

We have begun a campaign to image 56 UCHVCs with the WIYN 3.5-m telescope and ODI camera. The UCHVC sample is shown in Figure 1. This WIYN campaign will allow us to address important questions: What fraction of the UCHVCs has a detectable stellar population? What is the minimum HI mass and density required for a galaxy to form stars? What factors (e.g., environment) influence whether stars are formed?

To date, 24 out of 56 UCHVCs have been imaged with WIYN/ODI. Here we describe our methods and present initial results.

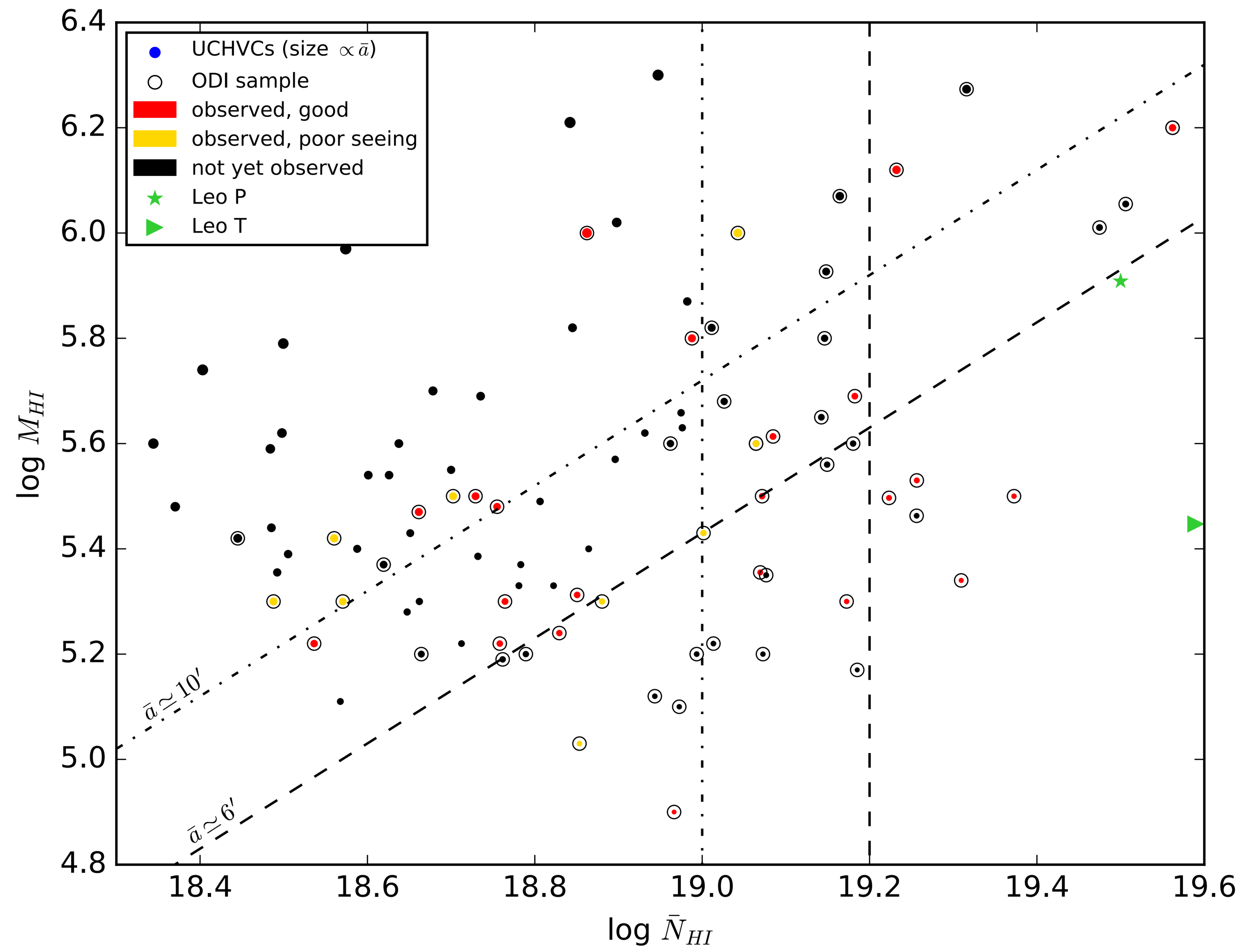

Figure 1: UCHVC Sample. HI mass and column density for the full sample (N=99) assuming 1 Mpc distance. Objects are sorted by angular size and column density and prioritized. The most compact and highest density UCHVCs comprise the sample of 56 objects for this study.

Detecting Stellar Counterparts to UCHVCs

1. Detect all point sources in deep *g* and *i* ODI images
2. Apply a CMD filter to select sources with a given age, metallicity, and distance, over a range 300 kpc - 2 Mpc
3. Smooth the distribution of filtered stars and find overdensities
4. Determine the significance of overdensities by creating random distributions with the same number of filtered stars

Leo P: A Case Study

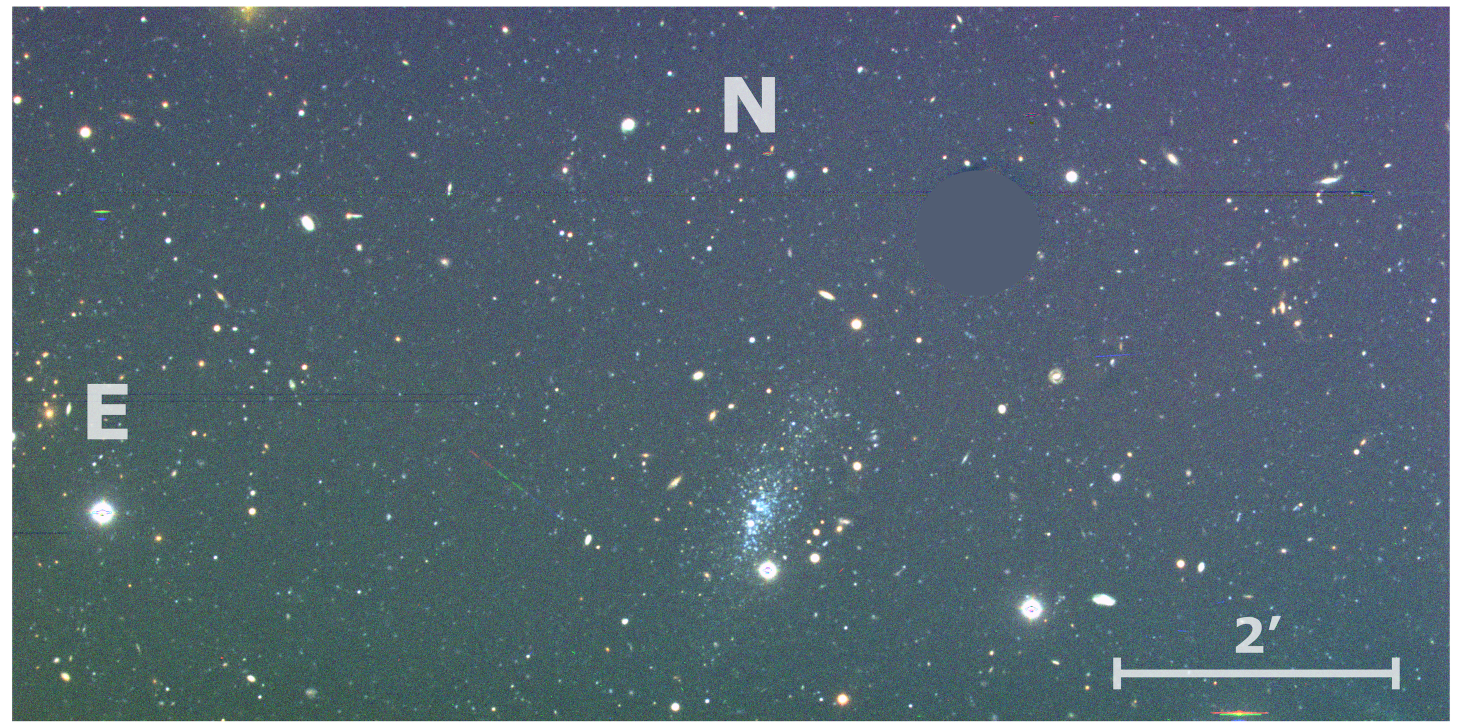

Figure 2: WIYN Minimosaic *BVR* image of Leo P (AGC208583). This nearby (1.6 Mpc) galaxy was discovered as a UCHVC by ALFALFA (Giovanelli+13) and first imaged with WIYN (Rhode+13). We converted the *BVR* photometry to *g* and *i* and used the data to test our detection method (Figure 3).

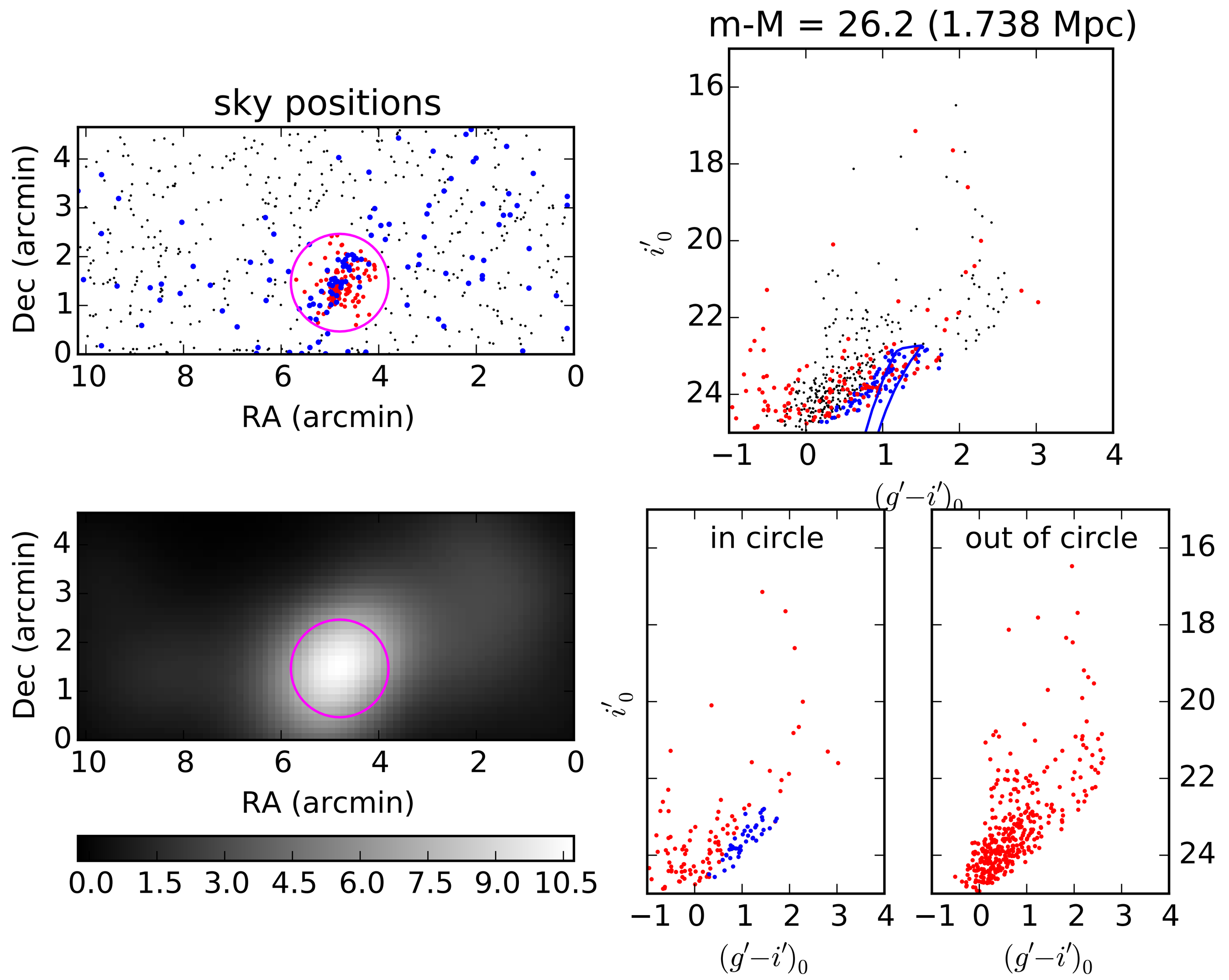

Figure 3: Leo P as a test of our detection method. We find a highly significant detection at 1.74 Mpc, which matches the distance from McQuinn et al. 2014. We select stars in the CMD filter (blue points) and place a 2' diameter circle at the peak shown in the bottom left panel. Red points are stars inside the circle but not in the filter. We also include a CMD of stars inside and outside of the circle. Monte Carlo simulations show that overdensities like this one occur randomly 0% of the time.

AGC198606: "Friend of Leo T"

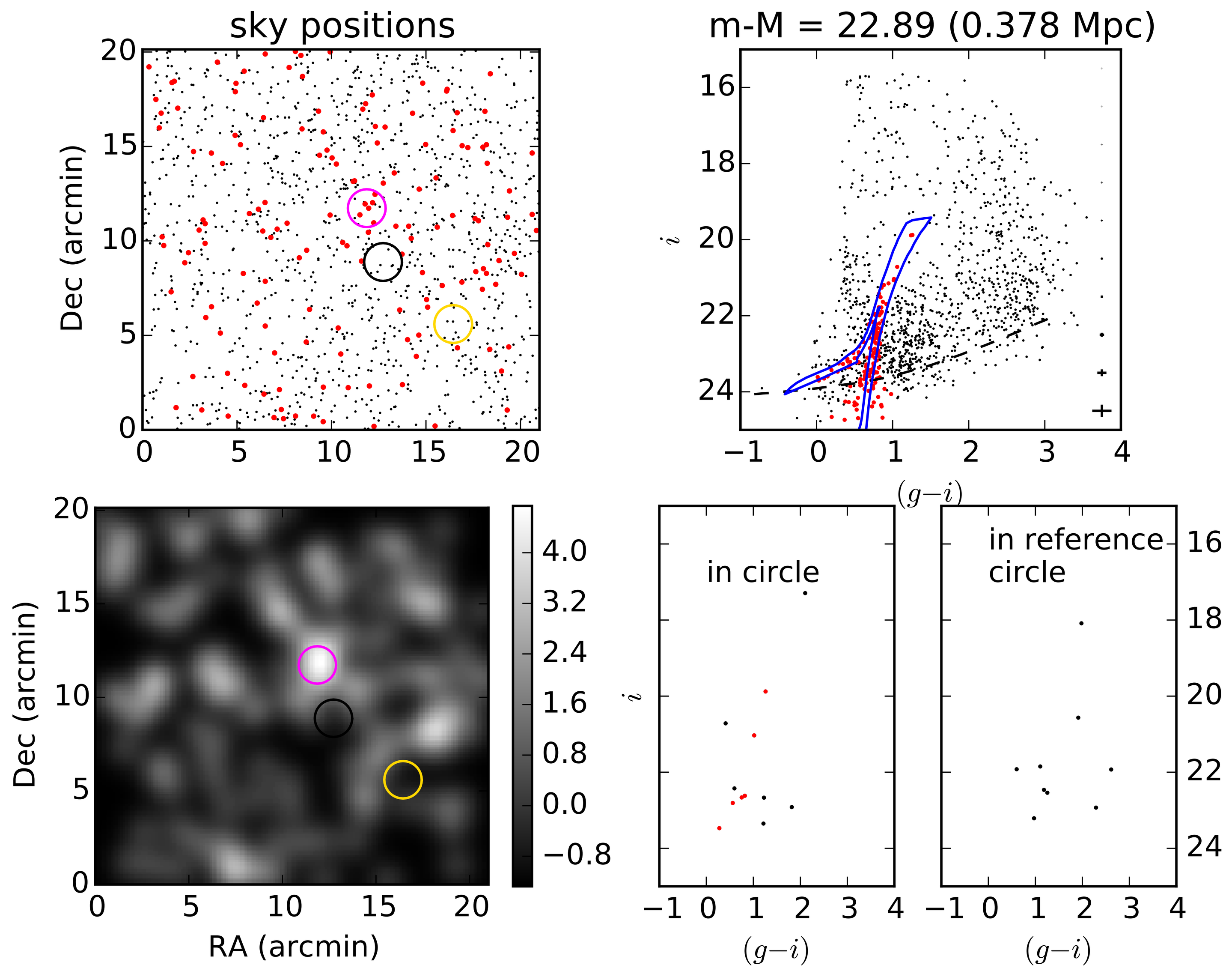

Figure 4: CMD filtering results for AGC 198606. We carried out the detection and CMD filtering process for AGC 198606, a UCHVC nicknamed “Friend of Leo T” because it is near the dwarf galaxy Leo T in sky position and velocity. **This revealed an overdensity at at a distance of ~380 kpc, only 40 kpc different from Leo T.** This overdensity is near the HI centroid of AGC198606 (Figure 6), and contains a number of stars along the red giant branch inside of a 1′ radius circle centered on the overdensity.

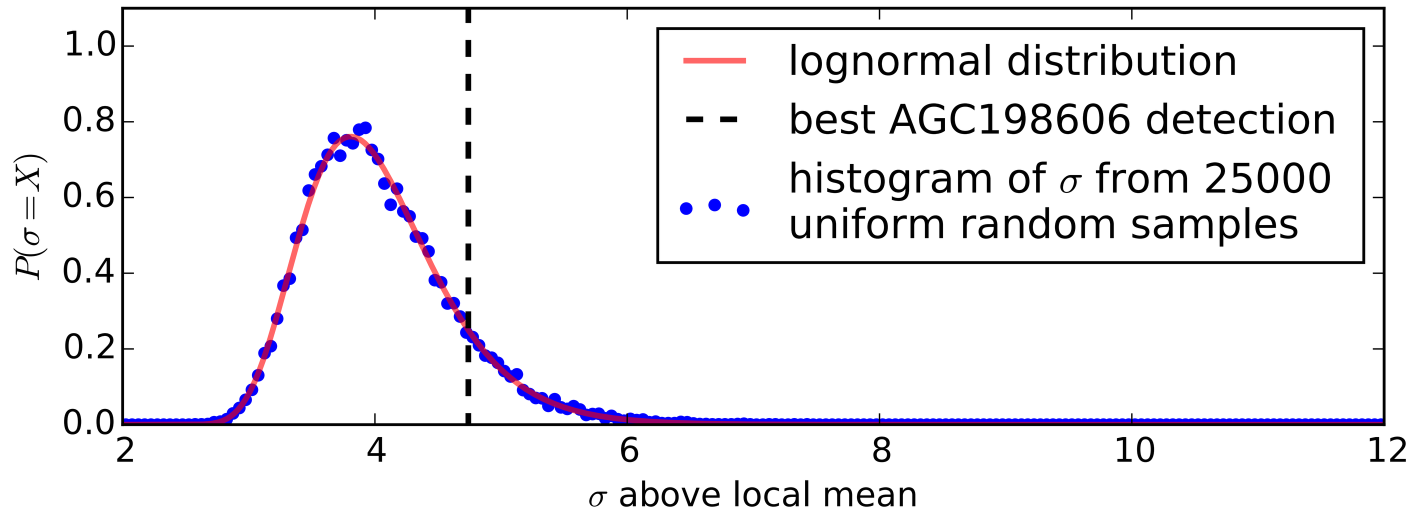

Figure 5: Significance of the AGC 198606 Detection. Monte Carlo simulations show that an overdensity like this occurs randomly 8% of the time. **Deeper imaging from the Large Binocular Telescope is undergoing analysis.**

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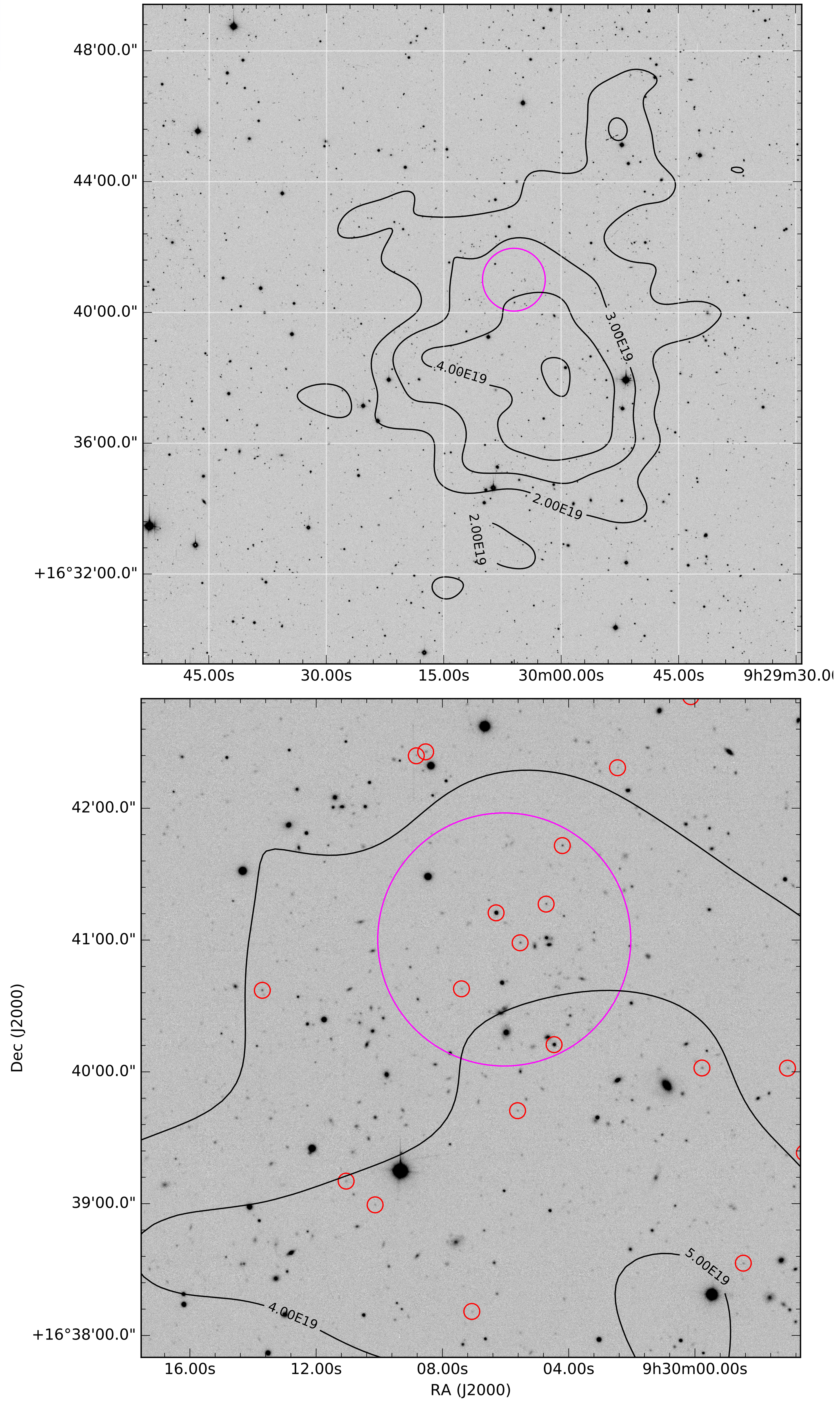

Figure 6: WIYN pODI *i* image of AGC198606. The full 20′ by 20′ image (top) and a 5′ by 5′ cutout (bottom) near the overdensity from Figure 4. Stars falling in the CMD filter are marked by red circles and the overdensity is marked with a 2′ diameter pink circle. HI contours are overlaid in black.