The GALEX Arecibo SDSS Survey (GASS)

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Abstract. The GALEX Arecibo SDSS Survey (GASS) is a large targeted survey that started at Arecibo in March 2008. GASS is designed to measure the neutral hydrogen content of $\sim$1000 massive galaxies (with stellar mass $M_*>10^{10}$ $M_\odot$) at redshift $0.025 < z < 0.05$, uniformly selected from the SDSS spectroscopic and GALEX imaging surveys. Our selected mass range straddles the recently identified "transition mass" ($M_*\sim3\times10^{10}$ $M_\odot$) above which galaxies show a marked decrease in their present to past-averaged star formation rates. GASS will produce the first statistically significant sample of massive "transition" galaxies with homogeneously measured stellar masses, star formation rates and gas properties. The analysis of this sample will allow us to investigate if and how the cold gas responds to a variety of different physical conditions in the galaxy, thus yielding insights on the physical processes responsible for the transition between blue, star-forming and red, passively evolving galaxies. GASS will be of considerably legacy value not only in isolation but also by complementing ongoing HI-selected surveys.

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INTRODUCTION

While the clear distinction between red and old ellipticals and bluer and star-forming spirals has been known for a long time, recent work has shown that galaxies appear to divide into two distinct "families" at a stellar mass $M_*\sim3\times10^{10}$ $M_\odot$ [1, 2, 3]. Lower mass galaxies typically have young stellar populations, low surface mass densities and the low concentrations characteristic of disks. On the other hand, galaxies with old stellar populations, high surface mass densities and the high concentrations typical of bulges tend to have higher mass, $M_*> 3\times10^{10}$ $M_\odot$. It is clearly important to understand why there should be a characteristic mass scale where galaxies transition from young to old. And, in order to understand how such transition takes place, it is critical to study the cold HI gas, which is the source of the material that will eventually form stars.

HI studies of transitional galaxies are currently not possible using existing HI surveys, which sample only shallow volumes: a specifically designed, targeted survey is required. The GALEX Arecibo SDSS Survey (GASS; P.I.: D. Schiminovich) is such a survey, designed to measure the neutral hydrogen content of a representative sample of massive, transitional galaxies, uniformly selected from the Sloan Digital Sky Survey (SDSS, [4]) spectroscopic data base and *Galaxy Evolution Explorer* (GALEX, [5]) imaging surveys (Fig. 1). The final data base will include optical, UV and HI parameters for $\sim$1000 galaxies with stellar mass $M_*> 10^{10}$ $M_\odot$ and gas mass fractions as low as 1.5%. Several key questions will be addressed using these data:

– What fraction of massive galaxies possess reservoirs of cold gas but no active star formation (SF)? Is this population distinguished by its environment, presence of an

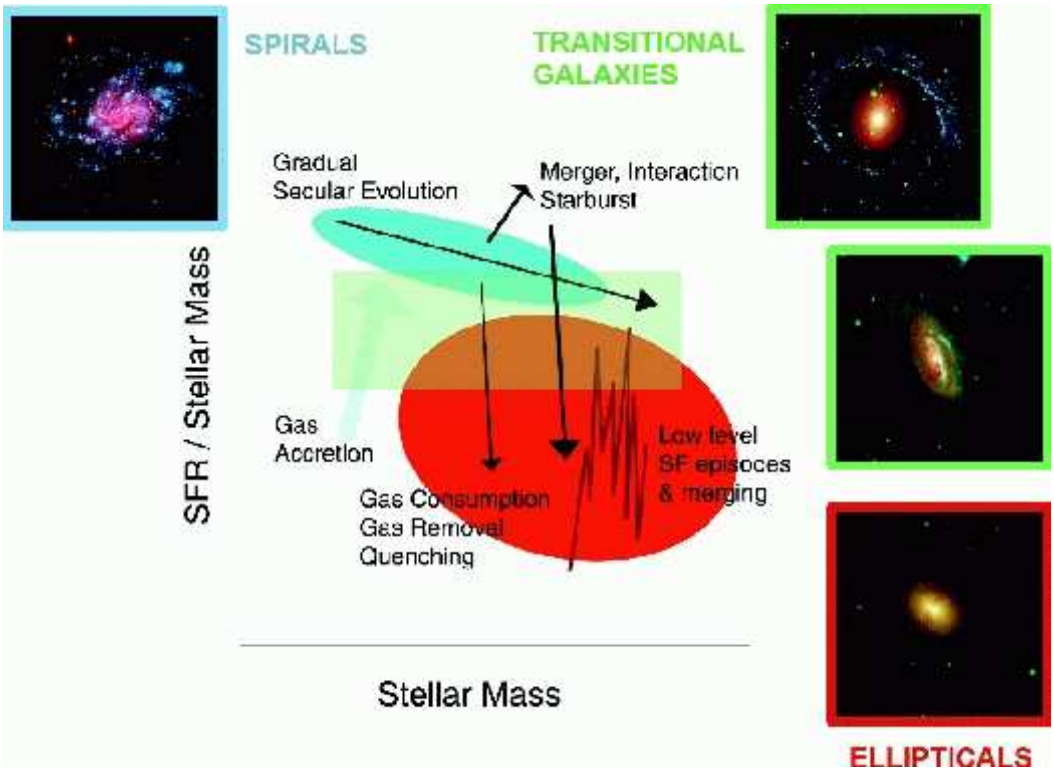

FIGURE 1. Schematic view of star formation history vs. stellar mass, adapted from [6]. GASS will shed light on the physical processes responsible for the transition between blue, star-forming galaxies and red sequence.

active galactic nucleus (AGN) and/or morphology? What implications does this have for the gas accretion history of the galaxies and SF thresholds?
– Which populations are gas deficient (at fixed M_* and/or fixed SF rate) with respect to the complete sample? Can we identify a quenching process, starvation or gas removal process that can explain this deficiency?
We seek to answer these questions by performing an unbiased survey, targeting galaxies in the SDSS spectroscopic sample selected only by their redshift and stellar mass.

SAMPLE SELECTION

The selection criteria for the GASS targets are the following:
(1) Location within the intersection of the footprints of the SDSS DR6 primary spectroscopic survey, the GALEX Medium Imaging Survey (MIS) and the Arecibo Legacy Fast ALFA (ALFALFA; [7]) survey. ALFALFA is an ongoing, blind HI survey of the extragalactic sky visible from Arecibo. Existing ALFALFA coverage greatly increases our survey efficiency – the gas-richest GASS targets (roughly 20% of the sample) will be already detected by the shallow ALFALFA observations.
(2) Redshift $0.025 < z < 0.05$
(3) Stellar mass $10.0 < \log(M_*/M_\odot) < 11.5$.

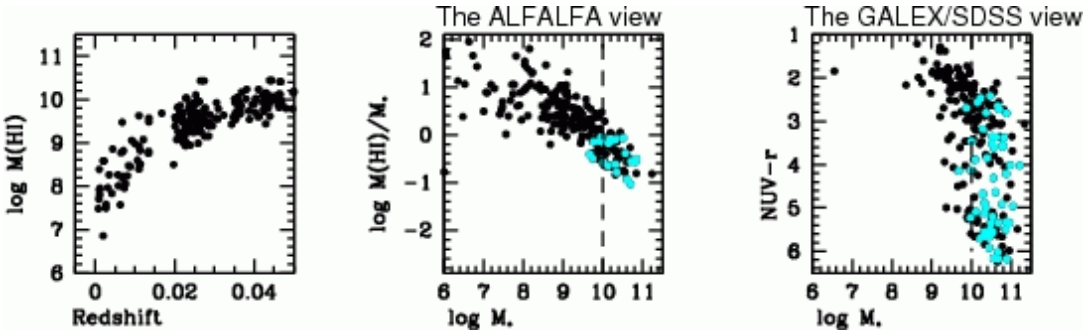

FIGURE 2. Left: HI mass vs. redshift for a sample of 227 galaxies from ALFALFA with matches in the SDSS spectroscopic sample. Center: HI gas mass fraction vs. stellar mass. Right: Properties of a random sample of 227 galaxies from GALEX/MIS with matches in SDSS and $0.01 < z < 0.05$. Cyan points denote AGN. Dashed line: GASS stellar mass limit.

The targets will be observed until either a gas fraction limit $f_{\rm gas} \equiv {\rm M_{HI}}/{\rm M_*} = 1.5\%$ or a minimum HI mass of $10^{8.5}$ $\rm M_\odot$ is reached.

As Fig. 2 shows, a complete sample of galaxies with $\rm M_* > 10^{10}$ $\rm M_\odot$ spans a very wide range in NUV/optical colors. The spread is much more dramatic than that seen in optical colors alone. Galaxies with NUV$-r < 3$ are typically star-forming spirals and are likely to have reasonably high gas fractions. Passive ellipticals have redder colors, typically NUV$-r > 5$. The intermediate color regime, where the transitional galaxies are found, is consistent with ongoing SF rate at a level of a few percent of $\rm M_*$ over the past Gyr and moderate gas fractions (1$-$10%). Over this $\rm M_*$ regime, ALFALFA detects only systems with $f_{\rm gas} > 10\%$. Thus it is clear that, in order to systematically quantify the HI properties of these objects, a significantly deeper, targeted HI survey is required.

GASS DATA

GASS will deliver catalogs of HI and value-added properties which will be used as the basis for a large number of studies. The HI spectral data products will be incorporated into the Cornell-NAIC Extragalactic HI Digital Archive (*http://arecibo.tc.cornell.edu/hiarchive*), a registered US National Virtual Observatory node that contains the ALFALFA data releases as well as other HI data sets. More details, including the current status of the survey and the list of team members, can be found on the GASS web site (*http://www.mpa-garching.mpg.de/GASS*).

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