The gas content of galaxies in filaments around the Virgo cluster

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Introduction

Galaxy evolution depends on the environment in which galaxies are located. The various physical processes (e.g., ram-pressure stripping, tidal interactions, etc.) able to affect the gas content in galaxies have different efficiency in the different environments. Here we examine the gas (atomic HI and molecular H_2) content of local galaxies inside and outside clusters, groups, filaments, and in isolation using a combination of observational and simulated data.

HI and H_2-deficiency of galaxies in different environments

- **C22** — observational data from Castignani et. al 2022b catalogue for ~7000 of galaxies around the Virgo cluster across all the environments
- **GAEA-mock** — mock data catalog of galaxies around Virgo-like clusters in GAEA semi-analytical model (De Lucia et. al 2024)
- **GAEA-all** — all galaxies around Virgo-like clusters in GAEA semi-analytical model

$$H_{x,\text{def}} = \log[M_x^{\text{EXP}}/M_\odot] - \log[M_x^{\text{MES}}/M_\odot], \quad (1)$$

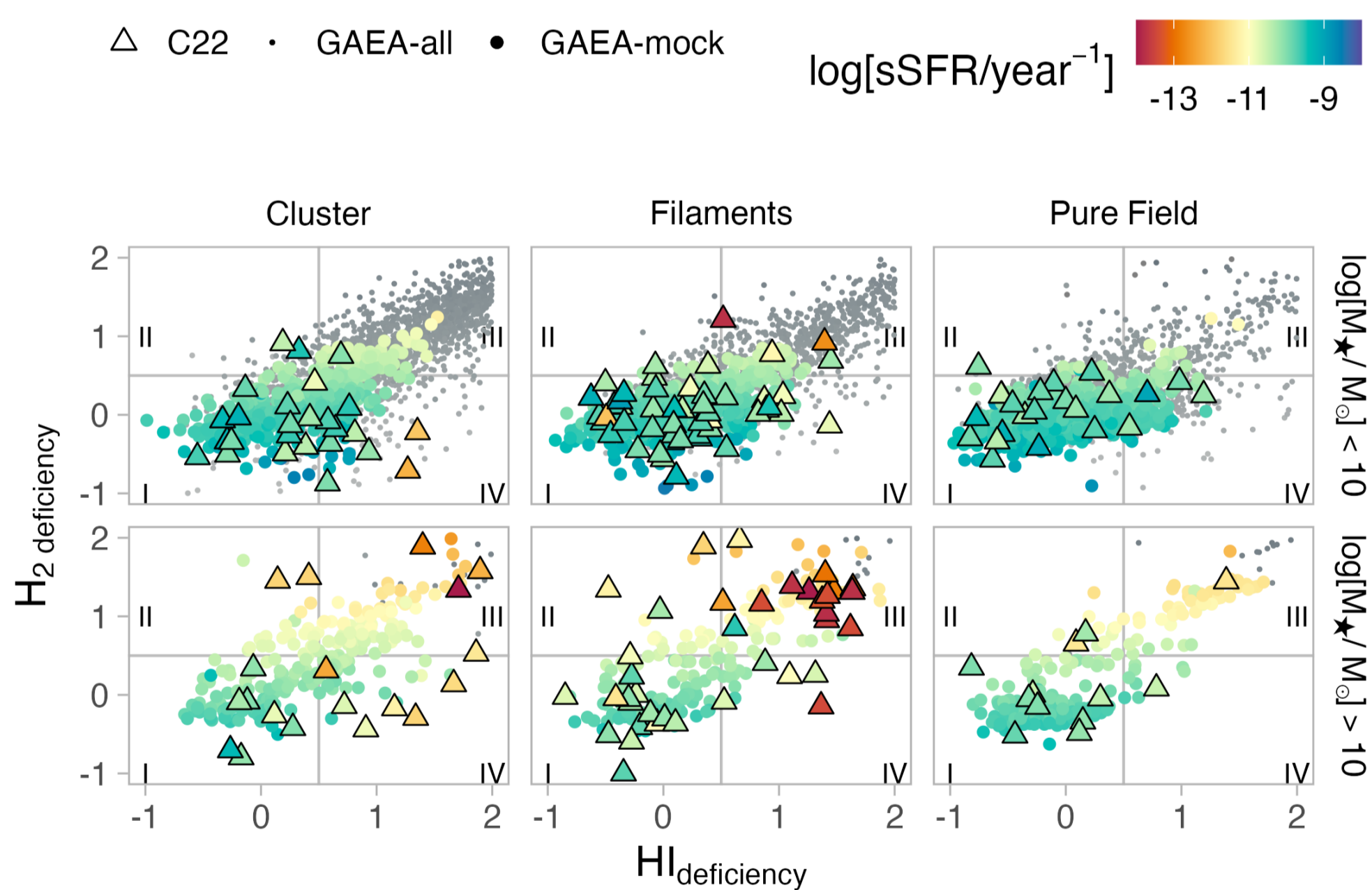*Figure 1: $H_{2,\text{def}}$-HI_{def} relations for low-mass (top) and massive (bottom) galaxies in different environments. GAEA-mock data is represented by big circles, GAEA-all by small circles, and C22 data by triangles. Each point of GAEA-mock/C22 is colored by sSFR. The vertical and horizontal lines show 0.5 dex deficiency levels used to separate gas normal from gas deficient galaxies.*

- We recover a clear correlation between HI and H_2-deficiency for galaxies of all stellar mass across all the environments
- Low-mass galaxies are mostly both HI and H_2 normal and star-forming

- Massive galaxies are either both HI- and H_2-normal or both HI and H_2-deficient (compliment with low specific star-formation rate)
- Cluster members have a higest fraction of HI and H_2-deficient population, while pure field galaxies have lowest.
- Filament members demonstrate intermediate gas properties between cluster and pure field in the observations and model.

The role of the filaments

We investigated whether the filaments have an impact on the galaxies within haloes of fixed mass.
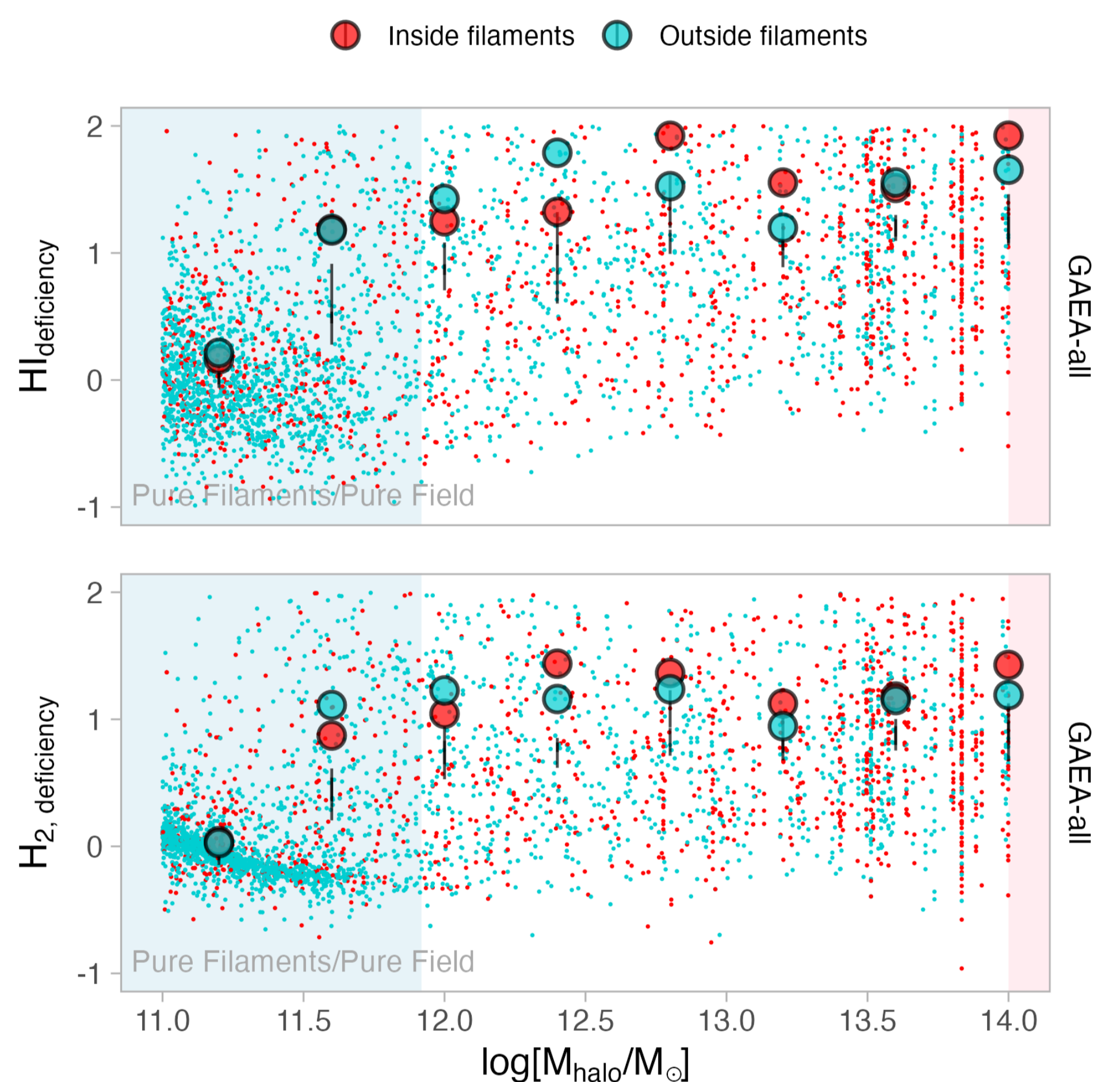

Figure 2: HI- (top) and H_2-deficiency as a function of the host halo mass M_{halo} in GAEA-all. Color coding reflects the position concerning filaments: inside or outside.

- The median HI- or H_2-deficiency for a given M_{halo} is the same within errors for galaxies inside and outside filaments (neither for isolated galaxies with low-mass haloes, nor for groups with massive halo)
- The median HI-deficiency and H_2-deficiency monotonously increase with the increasing host halo mass.

Additional note

We do not exclude the role of filaments in the gaseous evolution of galaxies, but we expect it to be a second order effect.