Comparing APERTIF HI statistics with baryonic scaling relations in the Local Universe

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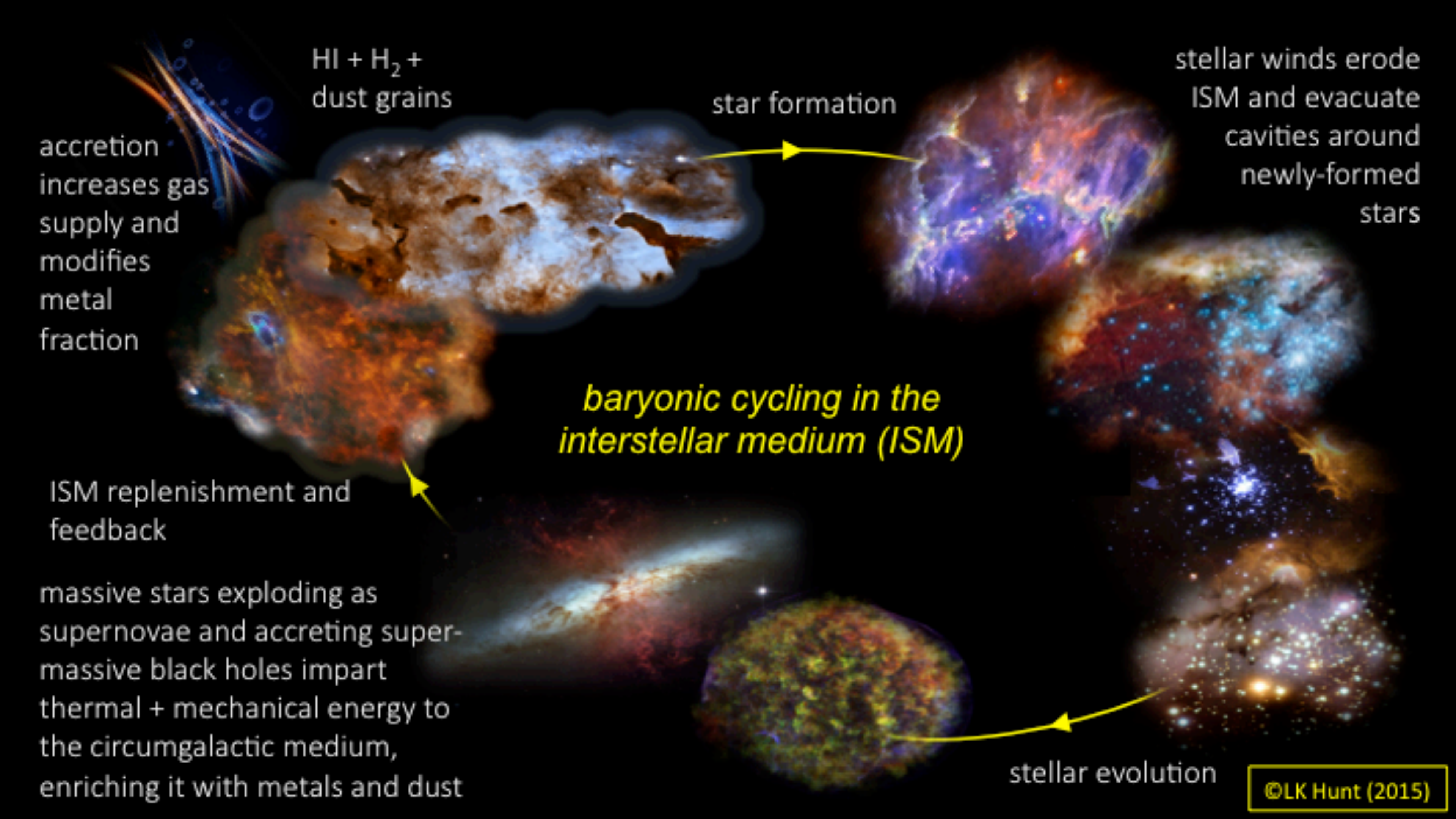
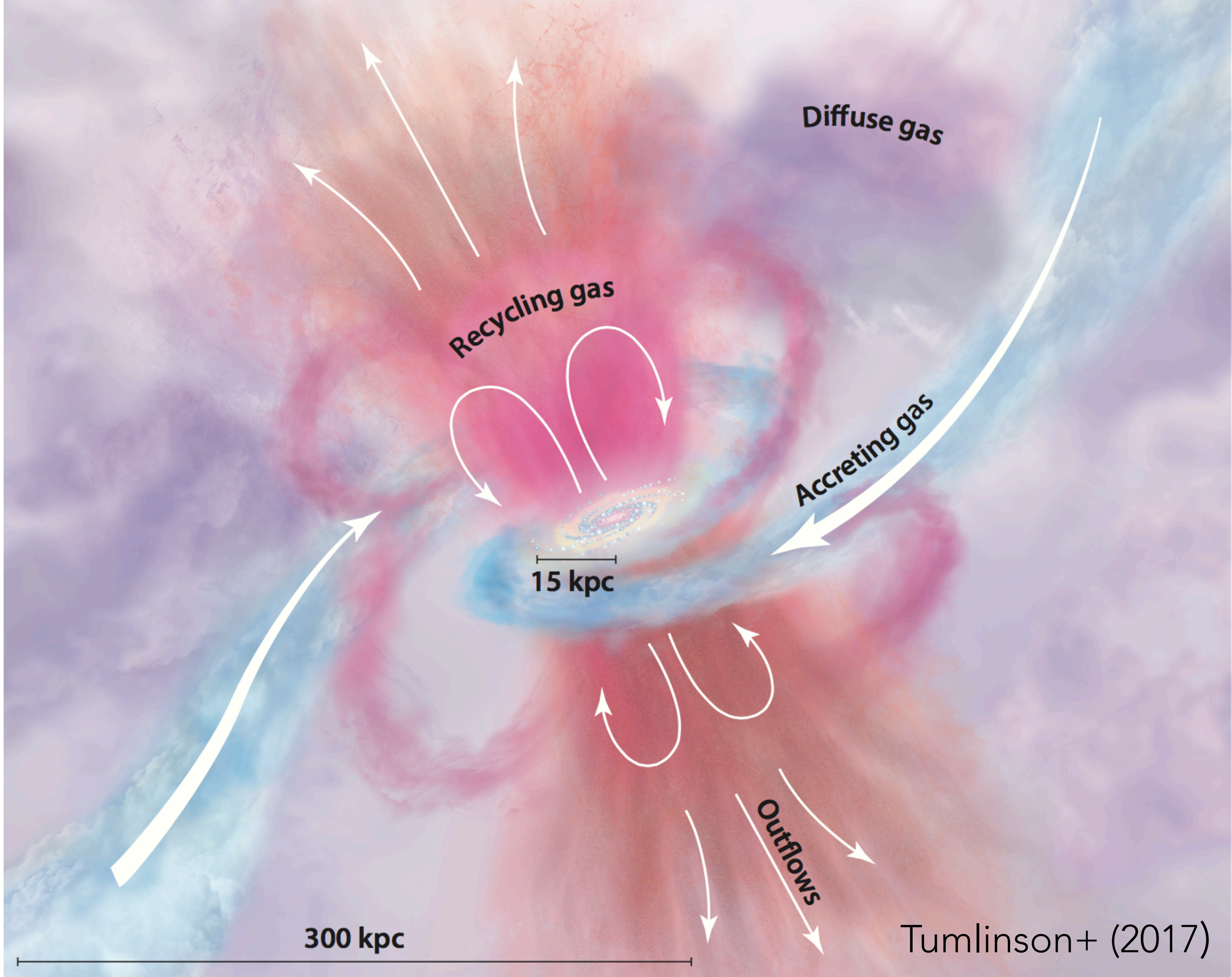
(* APERTIF external collaborators)

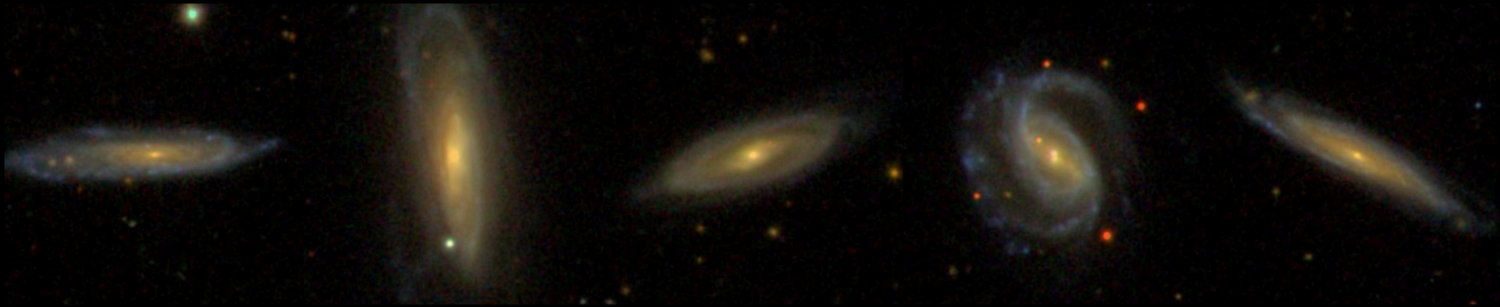

HI + H_2 +
dust grains
star formation
stellar winds erode
ISM and evacuate
cavities around
newly-formed
stars
accretion
increases gas
supply and
modifies
metal
fraction
baryonic cycling in the
interstellar medium (ISM)
ISM replenishment and
feedback
massive stars exploding as
supernovae and accreting super-
massive black holes impart
thermal + mechanical energy to
the circumgalactic medium,
enriching it with metals and dust
stellar evolution
©LK Hunt (2015)

Atomic gas HI is arguably the most important constituent of the ISM for galaxy evolution; it is being accreted onto galaxies from the Intergalactic Galactic Medium and provides the gas reservoir for star formation through conversion to H_2



Tumlinson+ (2017)

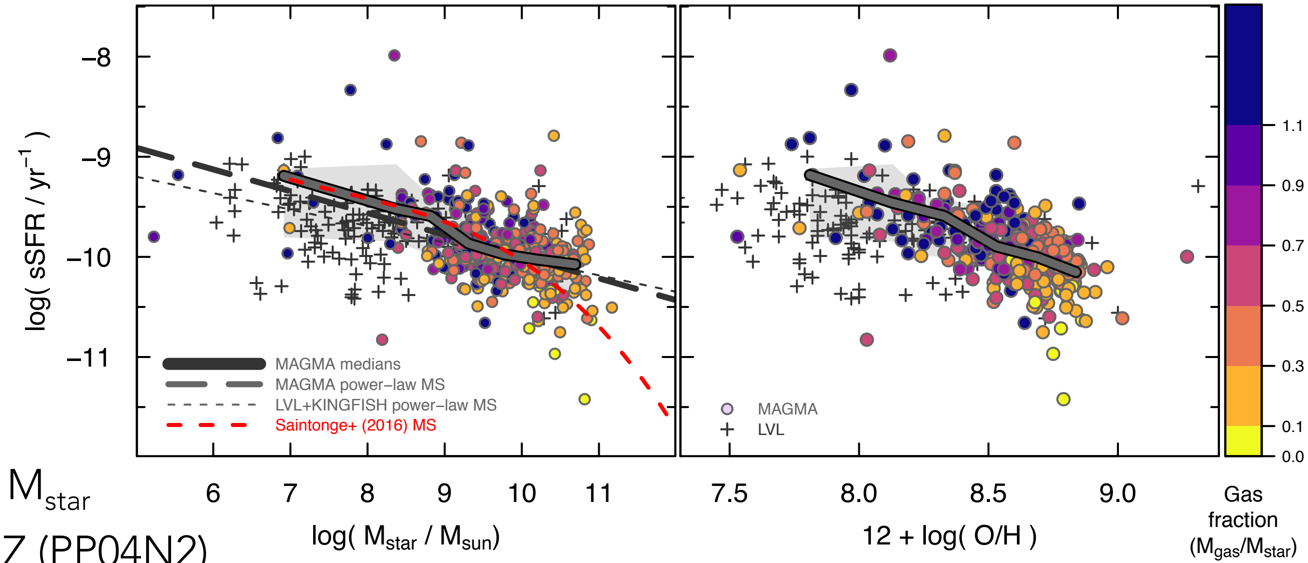
Estimating HI mass in nearby galaxies with MAGMA



Local benchmark for baryonic cycling: Metallicity and Gas for Mass Assembly sample (MAGMA) at z ≈ 0

MAGMA is essentially a "main sequence" sample

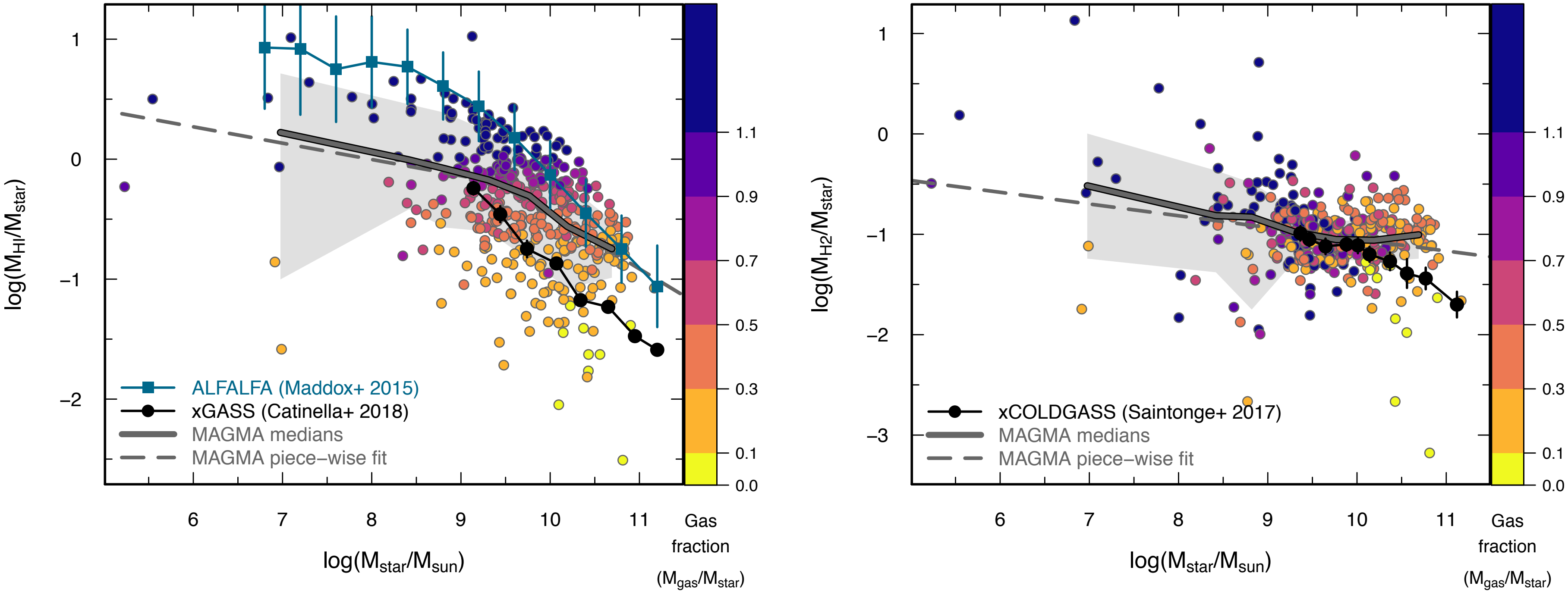
MAGMA with homogeneous HI, H_2 (from CO), O/H, M_{star}, SFR measurements for **392 galaxies** spans an unprecedented range in parameter space:



- ✓ 5 orders of magnitude in M_{star}
- ✓ factor of 60 in metallicity Z (PP04N2)
- ✓ > 4 orders of magnitude in SFR and M_{HI}, M_{H2}

Ginolfi+ (2020)

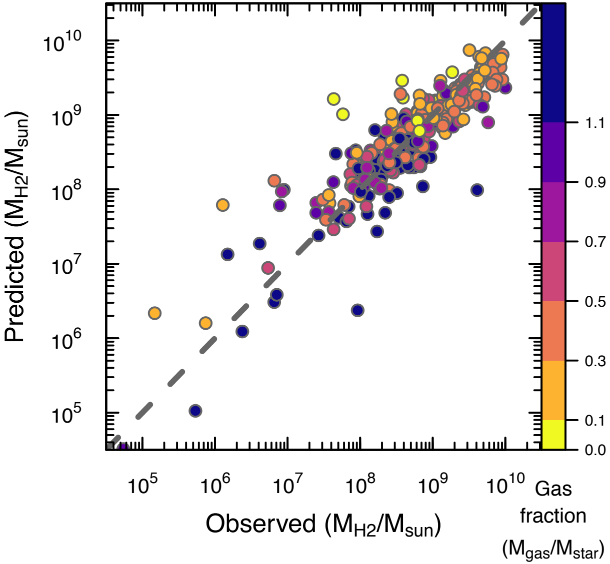
HI dominates H_2 in overall MAGMA gas mass budget but HI has more scatter

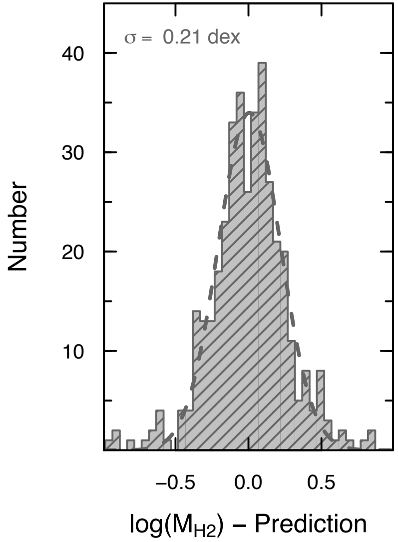


Hunt+ (2020)

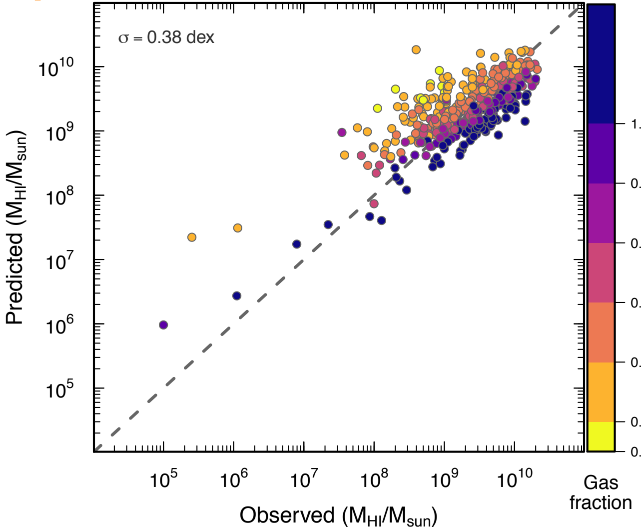
Scaling relations for H_2 with M_{star}, SFR show less scatter than those for HI

predicted H_2 mass vs observed





predicted HI mass vs observed

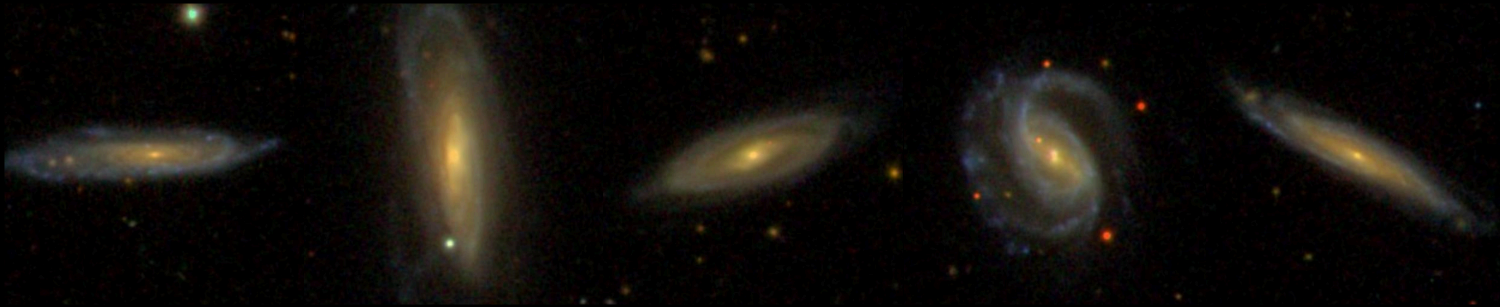


prediction: log MH_2 = (0.59 ± 0.04) log(M_{star}) + (0.35 ± 0.04) log(SFR) + (3.02 ± 0.36)

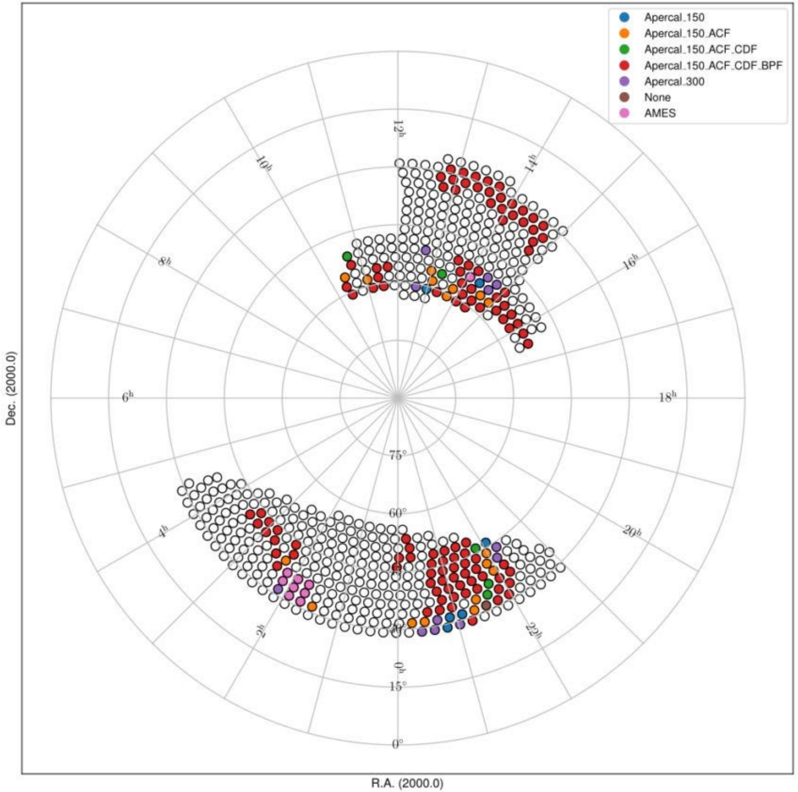
prediction: log MHI = (0.41 ± 0.06) log(M_{star}) + (0.35 ± 0.07) log(SFR) + (5.43 ± 0.59)

Hunt+ (2020)

Comparing predicted to observed HI mass with APERTIF



APERTIF blind HI survey in progress



DR1: first year of survey observations (1 July 2019 - 30 June 2020). Released observations cover just over 1000 deg^2 of sky (here ~450 deg^2).

https://www.astron.nl/telescopes/wsrt-apertif/apertif-dr1-documentation/overview/released-observations/

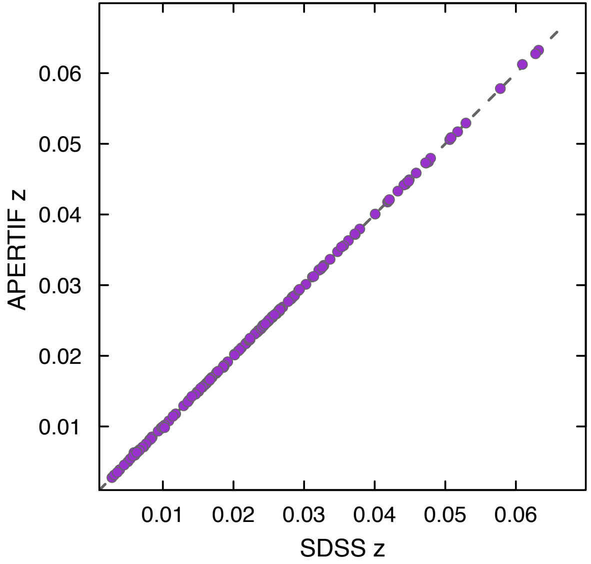
HI processed with subset of cubes using SoFiA-2 (Source Finding Application; Serra+ 2015), as described in **Hess+ (2021, in prep.)**

Preliminary matching SDSS with APERTIF HI detections

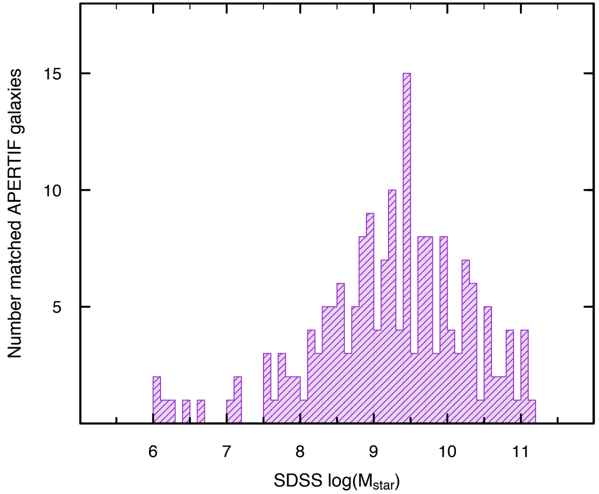
1231 HI sources identified, 179 matched with SDSS galaxies

SDSS stellar mass M_{star} from SED fitting of photometry

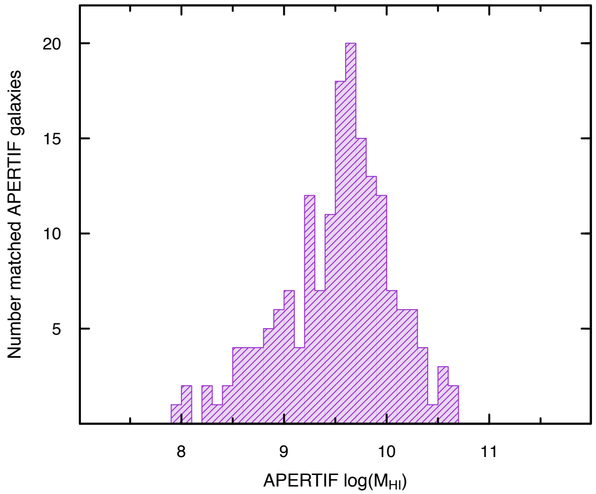
https://wwwmpa.mpa-garching.mpg.de/SDSS/DR7/



APERTIF vs SDSS redshifts



matched APERTIF stellar mass



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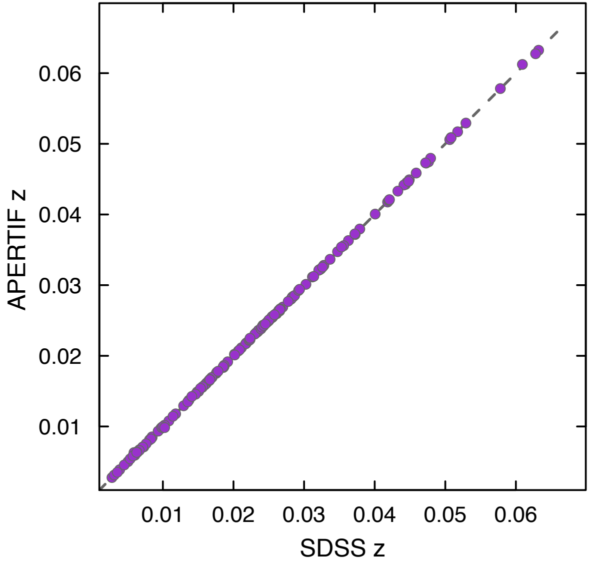

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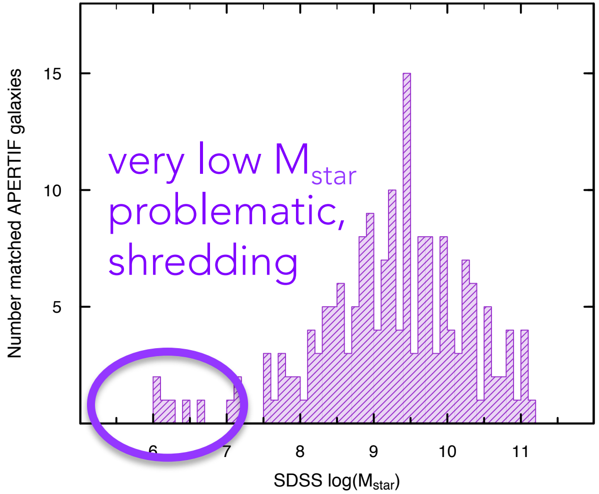

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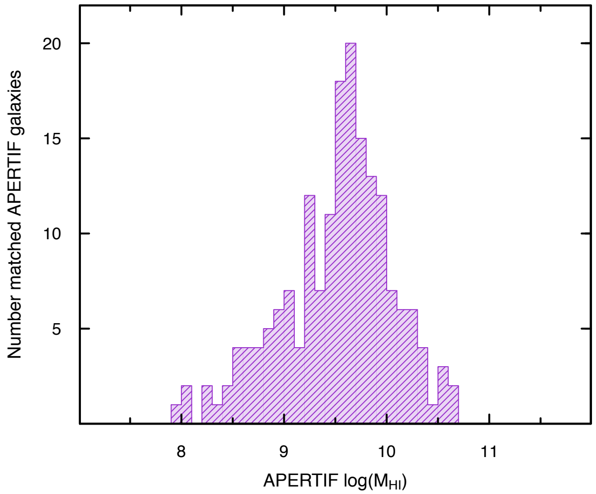
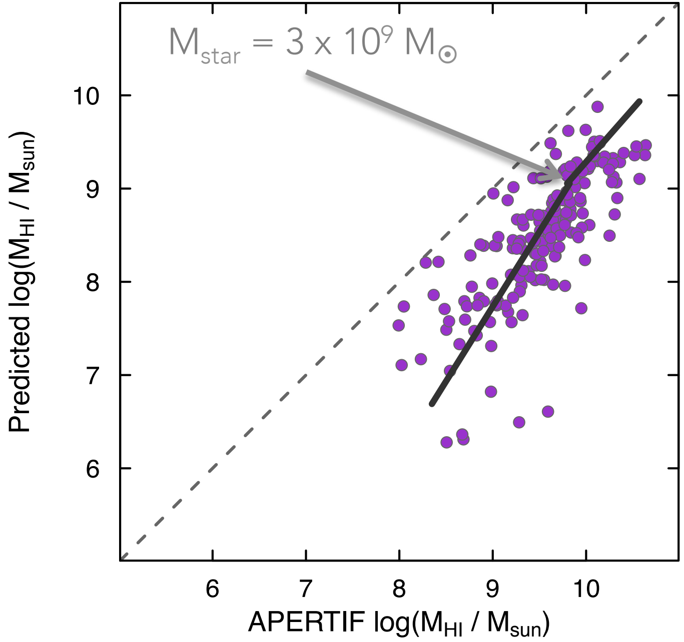
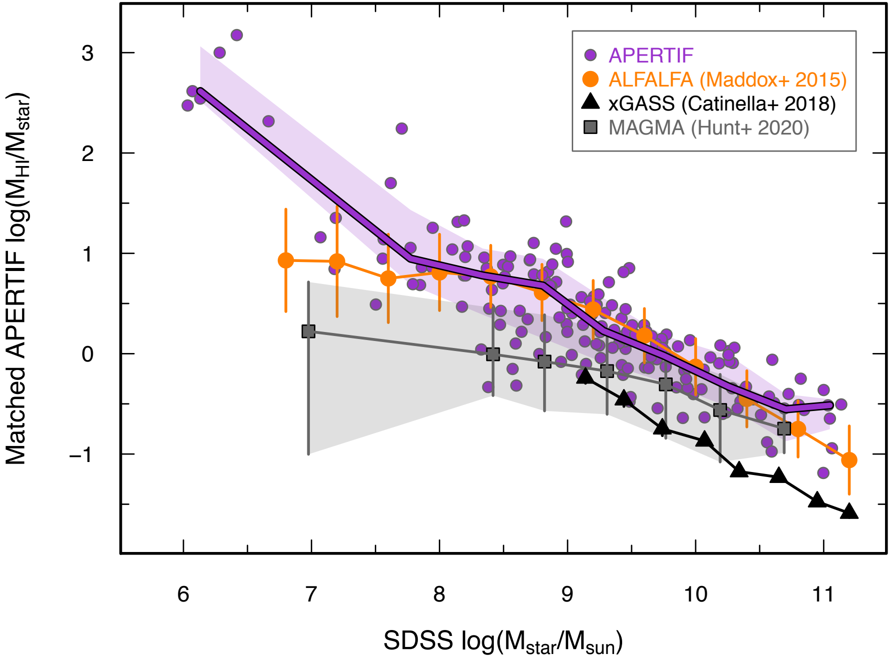


matched APERTIF HI mass

Comparing MAGMA HI predictions with APERTIF HI detections

Different HI scaling for HI-selected and mass-selected samples





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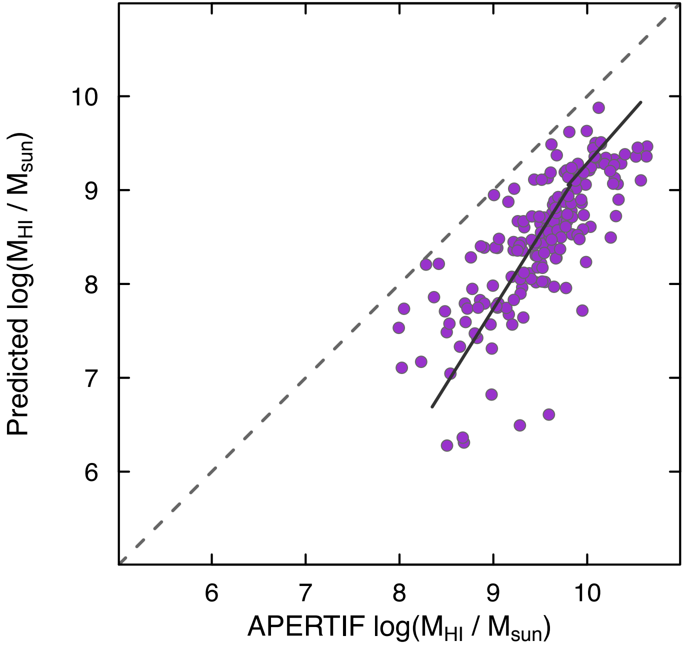
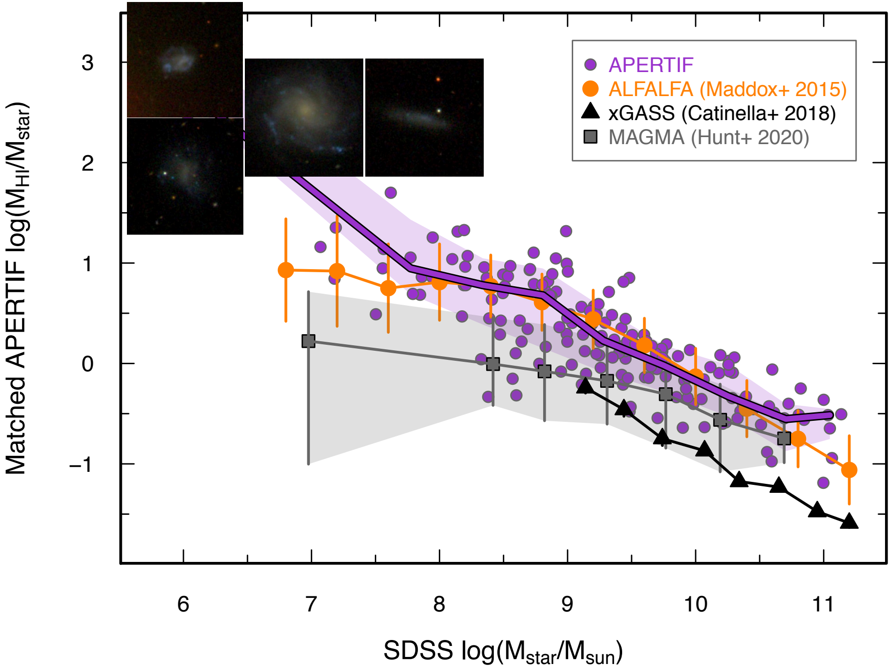
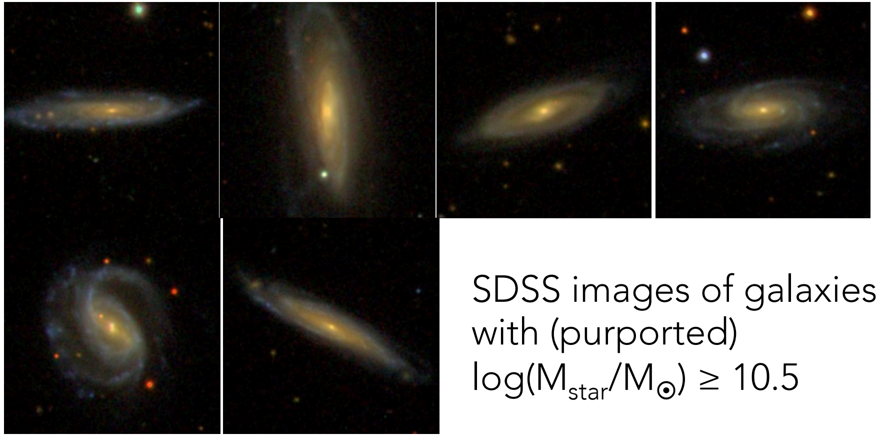


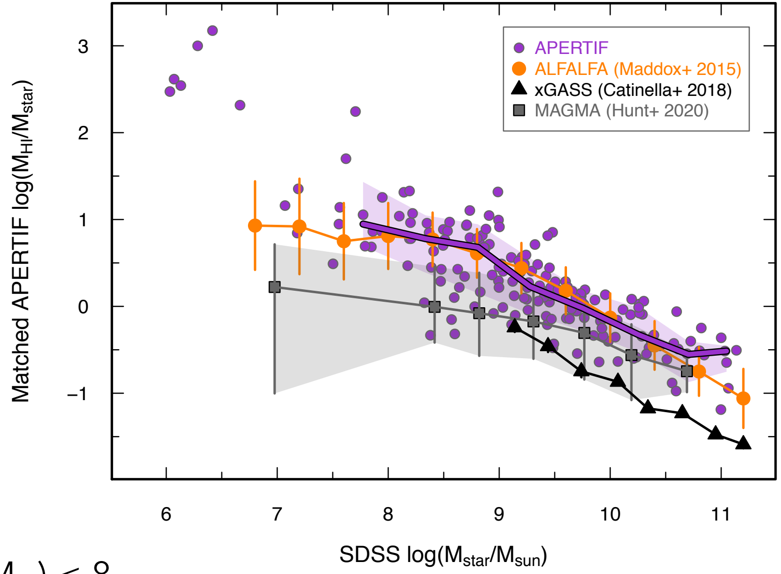
Problems with SDSS for very low-mass galaxies; bright clumps embedded in low surface brightness envelopes



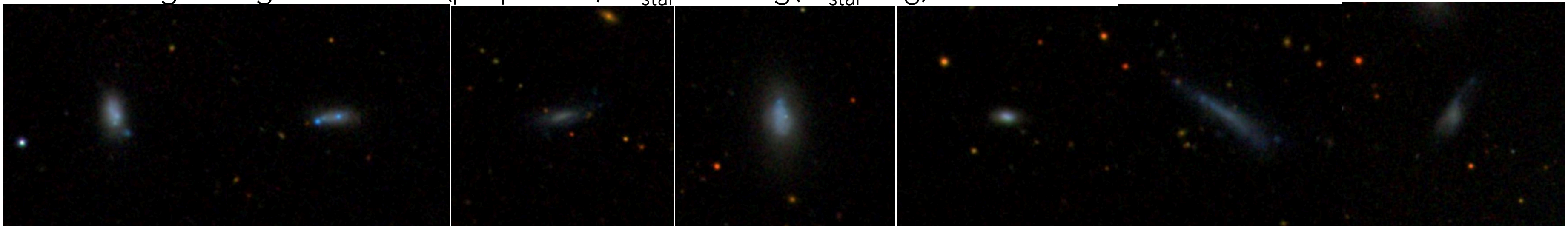
Need more reliable stellar mass estimates for accurate comparison



SDSS images of galaxies with (purported) $\log(M_{star}/M_{\odot}) \geq 10.5$



SDSS images of galaxies with (purported) M_{star}: $7 \leq \log(M_{star}/M_{\odot}) \leq 8$



Conclusions

APERTIF ongoing HI survey is functioning superbly, results statistically consistent with previous HI surveys (e.g., ALFALFA)

Comparisons between HI- and optically/mass-selected surveys show very different HI scaling relations; potential problems with SDSS at low surface brightness

Selection effects will be paramount when connecting gas content in local galaxies with high redshift