Bluedisk project: the size, morphology and radial distribution of HI in extremely HI-rich galaxies

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with
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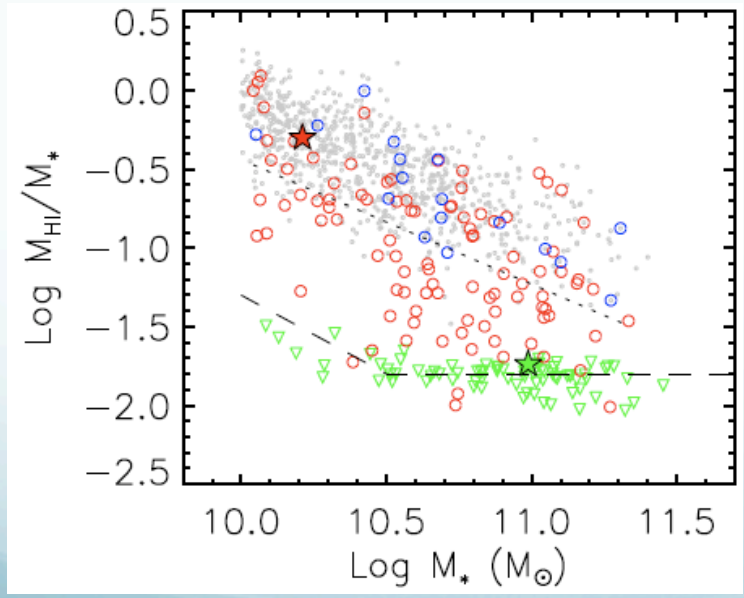
2014, ASTRON

Extremely HI-rich (massive) galaxies

Bluedisk project(PI: G. Kauffmann): 25 extremely HI-rich galaxies+ 25 control galaxies

What does extremely HI-rich mean?
SDSS DR7 spectroscopic galaxy sample:

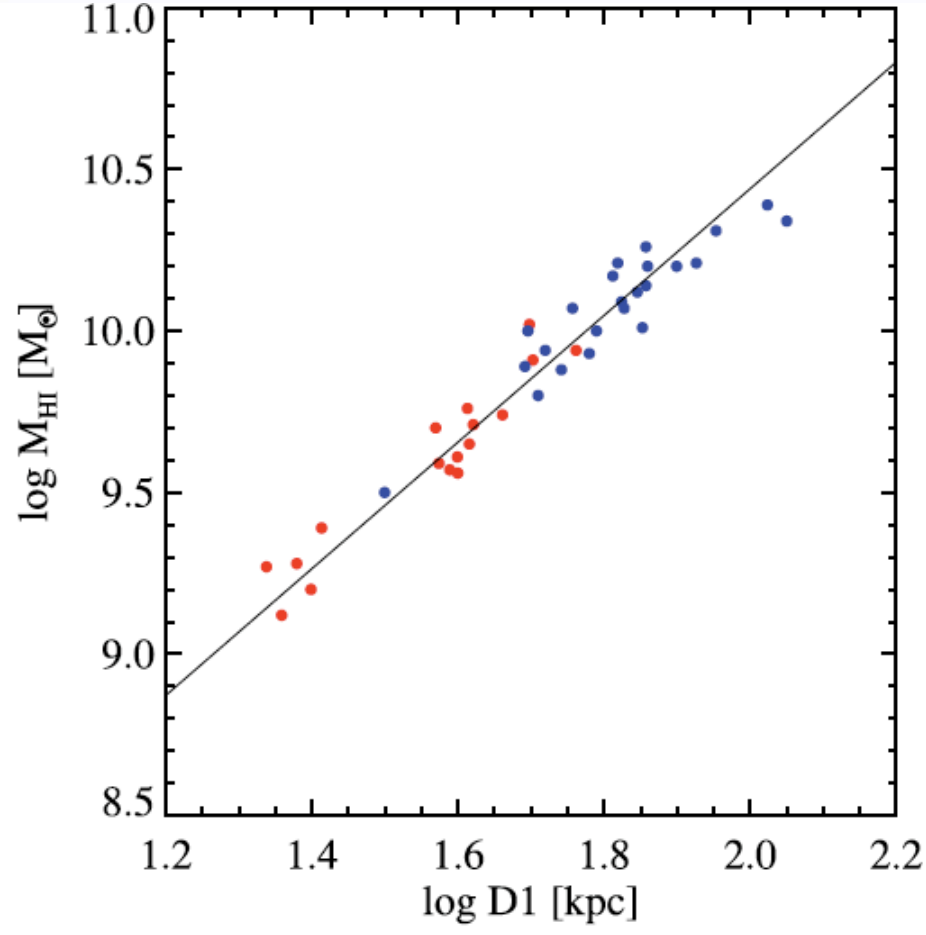
- M*>10 M_sun, 0.01<z<0.035, DEC>30 deg, : N=3437
- NUV-r<4.5 : N=1636



The M(HI)/M* vs M* relation
(GASS: Catinella + 2010)

- M(HI)/M*> 4 * [the median M(HI)/M* at the same M*] : N=123

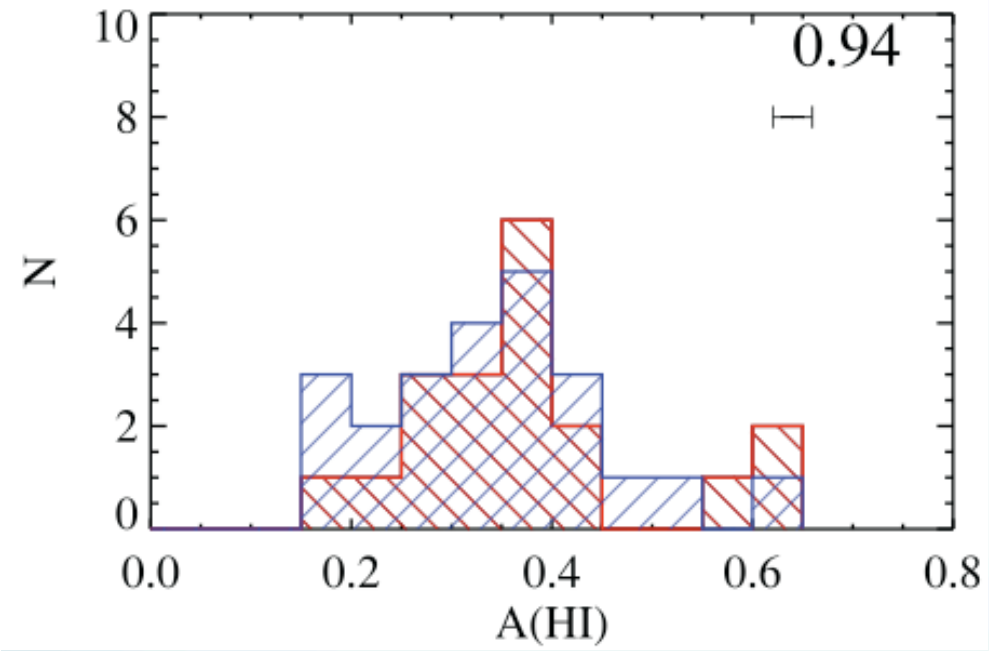
Sizes

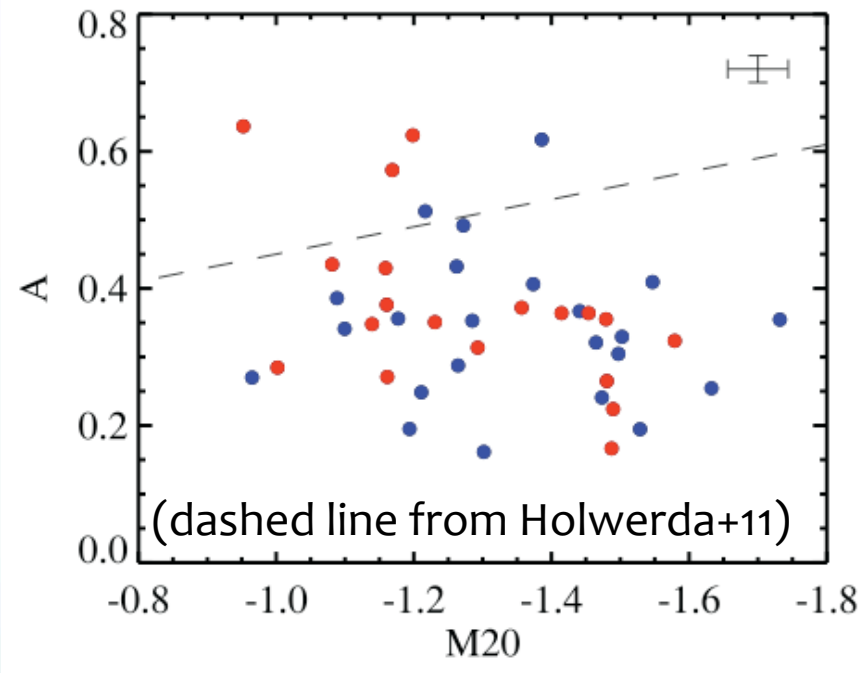


HI-rich
Control

Both samples lie perfectly on the Broeils+97 relation

Some traditional morphological parameterizing

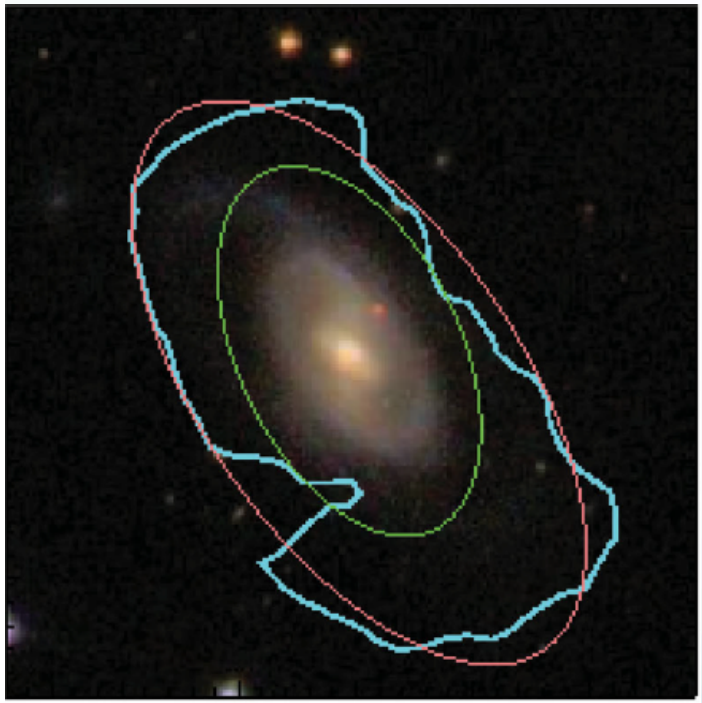


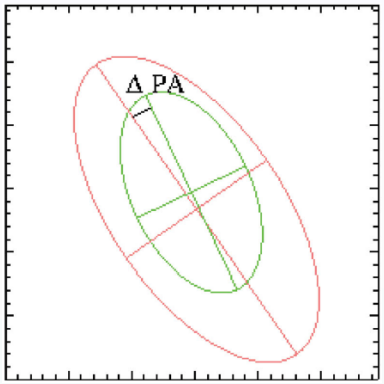


HI-rich
Control

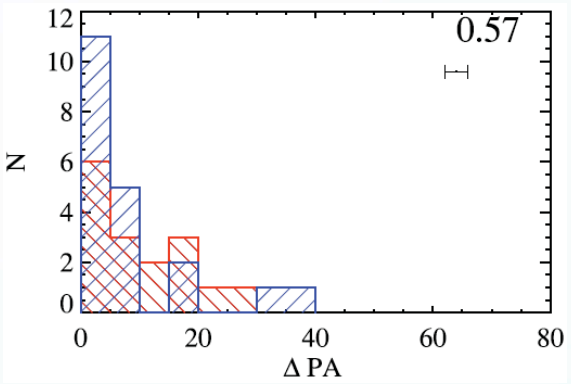
No difference

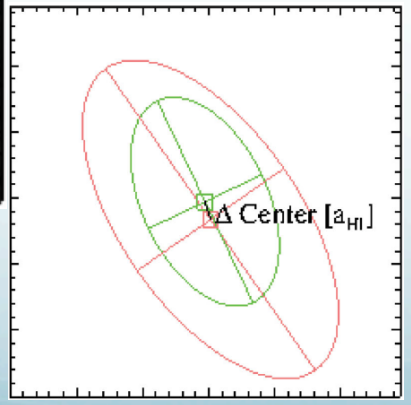
Morphologies (outer disks)



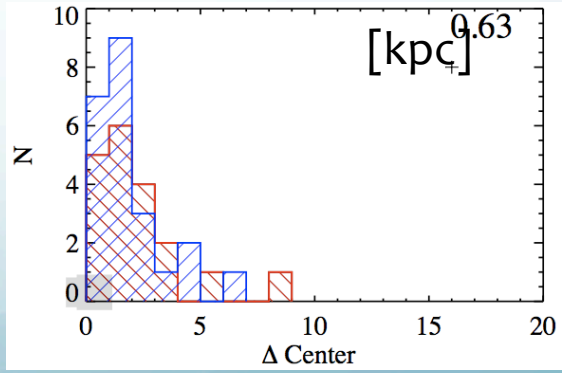


More warped?

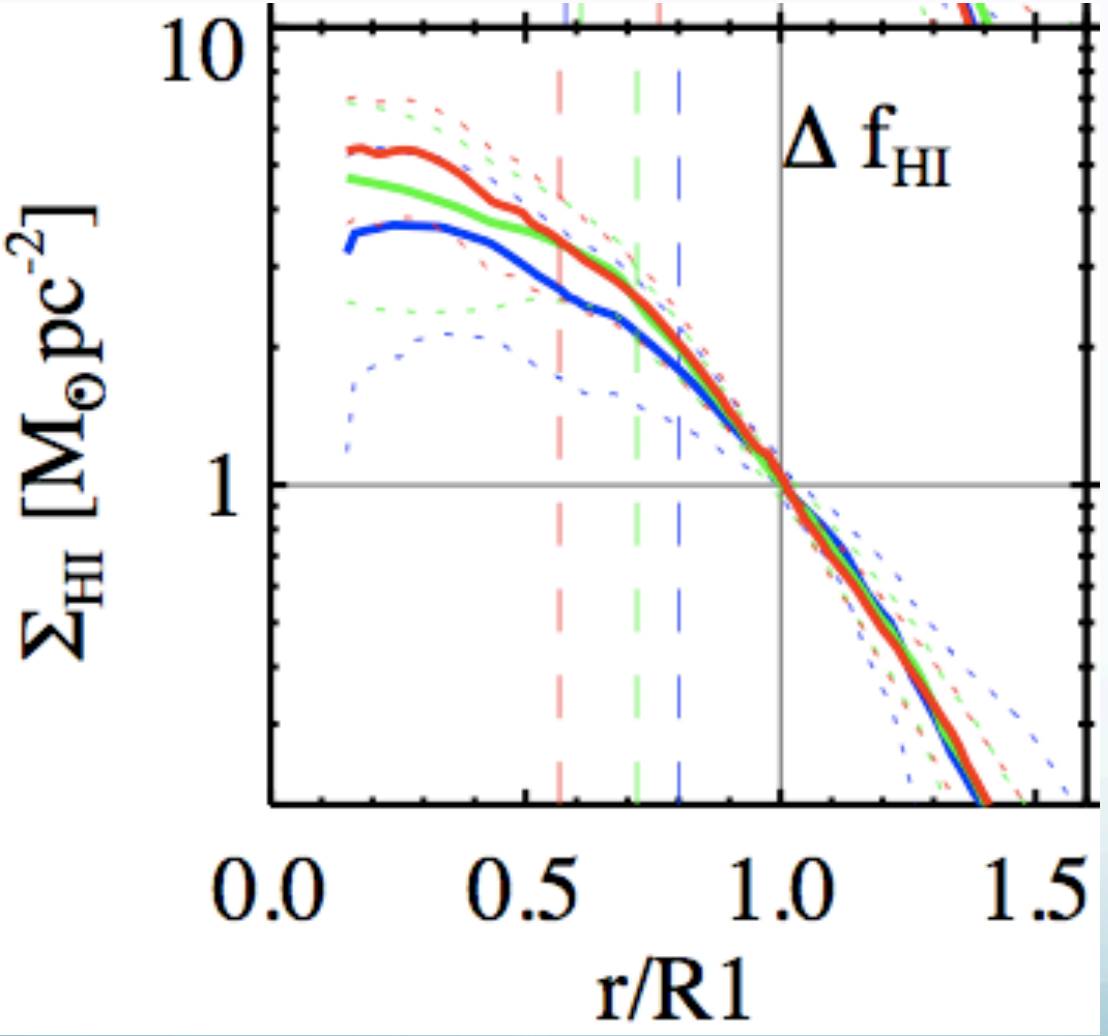




More mis-aligned?



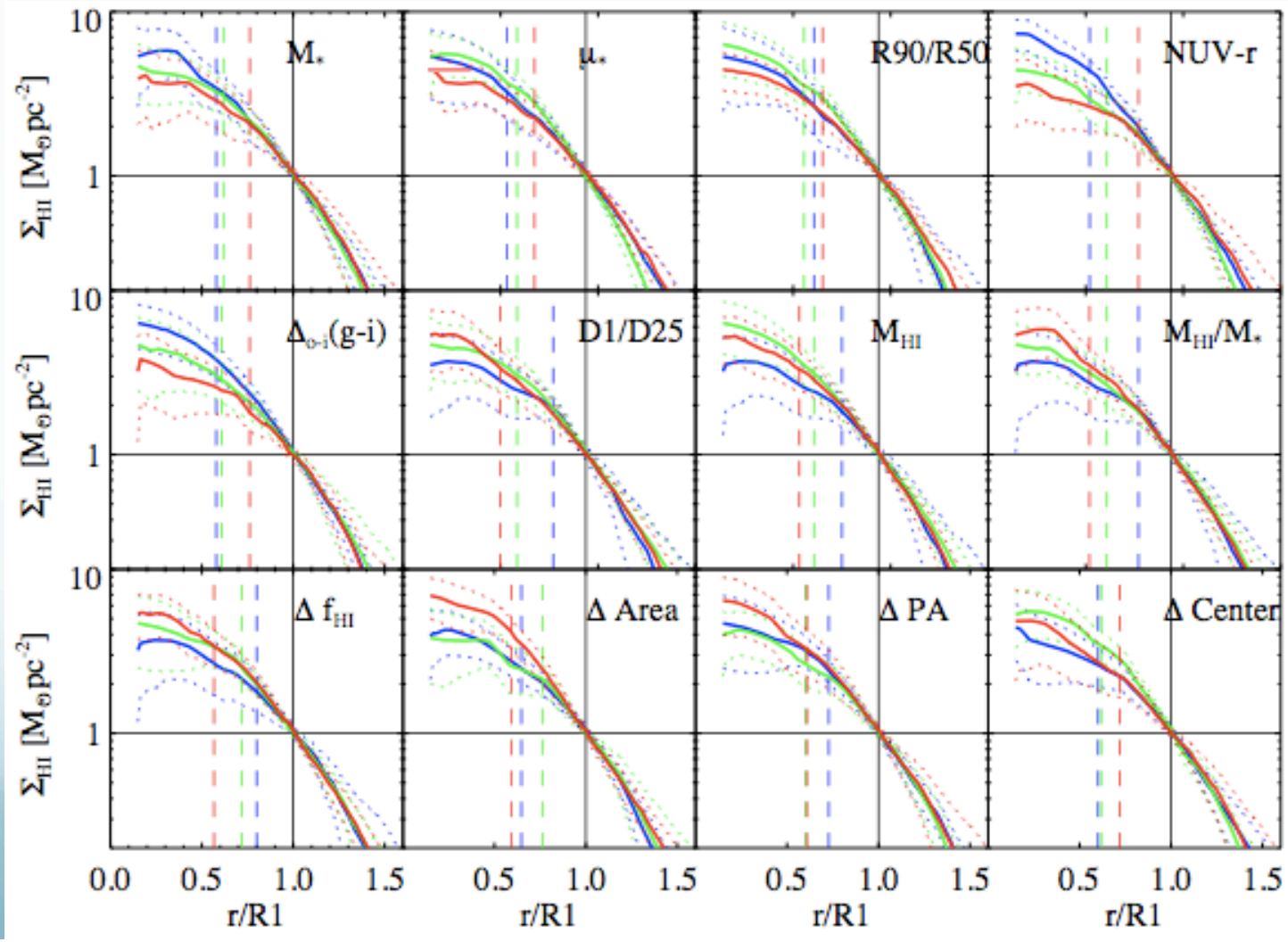
Radial distributions



High
Mediate
low

Similar profile in the outer region

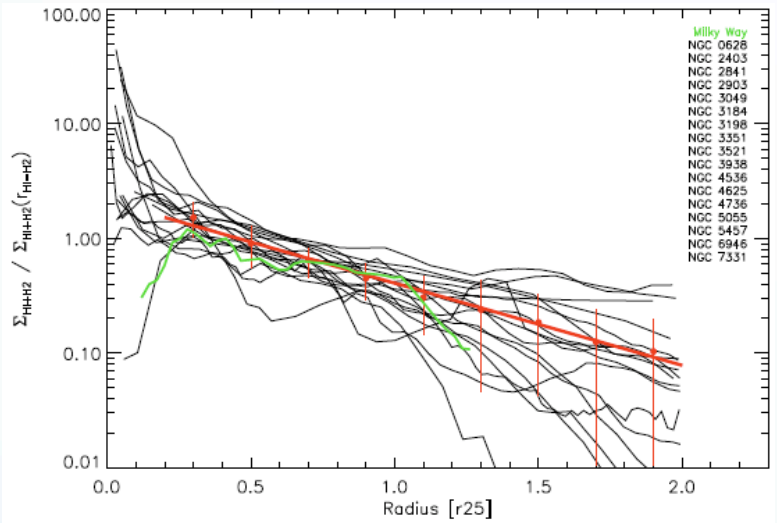
A homogeneous HI profile in the outer region



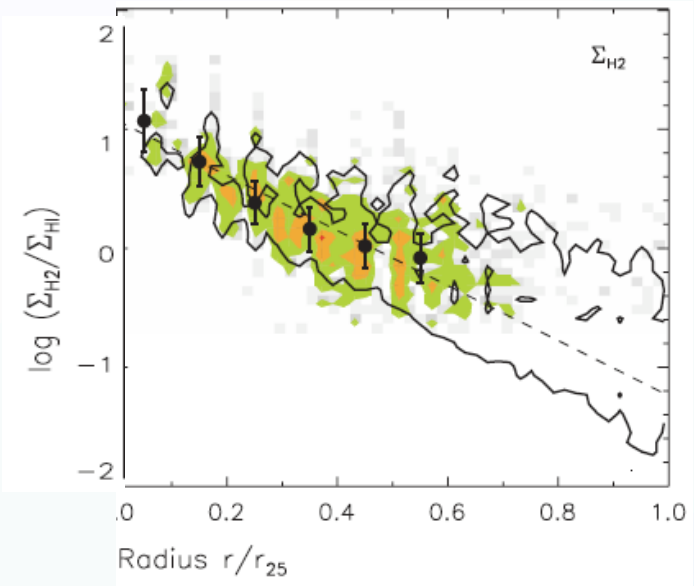
High
Mediate
low

An analytical model for Σ_{HI}

What we learn from high resolution data (THINGS):



The total gas (Bigiel et al.2012)



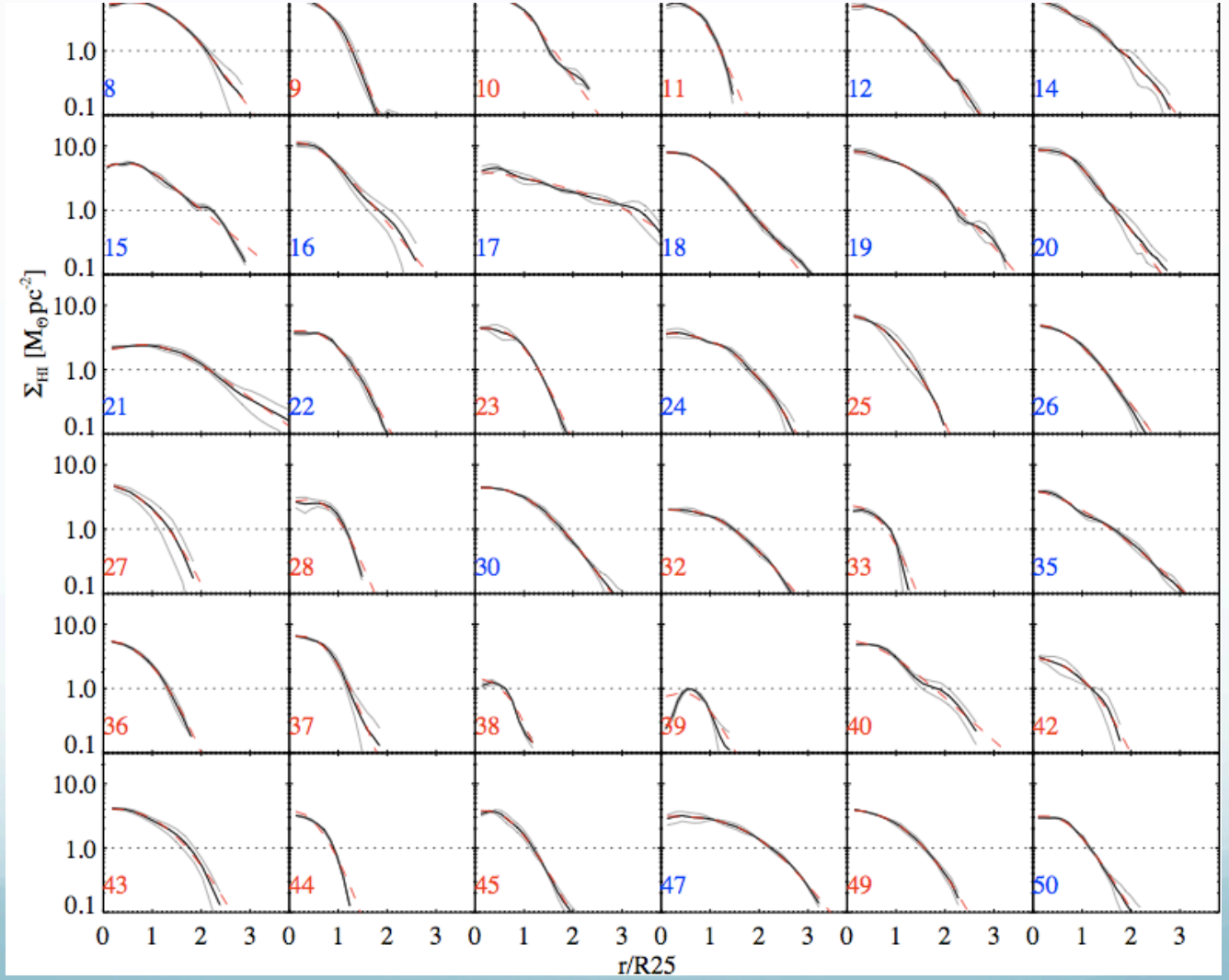
H2/HI (Bigiel et al. 2008, Leroy et al. 2008)

We propose the following formula to describe the radial distribution of HI:

$$\Sigma_{\mathrm{HI,model}}(r) = \frac{I_1 \exp(-r/r_s)}{1 + I_2 * \exp(-r/r_c)}$$

I1 : total gas at r=0
rs: scale-length of total gas
I2: H2/HI at r=0
rc: scale-length of H2/HI

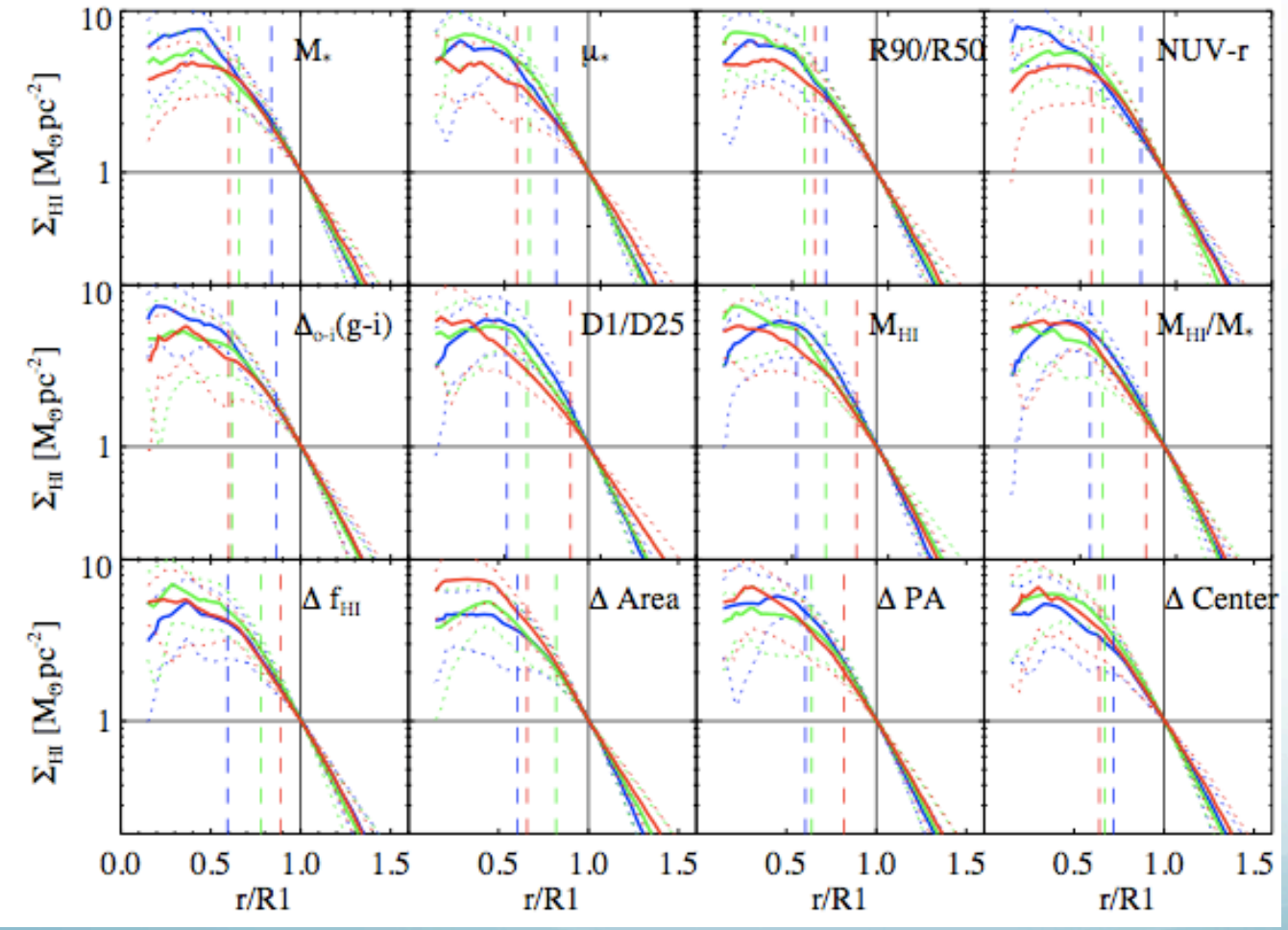
The fits



Models fit data well

Fits well!

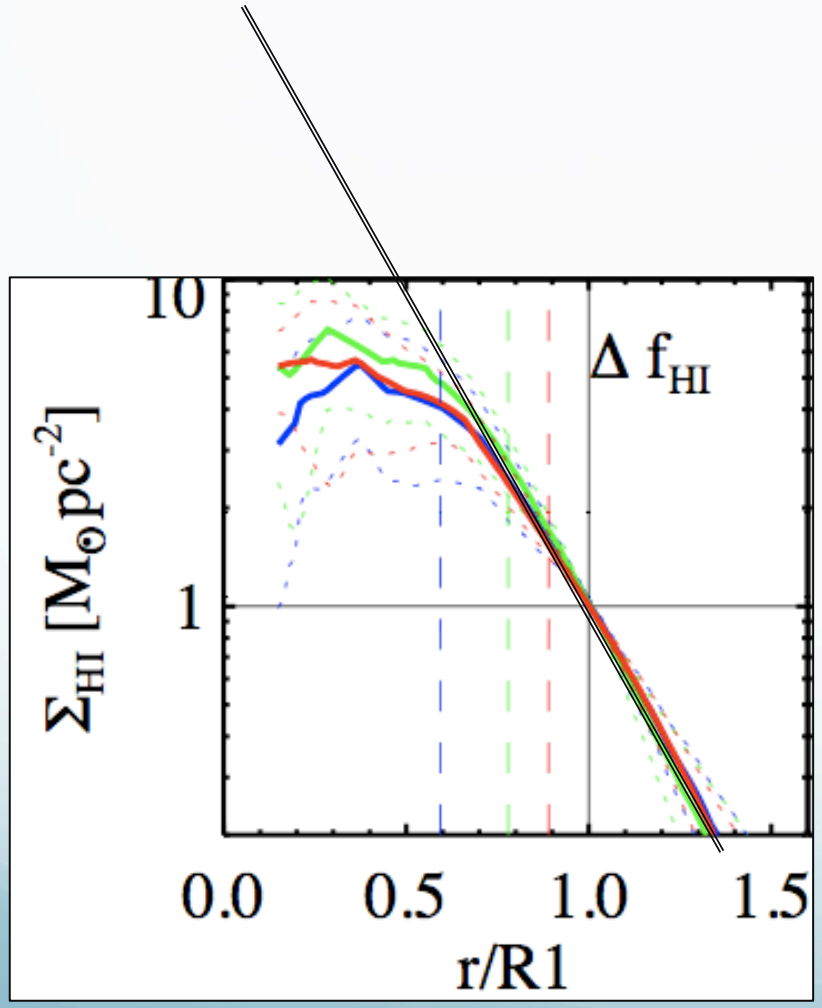
A homogeneous HI profile in the outer region (unconvolved)



High
Mediate
low

Rs~
0.19±0.03 R1

Indication from the homogeneous HI outer profiles



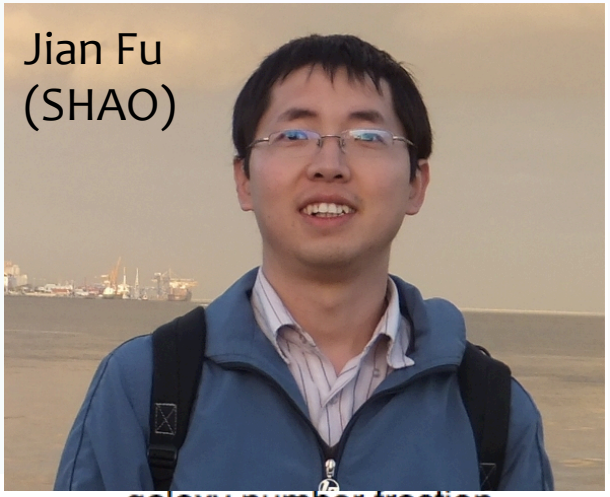
1. 1/4 explanation for the M(HI)–R1 relation, R1 is not "magical"

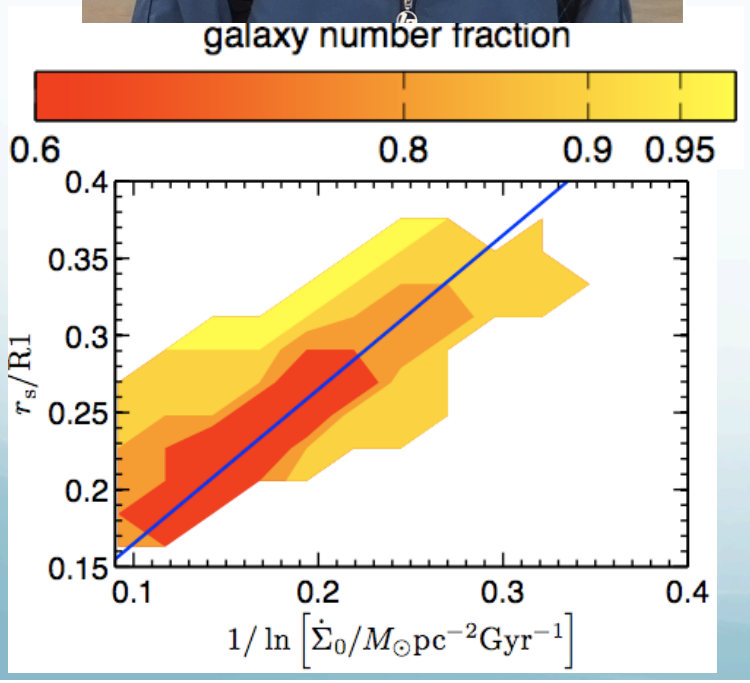
2. log Σ_{HI}(extrapolation, r=0)=2.4±0.4 M_sun/pc^2

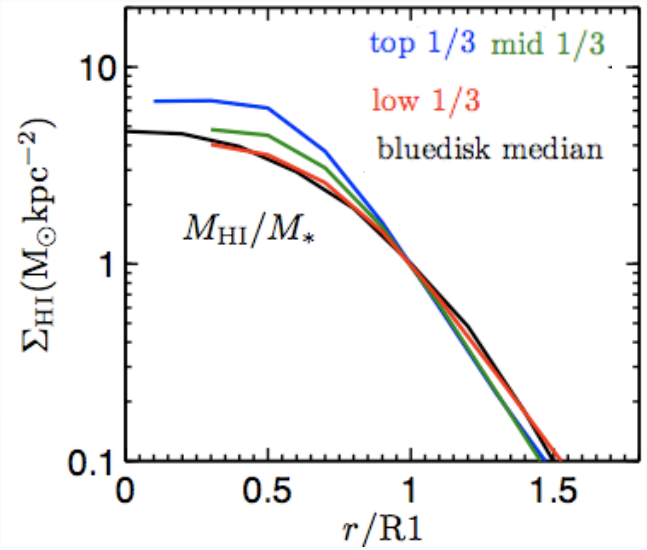
3. Cold gas accretion happens in a way that the normalized slope rs/R1 does not know the various galactic properties investigated here.

How to explain this?

The semi-analytical models



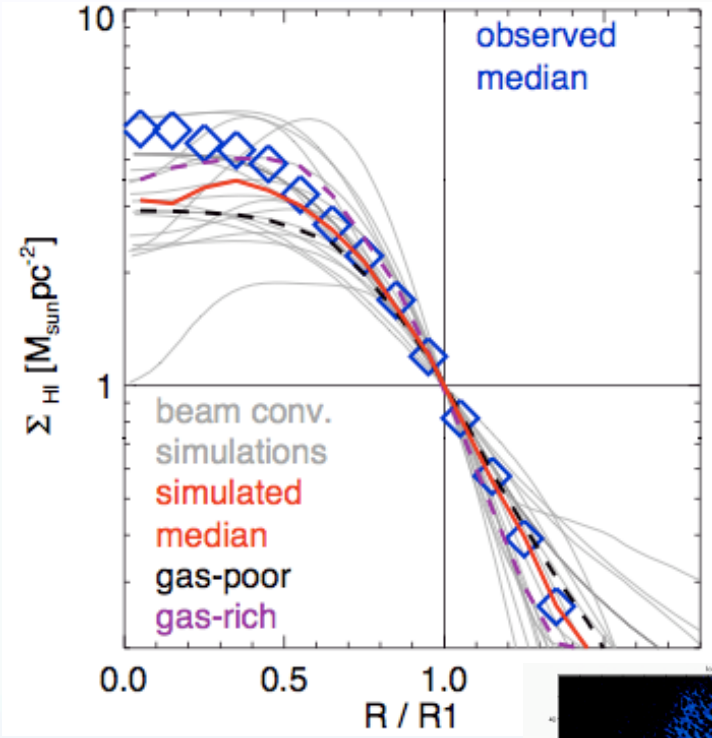


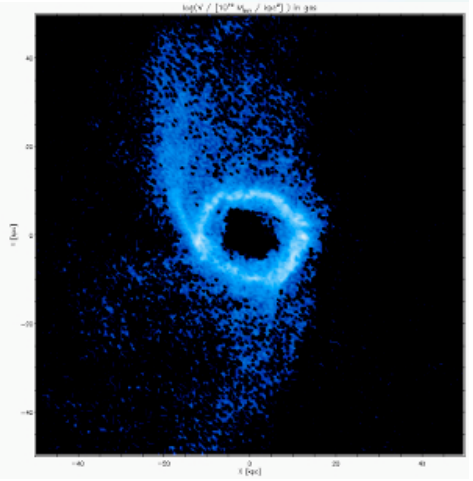


rs/R1 predicted from the Semi-analytical models: 0.23±0.01
rs/R1 from the Bluedisk data: 0.19±0.03

From SAM:
Exponentially accretion+ inside-out formaiton=
rs/R1 being unti-correlated with the accretion rate in the center.

The SPH simulations

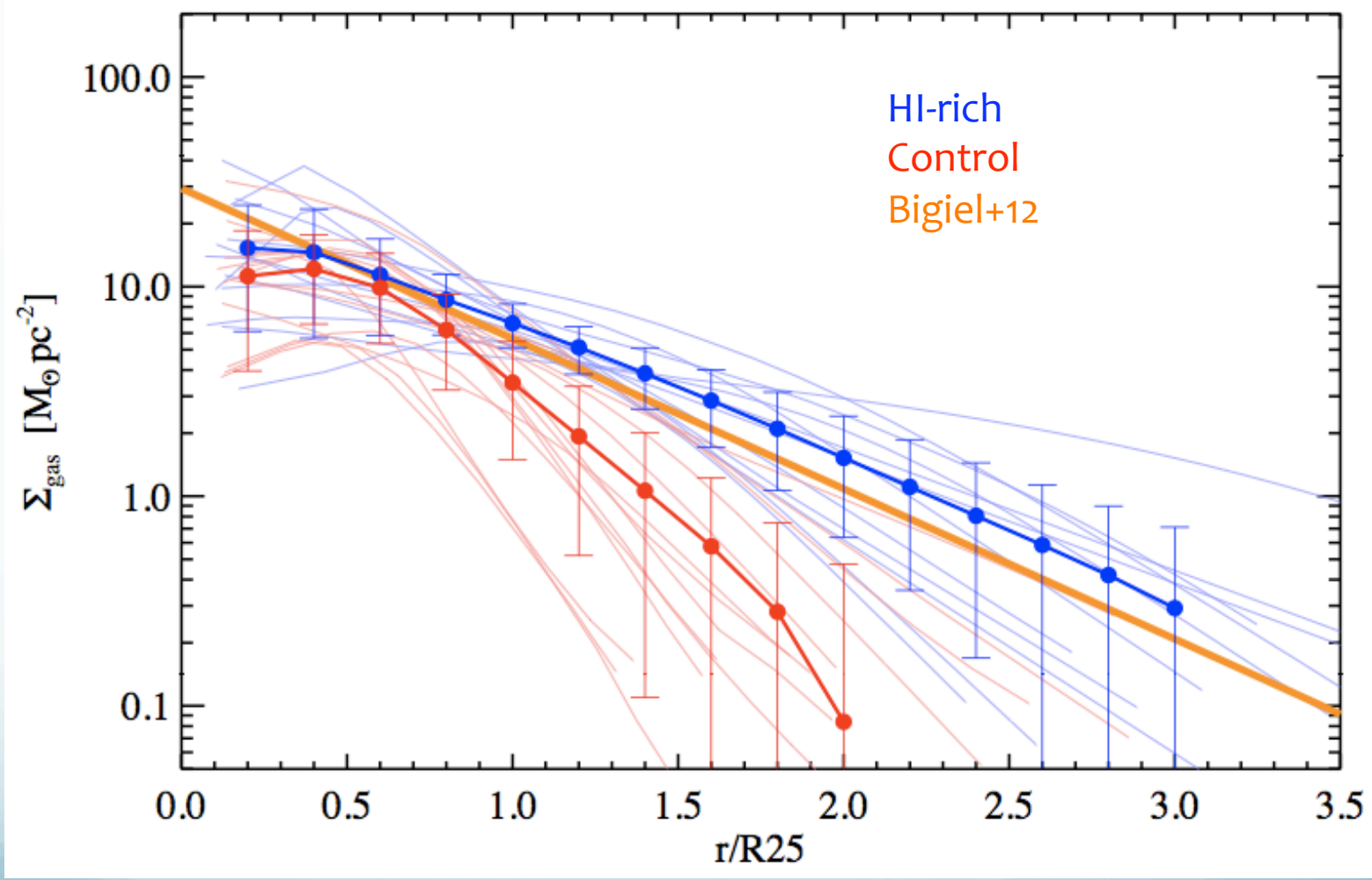




rs/R1 predicted from the Smoothed Particle Hydrodynamic simulations under a ΛCDM cosmology: 0.17

rs/R1 from the bluedisk data: 0.19

The “total” gas



The control galaxies deviate from the Bigiel+12 gas radial profile

summary

- Bluedisk project observed 25 extremely HI-rich galaxies and 25 control galaxies (

Wang et al.2013 (MNRAS433.270), Wang el al.2014 (arXiv1401.8164)

(data\catalogs\profiles are (will soon be) published at: www.mpa-garching.mpg.de/GASS/Bluedisk/data.php)

- The extremely HI-rich galaxies obey HI size-mass relation defined by normal disk galaxies; the morphologies are normal.
- The outer regions of HI disks are well regulated.
- The results argue against major merger as source of the excess HI; minor mergers or smooth accretion from the hot halo are most possible. Gas accretion for massive galaxies in the local universe is well regulated, resulting in tight M(HI)-size(HI) relation and narrow range of rs/R1.