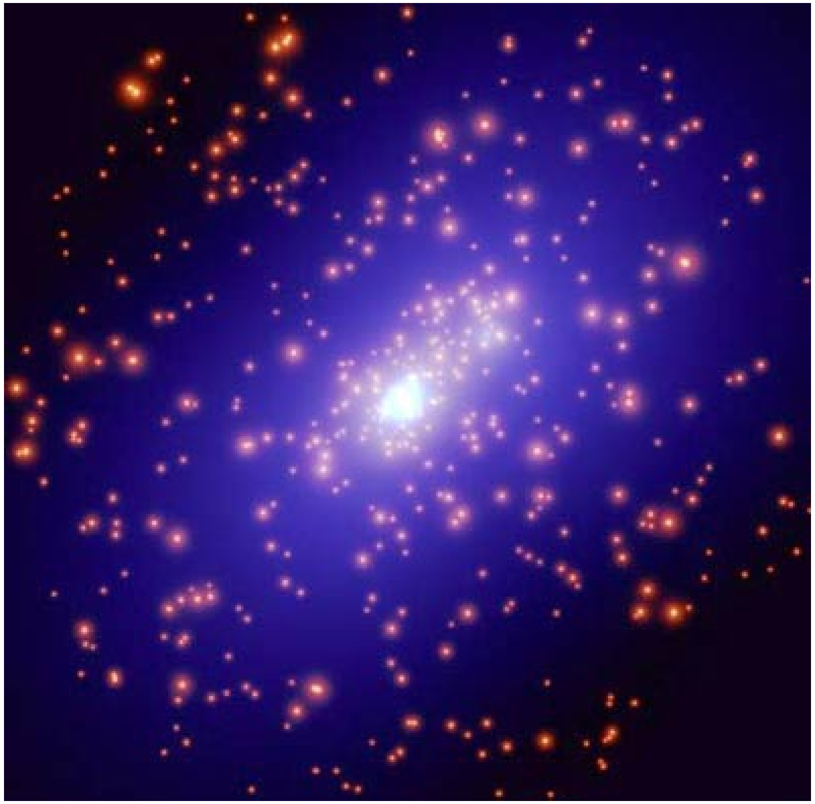
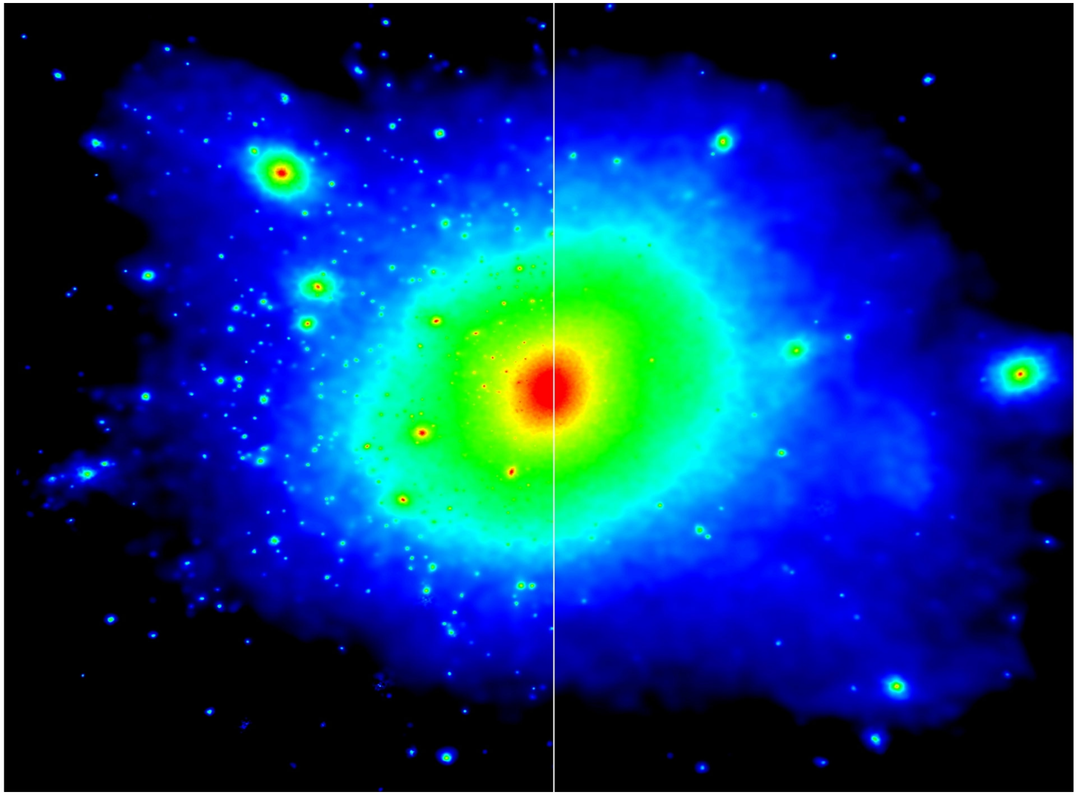
Why do satellite galaxy properties correlate with the central galaxy at scales beyond the virial radius of the parent halo?

EFFECT is called "conformity"

Halo of galaxies



Halo of gas



Development of observational work
2010

The accretion of gas on to galaxies as traced by their satellites

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ABSTRACT
We have compiled a large sample of isolated central galaxies from the Sloan Digital Sky Survey, which do not have a neighbour of comparable brightness within a projected distance of 1 Mpc. We use the colours, luminosities and surface brightnesses of satellite galaxies in the vicinity of these objects to estimate their neutral gas content and to derive the average total mass of H I gas contained in the satellites as a function of the projected radius from the primary. Recent calibrations of merging time-scales from *N*-body simulations are used to estimate the rate at which this gas will accrete on to the primary galaxies. Our estimated

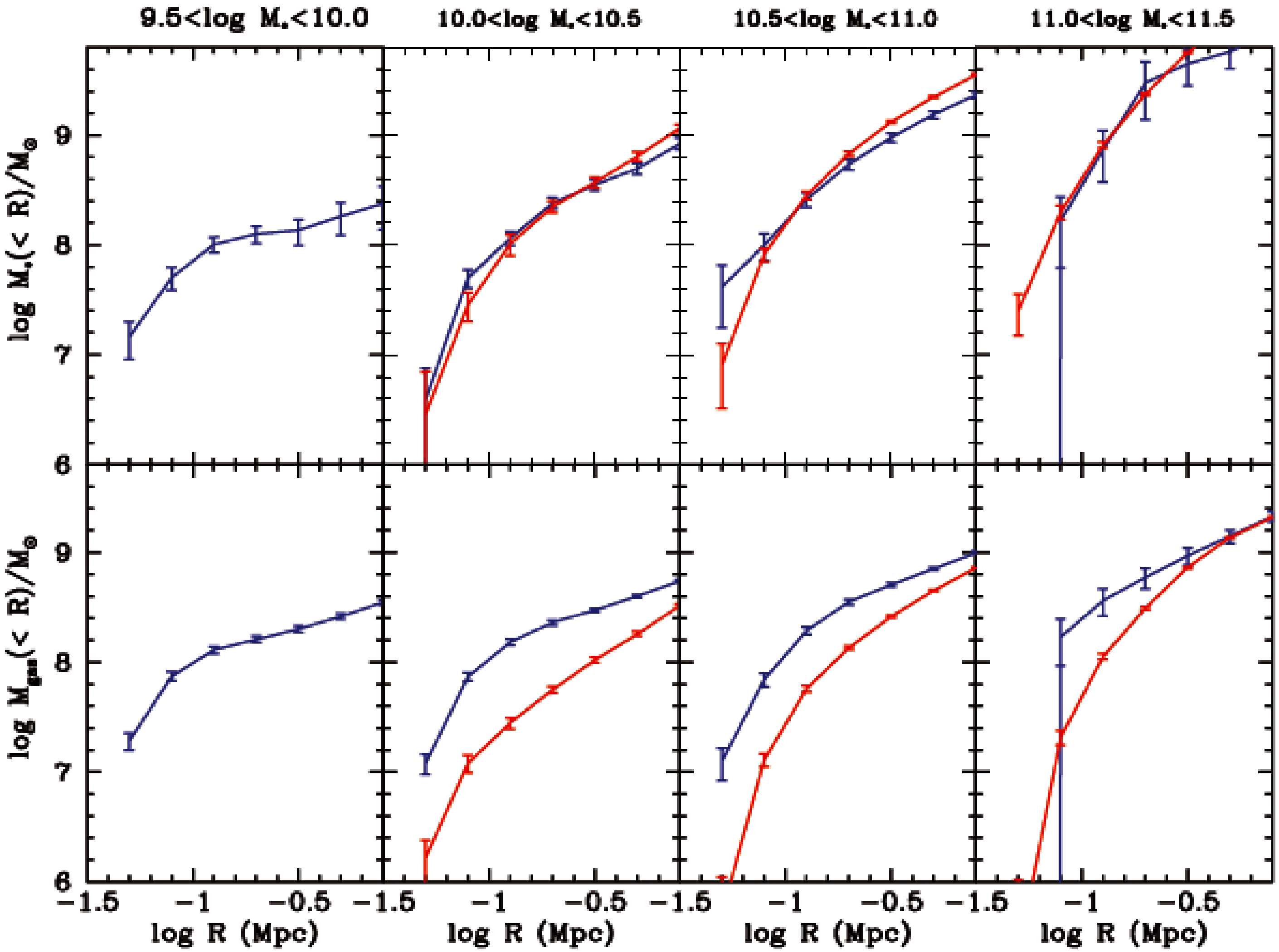

Figure 4. Cumulative stellar (top panel) and gas mass (bottom panel) contained in satellites interior to the projected radius, R_p, around 'central' galaxies. The central galaxy population is divided into blue-sequence galaxies with $g - r < 0.65$ (blue curves) and red-sequence galaxies with $g - r > 0.65$ (red curves).

A Re-examination of Galactic Conformity and a Comparison with Semi-analytic Models of Galaxy Formation

2012

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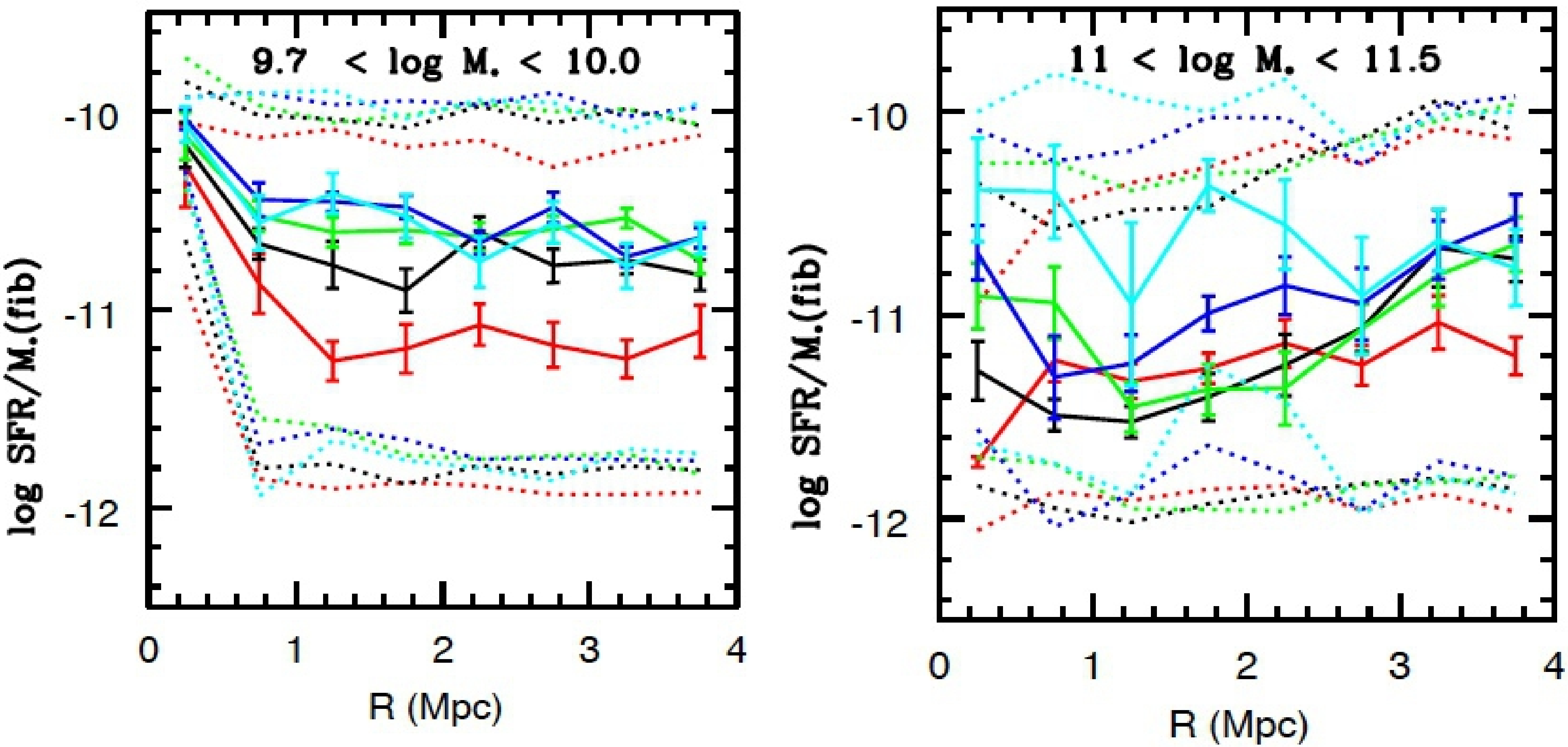
19 September 2012

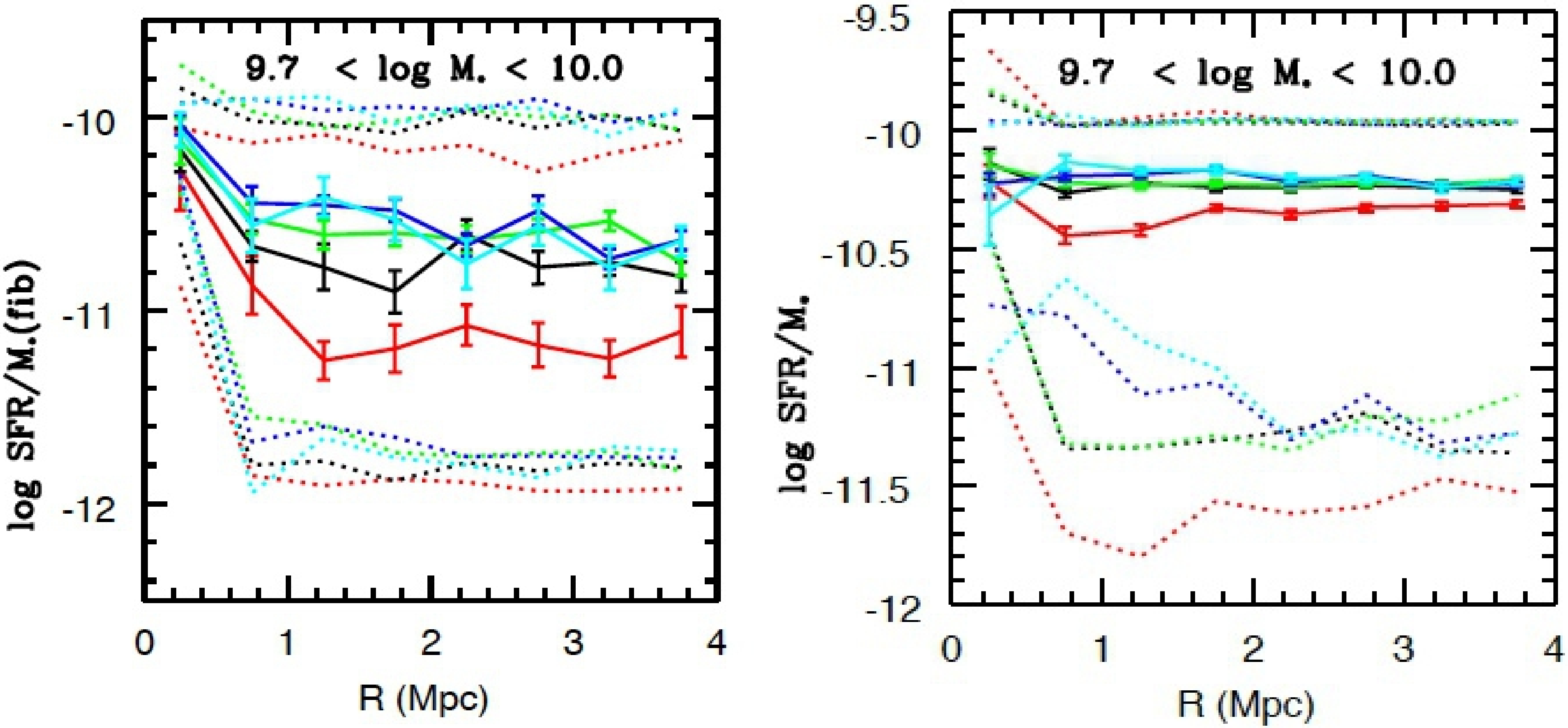
ABSTRACT

The observed correlation between star-formation in central galaxies and in their neighbours (a phenomenon dubbed "galactic conformity") is in need of a convincing physical explanation. To gain further insight, we use a volume-limited sample of galaxies with redshifts less than 0.03 drawn from the SDSS Data Release 7 to investigate the scale dependence of the effect and how it changes as a function of the mass of the central galaxy. Conformity extends over a central galaxy stellar mass range spanning two orders of magnitude. The scale dependence and the precise nature of the effect depend on the mass of the central. In central galaxies with masses less than $10^{10} M_{\odot}$, conformity extends out to scales in excess of 4 Mpc, well beyond the virial radii of their dark matter halos. For low mass central galaxies, conformity with neighbours on very large scales is only seen when they have low star formation rate or gas content. In contrast, at high stellar masses, conformity with neighbours applies in the gas-rich regime and is clearly confined to scales comparable to the virial radius of the dark matter halo of the central galaxy. Our analysis of a mock catalogue from the Guo et al (2011) semi-analytic models shows that conformity-like effects arise because gas-poor satellite galaxies are sometimes misclassified as centrals. However, the effects in the models are much weaker than observed. Mis-classification only influences the low-end

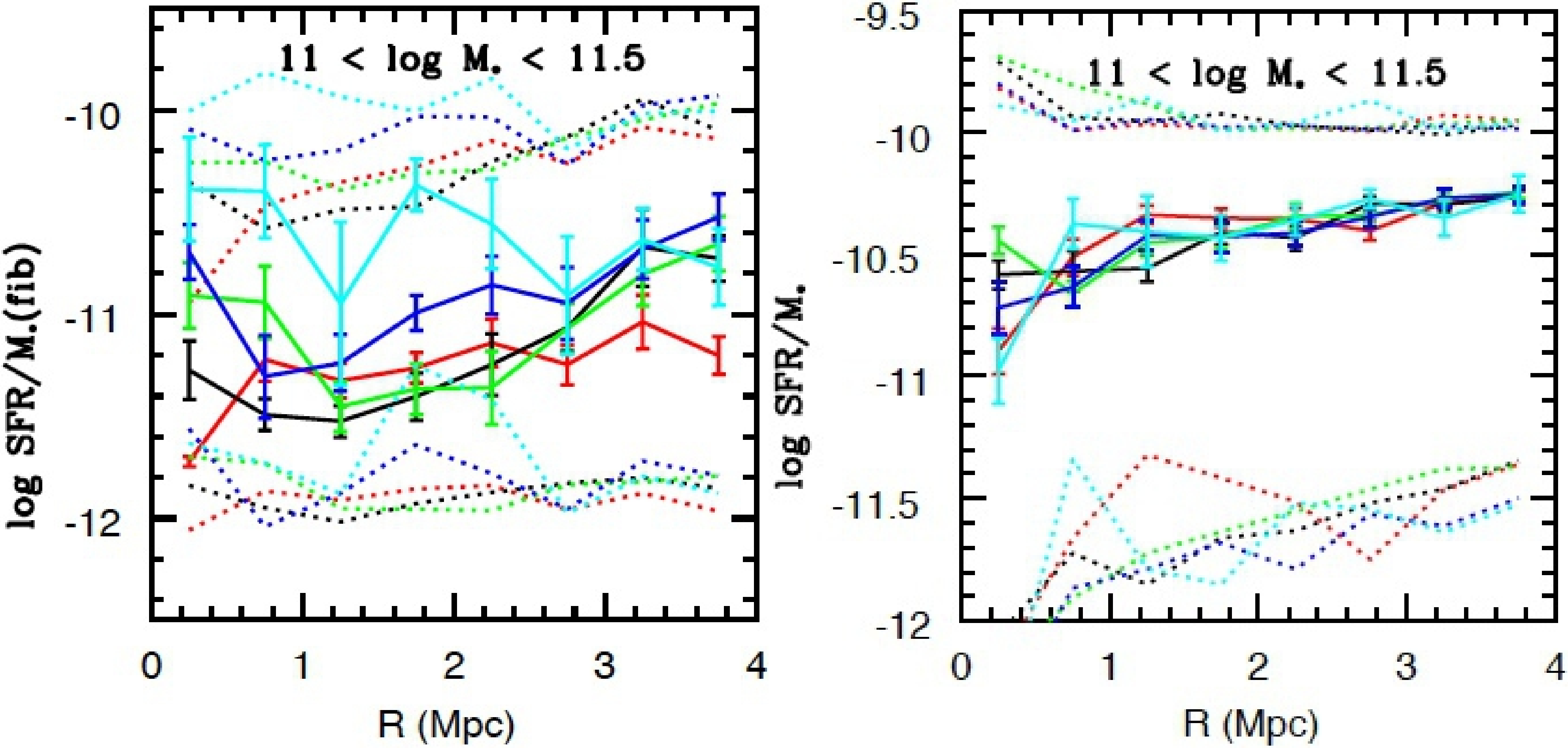
Specific star formation rates of satellites around “central” galaxies (selected by an isolation criterion) partitioned into different bins (from passive to active)



Low mass galaxies: data (left) and models (right)



High mass galaxies: data (left) and models(right)



2015

Physical origin of the large-scale conformity in the specific star formation rates of galaxies

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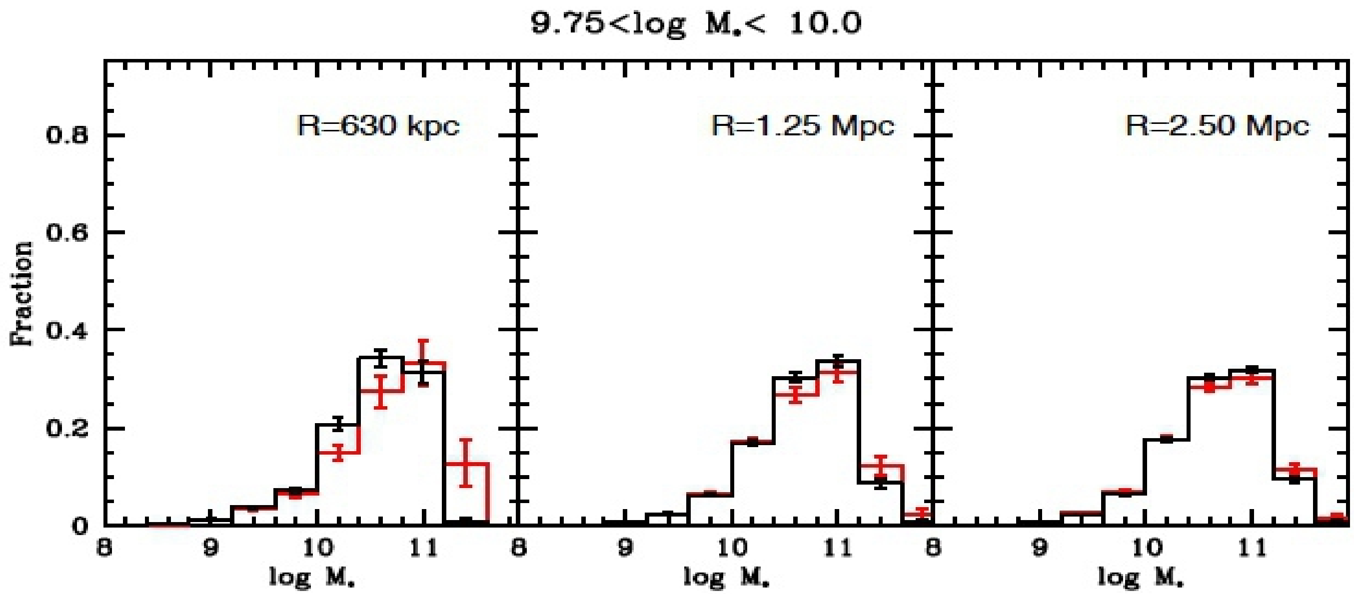
12 August 2015

ABSTRACT
Two explanations have been put forward to explain the observed conformity between the colours and specific star formation rates (SFR/M_*) of galaxies on large scales: 1) the formation times of their surrounding dark matter halos are correlated (commonly referred to as "assembly bias"), 2) gas is heated over large scales at early times, leading to coherent modulation of cooling and star formation between well-separated galaxies (commonly referred to as "pre-heating") . To distinguish between the pre-heating and assembly bias scenarios, we search for relics of energetic feedback events in the neighbourhood of central galaxies with different specific star formation rates.



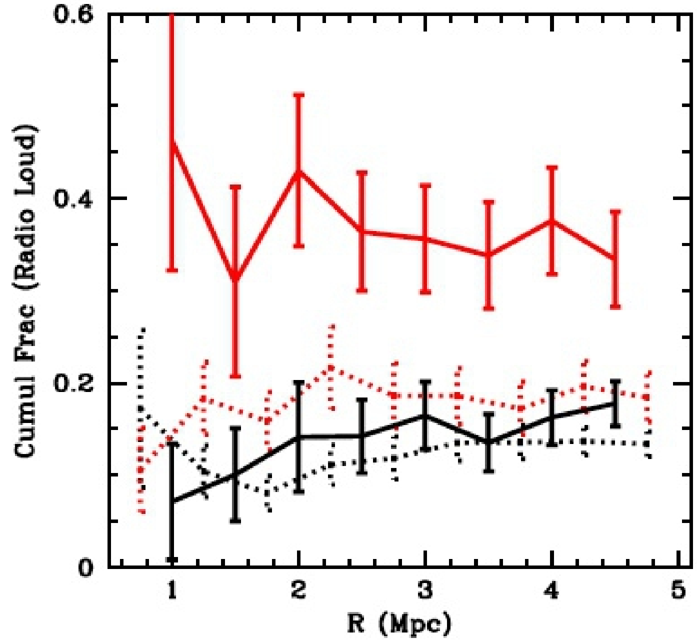
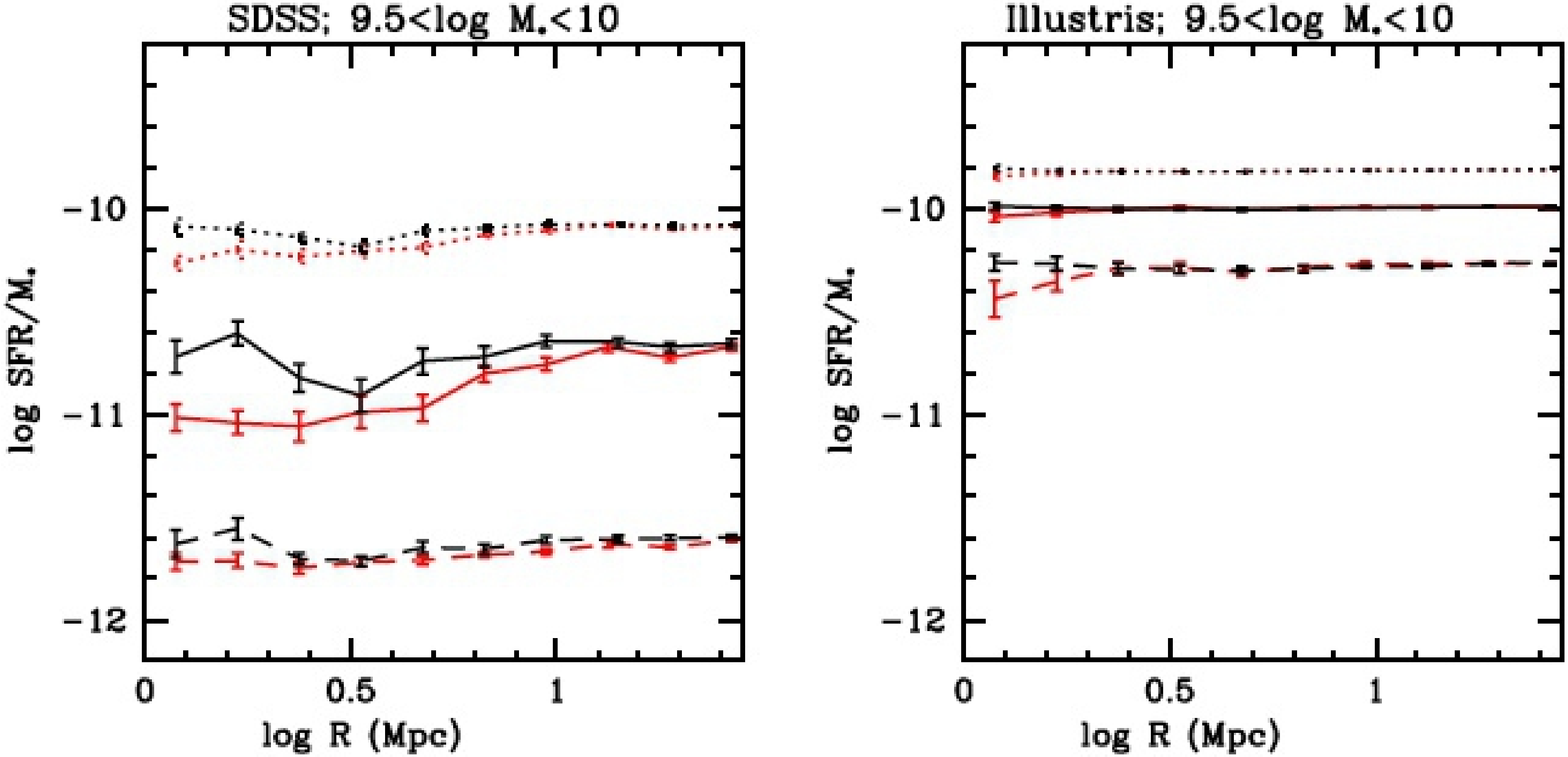


Figure 4. The cumulative fraction of neighbouring galaxies interior to radius R that host radio-loud AGN. Results for neighbours with $\log M_* > 11$ are shown as dotted lines, and for neighbours with $\log M_* > 11.3$ are shown as solid lines. Red lines are for passive centrals and black lines are for the control sample.



SDSS; 9.5<log M*<10
log SFR/M*
-10
-11
-12
0
0.5
1
log R (Mpc)
Illustris; 9.5<log M*<10
log SFR/M*
-10
-11
-12
0
0.5
1
log R (Mpc)

Effects beyond the virial radius

The splashback radius as a physical halo boundary and the growth of halo mass

Surhud More, Benedikt Diemer, Andrey Kravtsov

Apr 21, 2015 - 16 pages

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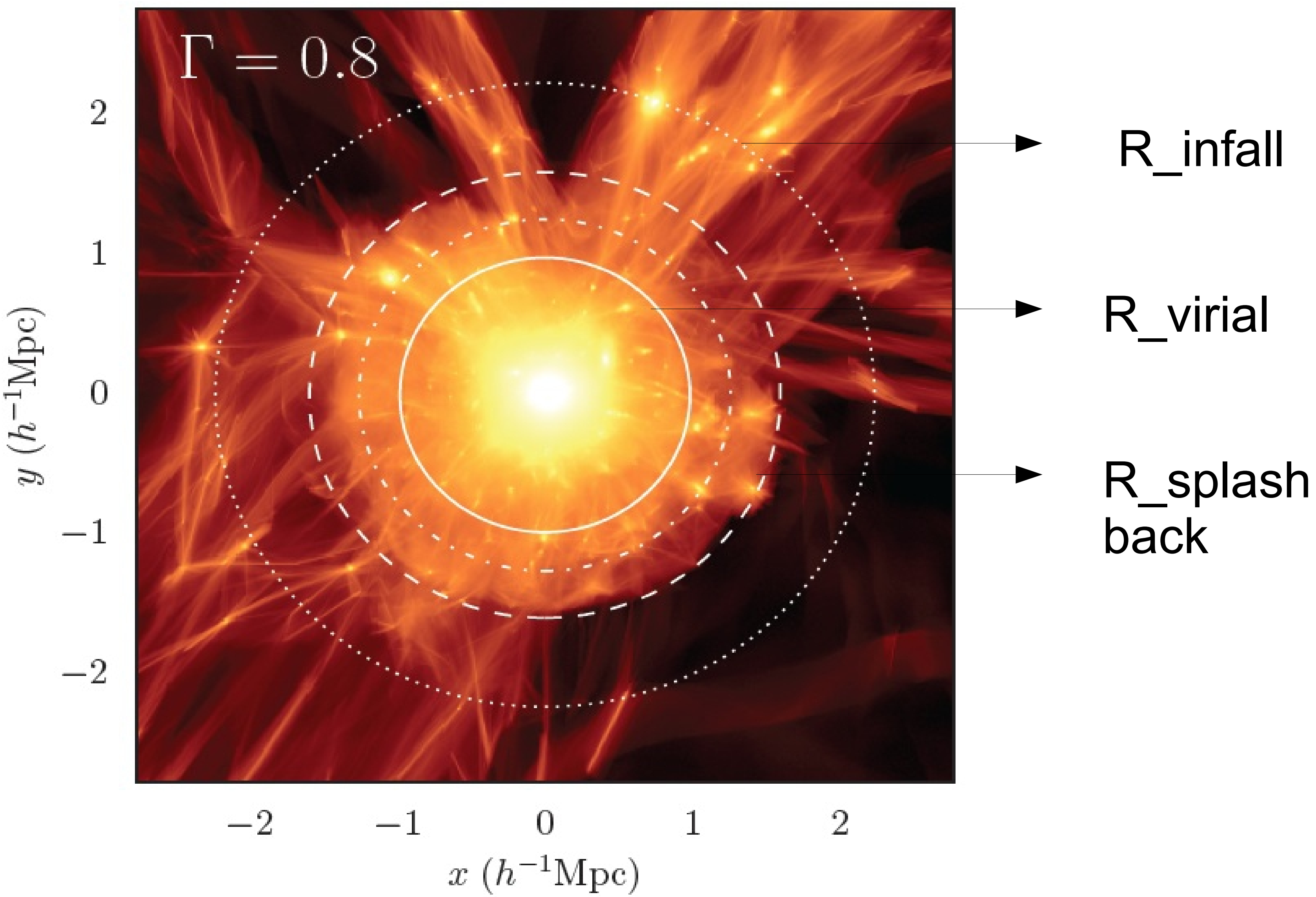
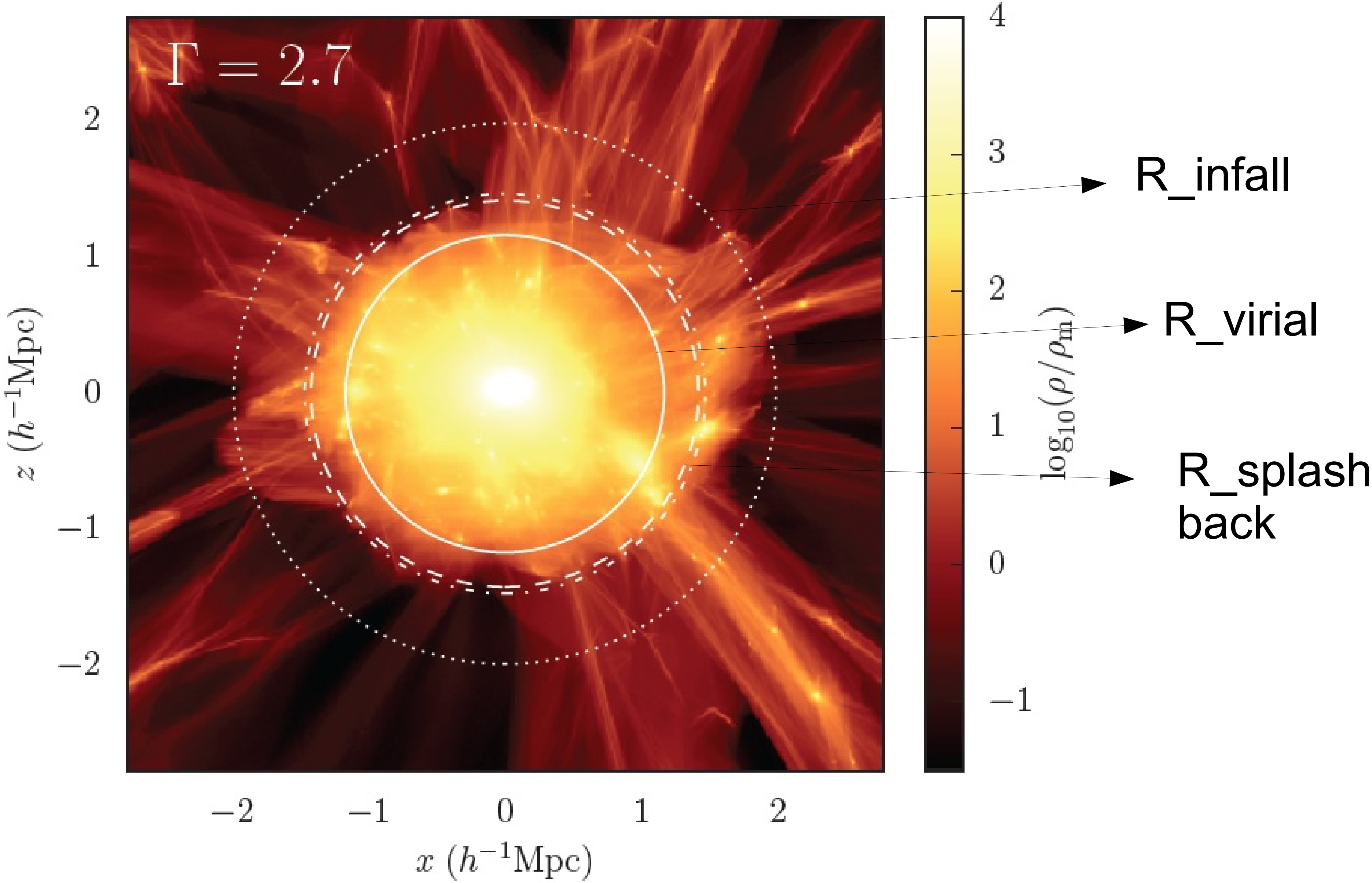
(2015-08-27)
DOI: 10.1088/0004-637X/810/1/36
e-Print: arXiv:1504.05591 [astro-ph.CO] | PDF

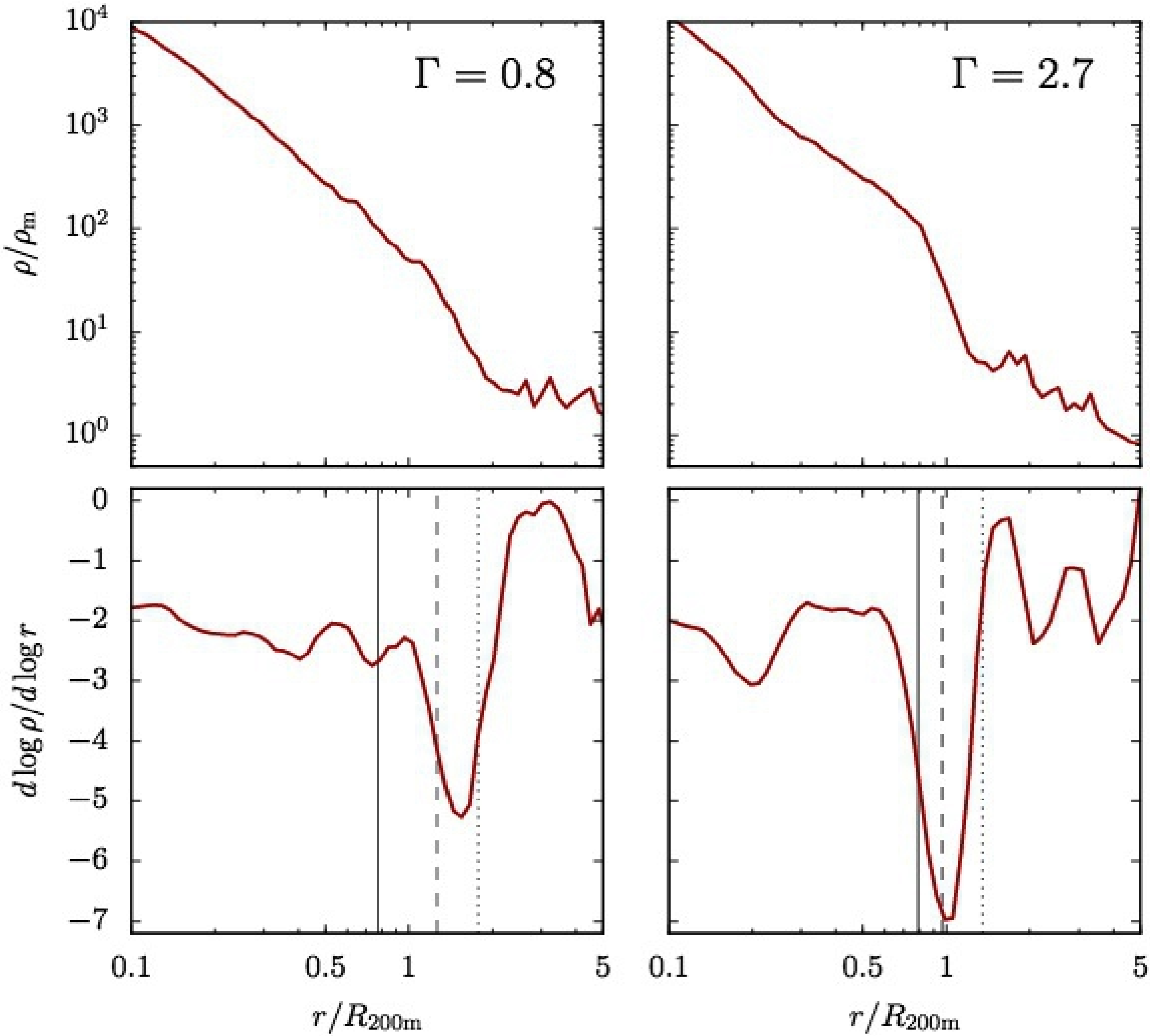
Abstract (IOP)
The boundaries of cold dark matter halos are commonly defined to enclose a density contrast Δ relative to a reference (mean or critical) density. We argue that a more physical halo boundary choice is the radius at which accreted matter reaches its first orbital apocenter after turnaround. This splashback radius, $R_{\rm sp}$, manifests itself as a sharp density drop in the halo outskirts, at a location that depends upon the mass accretion rate. We present calibrations of $R_{\rm sp}$ and the enclosed mass, $M_{\rm sp}$, as a function of mass accretion rate and peak height. We find that $R_{\rm sp}$ is in the range $\approx 0.8 - 1R_{\rm 200m}$ for rapidly accreting halos and is $\approx 1.5R_{\rm 200m}$ for slowly accreting halos. Thus, halos and their environmental effects can extend well beyond the conventionally defined "virial" radius. We show that $M_{\rm sp}$ and $R_{\rm sp}$

Low accretion rate halo

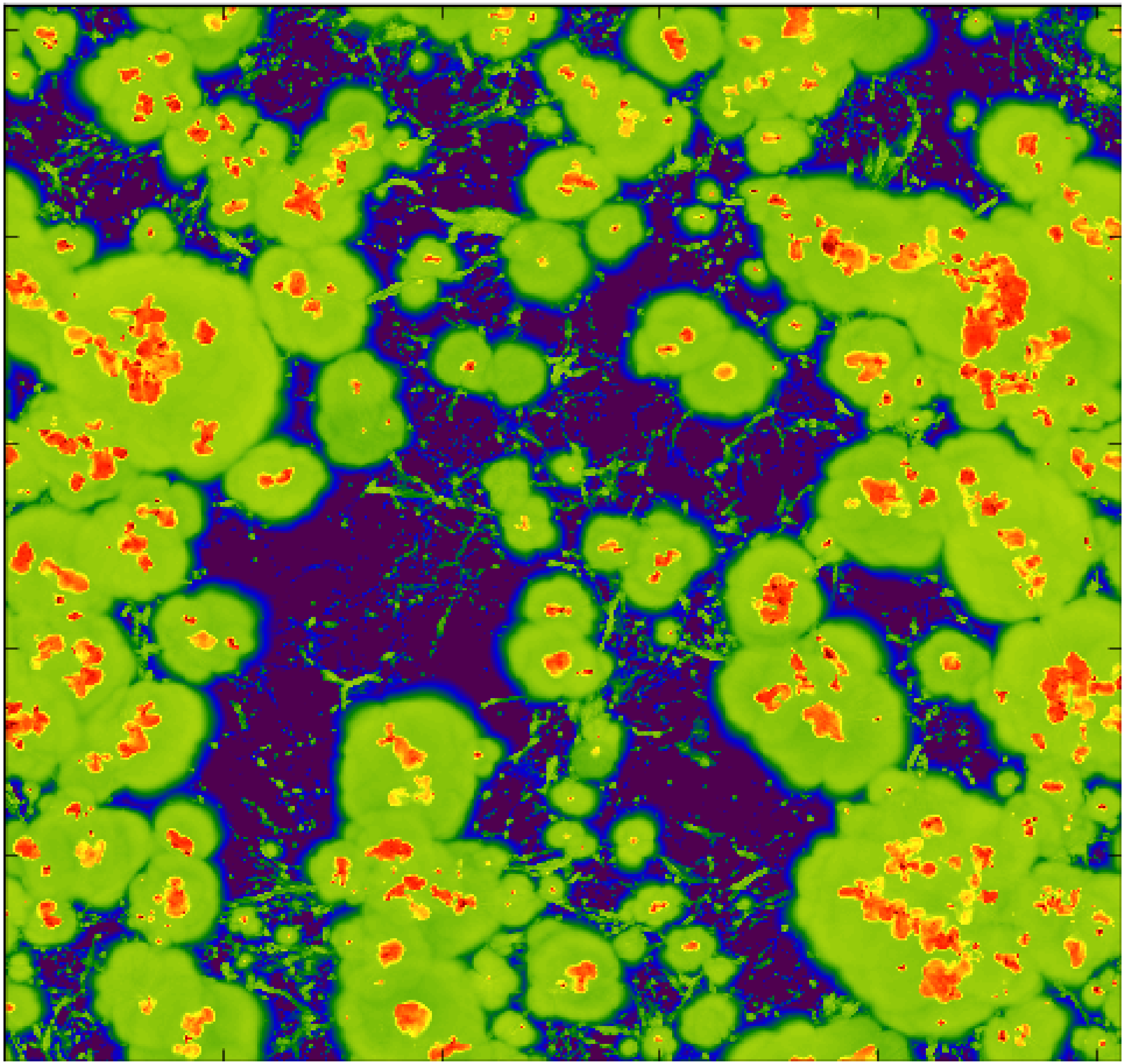


High accretion rate halo

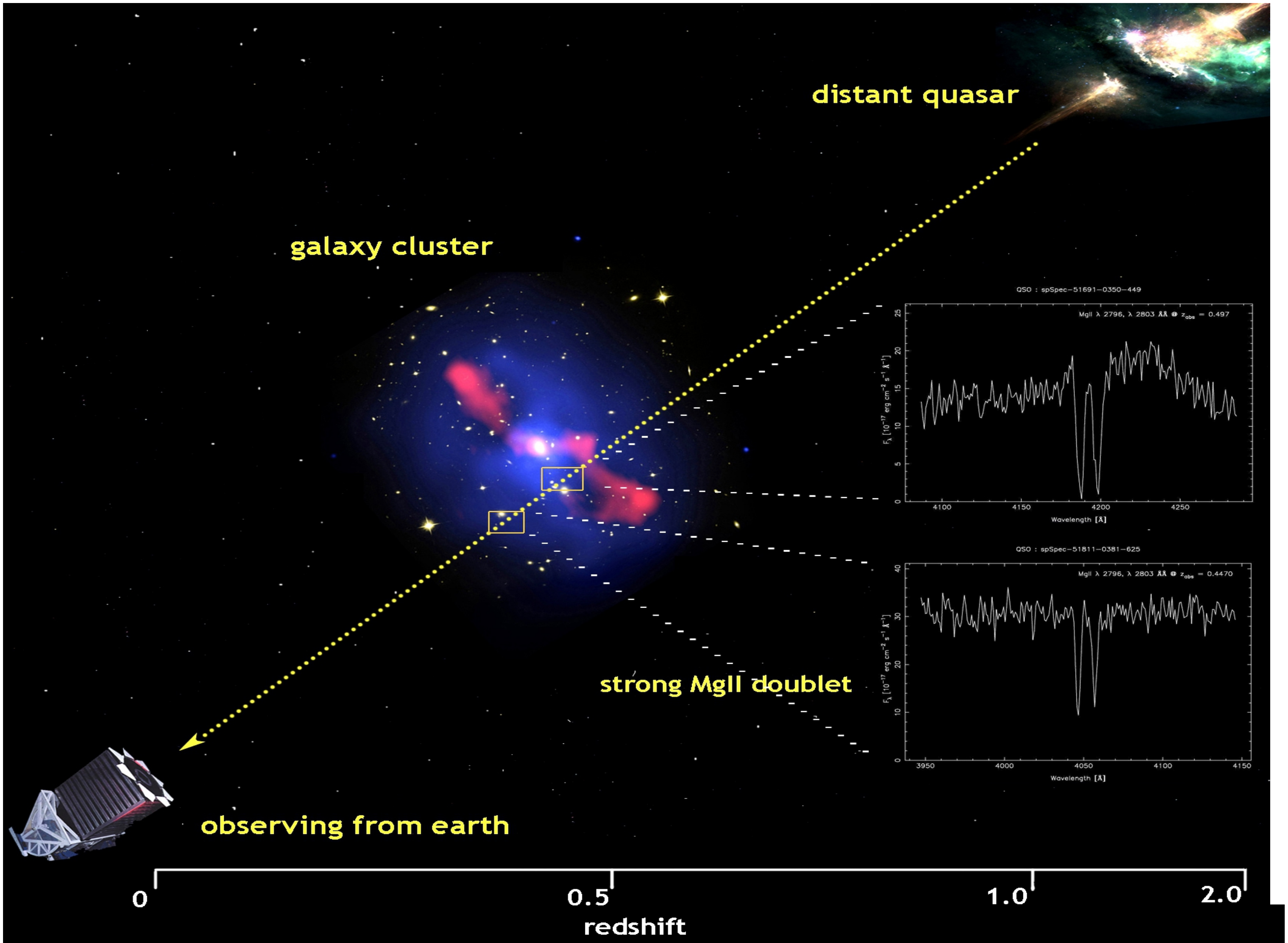


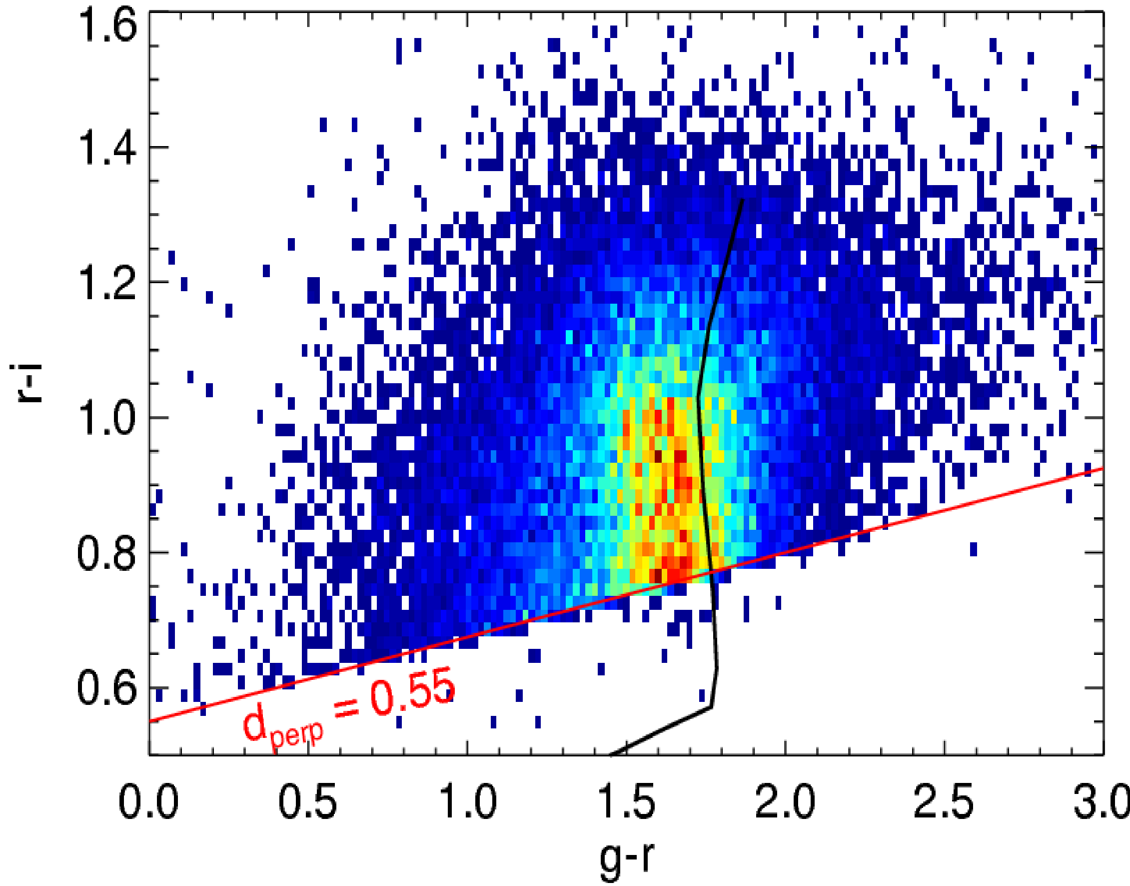

$\Gamma = 0.8$
$\Gamma = 2.7$
$\rho/\rho_{\rm m}$
10^4
10^3
10^2
10^1
10^0
$d\log\rho/d\log r$
0
−1
−2
−3
−4
−5
−6
−7
0.1
0.5
1
5
$r/R_{\rm 200m}$

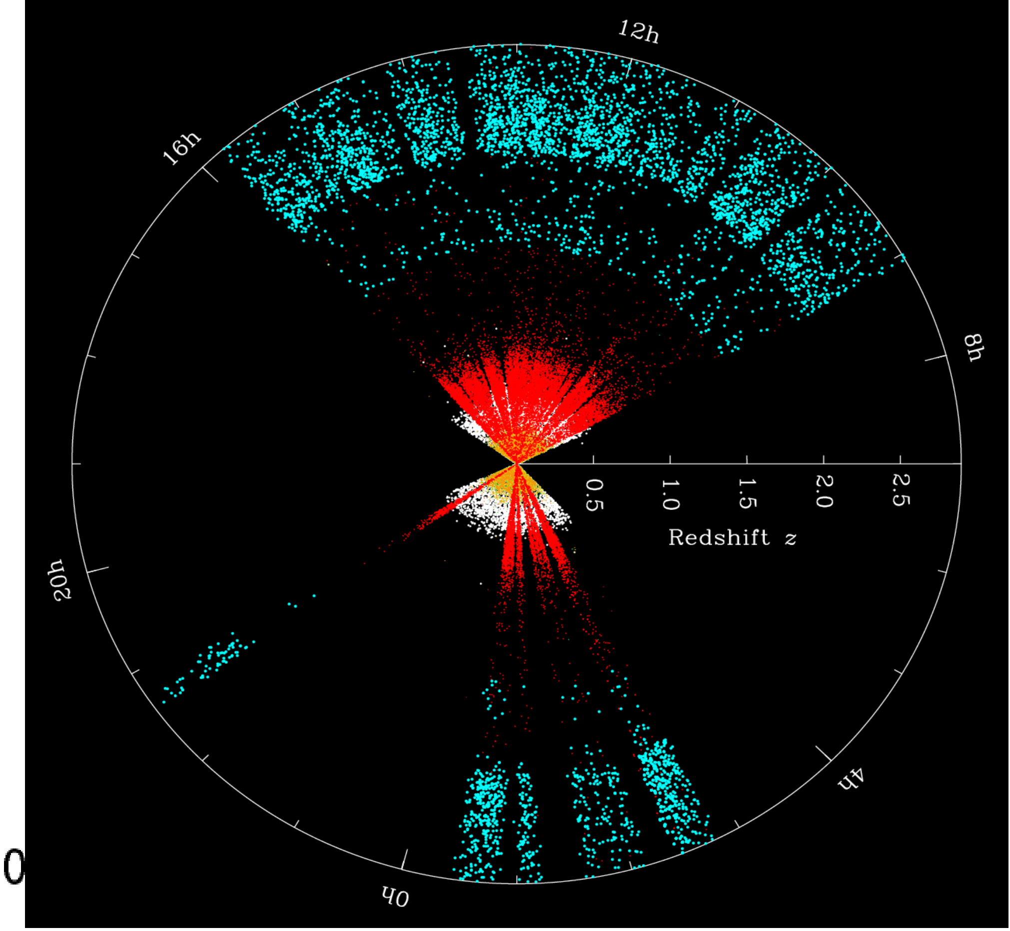
GAS HEATING OVER LARGE SCALES?



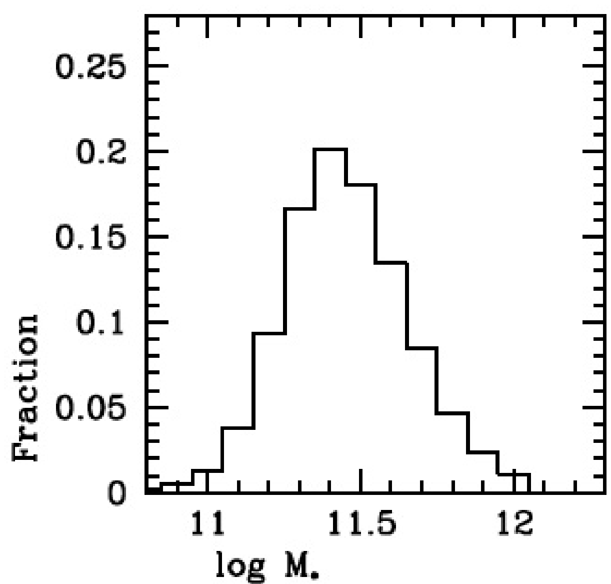
QSOs probing the circumgalactic medium (CGM) : the properties of quasar absorption lines in the vicinity of galaxies of known redshift, mass, type, SFR, etc

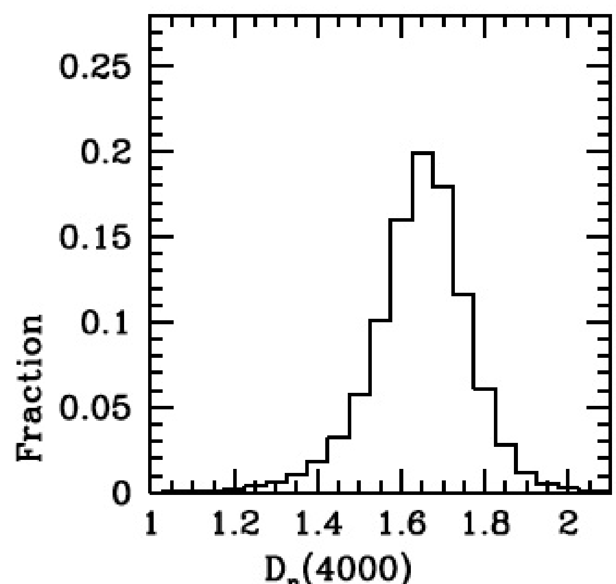




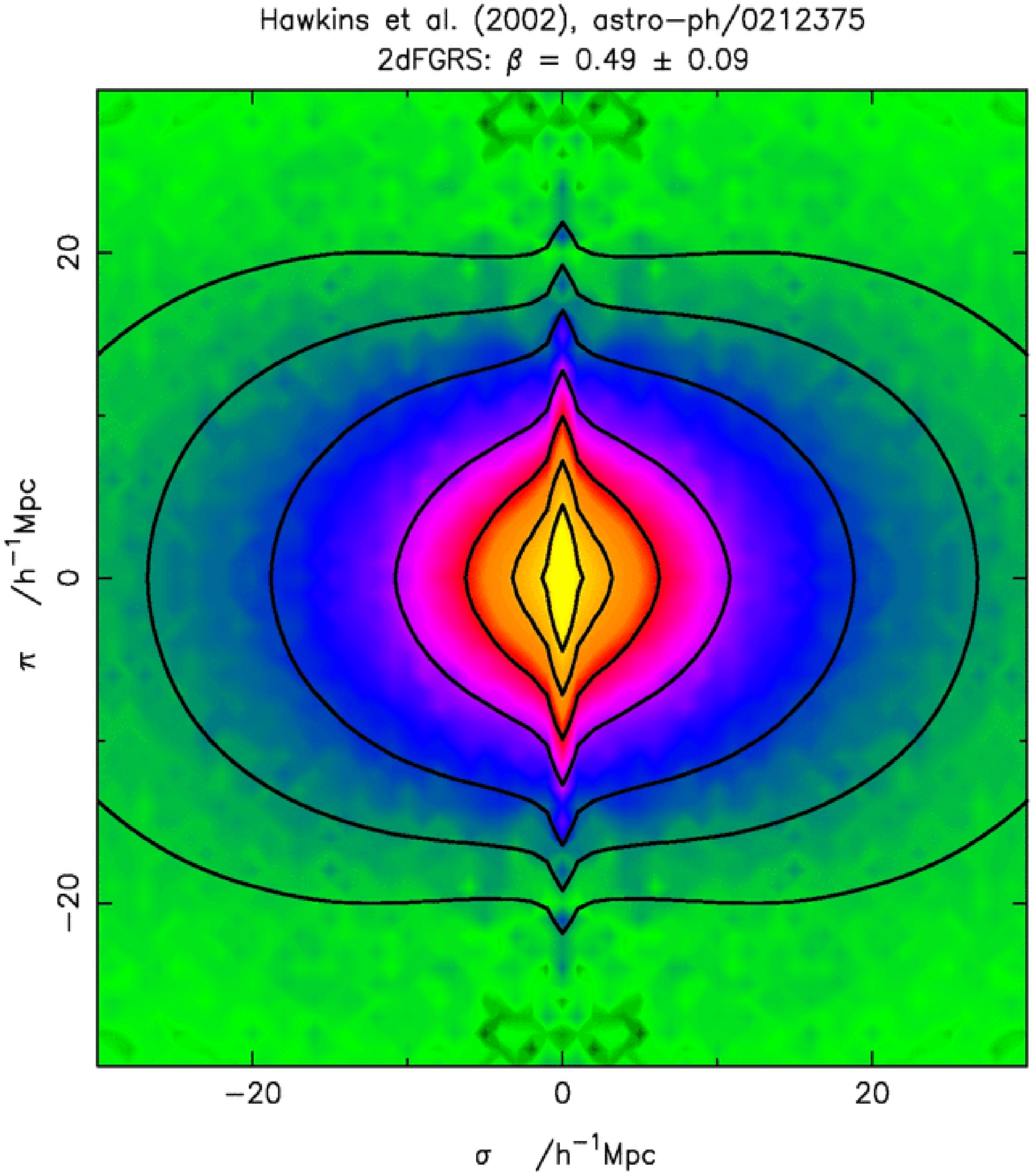


"CMASS" galaxy sample from the BOSS (SDSS-III) survey: massive galaxies (log M*>11) with redshifts in the range 0.4-0.8.





Evaluate clustering as a function of projected radius and velocity space separation.



Kauffmann et al 2017

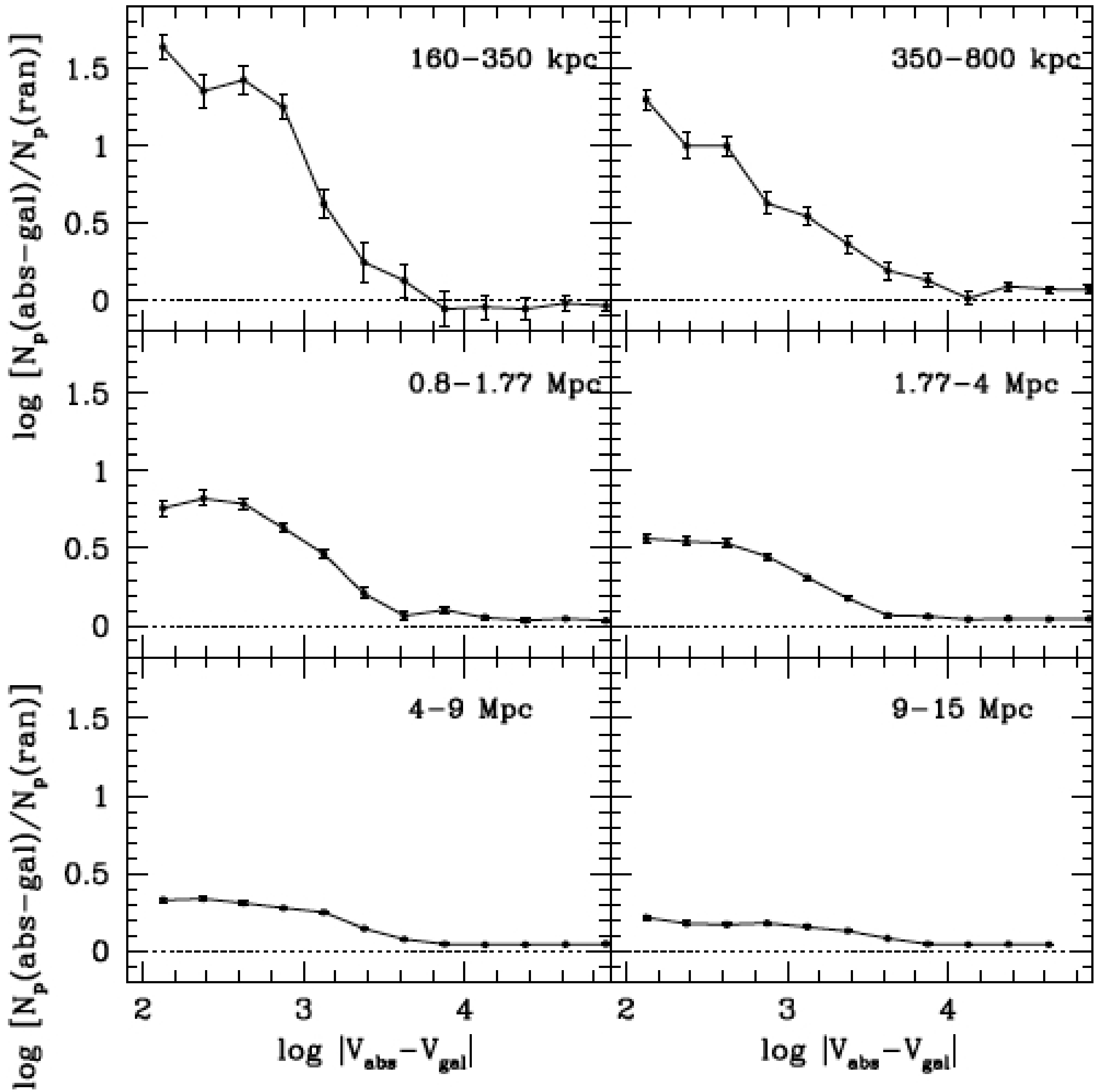
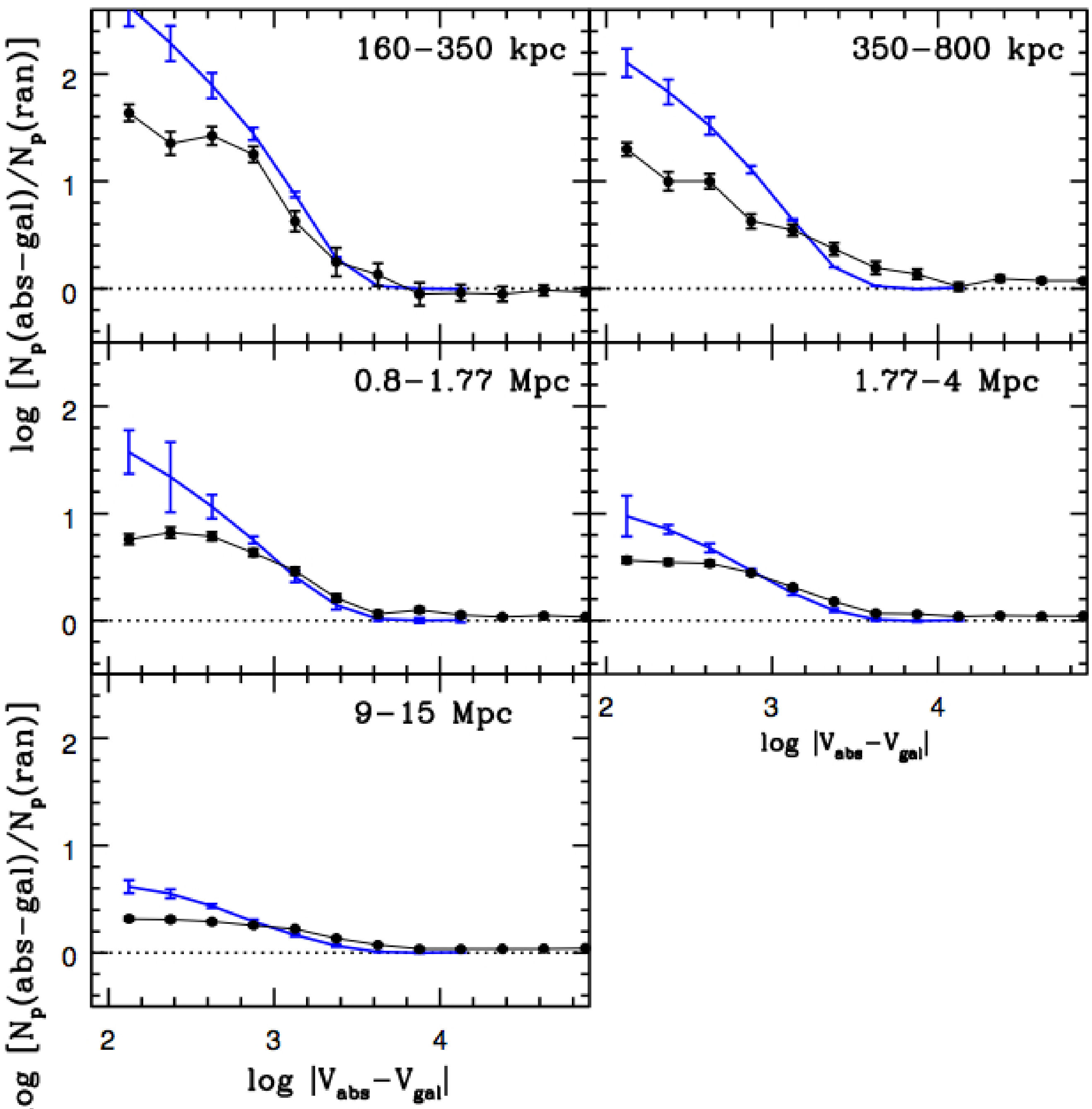


Figure 3. The logarithm of the number of galaxy-absorber pairs in the full CMASS sample divided by the average number of galaxy-absorber pairs in the random catalogues is plotted as a function of the absolute value of the velocity separation. Results are shown in 6 different bins in projected radius R.

Compared to model: MgII absorbers trace dark matter around CMASS-type galaxies in the Millennium Run simulation at z=0.55



Evidence that gas has been pushed out of dark matter halos