Suppressed radio emission in supercluster galaxies: The effects of mergers, flybys & ram pressure stripping

with Jean-Christophe MAUDUIT
arXiv:0704.3431

What drives the 1.4 GHz radio emission of galaxies?

synchrotron emission from relativistic electrons driven by AGN or SN IIs

→ $\begin{cases} \log L_{1.4\mathrm{GHz}} > 23.05 \rightarrow \text{AGN} \\ \log L_{1.4\mathrm{GHz}} < 23.05 \rightarrow \text{star forming galaxy} \end{cases}$

Sadler et al. 02

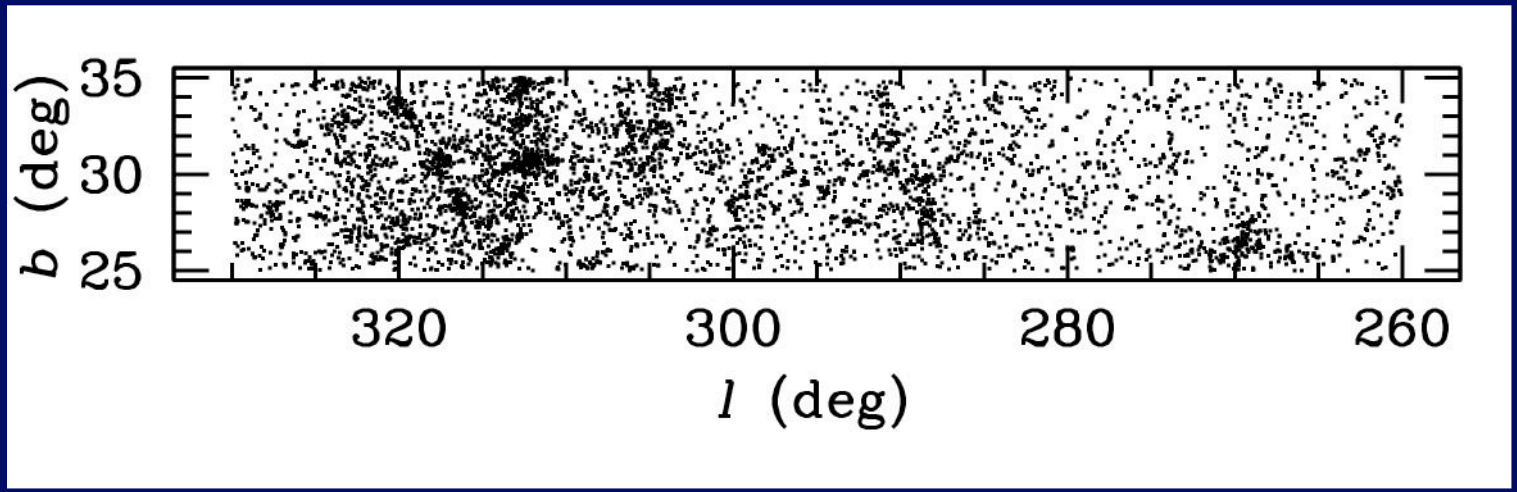
1.4 GHz emission unaffected by dust obscuration
→ good measure of AGN activity and/or SFR

Motivation

Is there a modulation of the 1.4 GHz emission with very large-scale (supercluster) environment?

Samples

FLASH Kaldare et al 03 + 6dFGS → 700 deg^2



NVSS 1.4 GHz (21cm) continuum radio sources

∩

6dFGS optical spectra

Volume & radio luminosity limits

NVSS

$S_{1.4GHz} > 3.5$ mJy

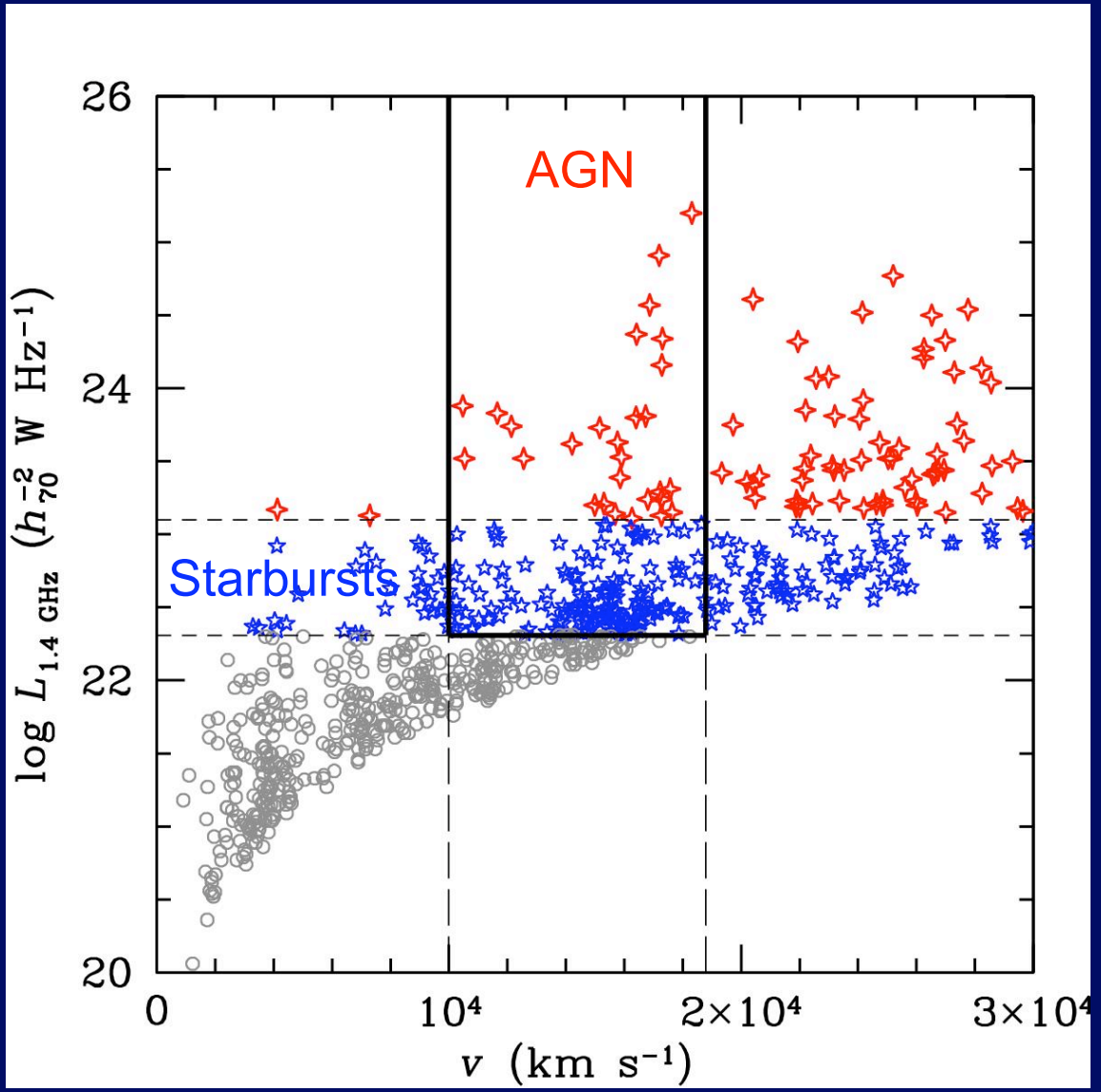
radio luminosity

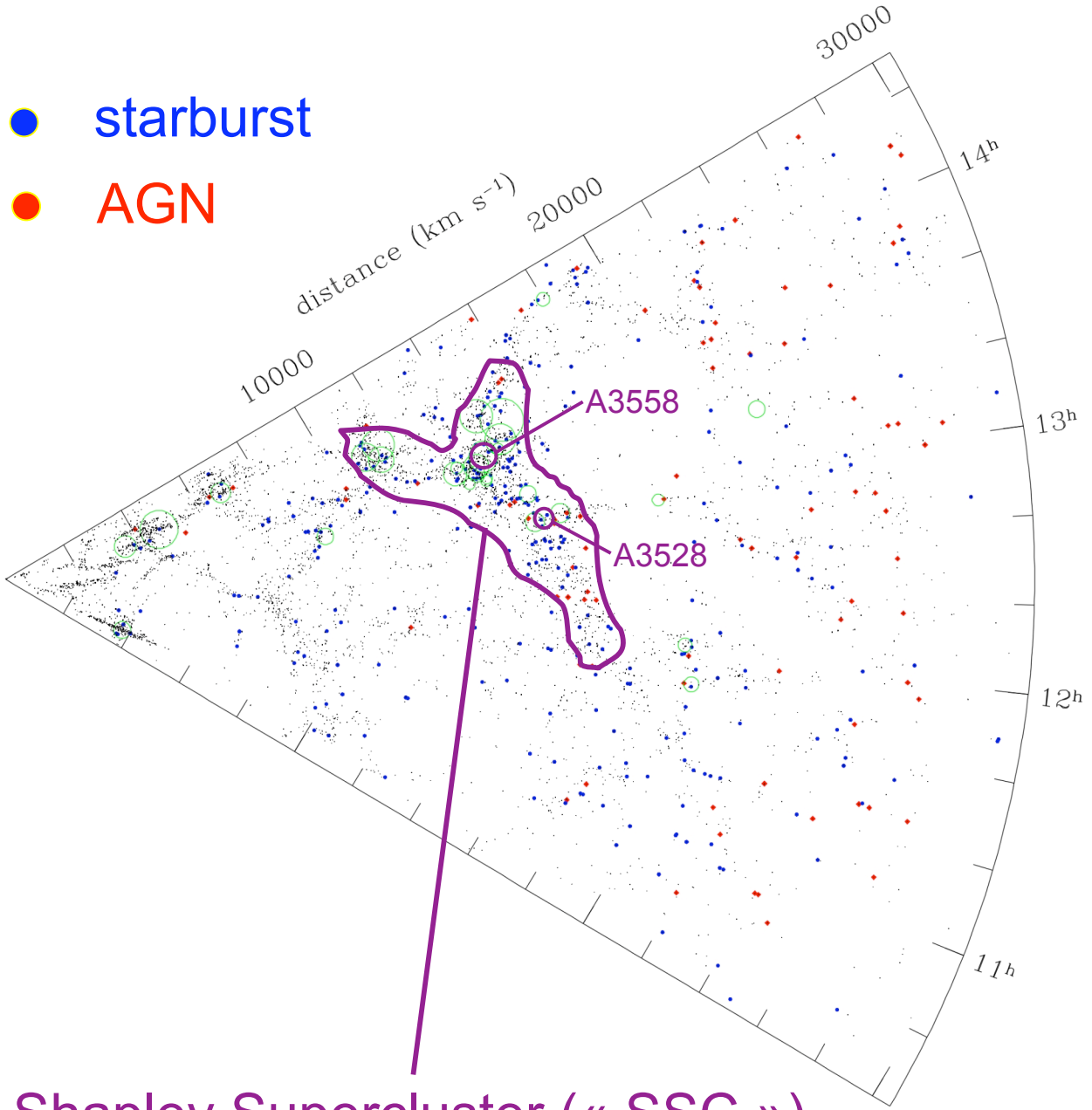
$L_{1.4GHz}$

radio loudness

$\mathcal{R}_K = L_{1.4GHz} / L_K$

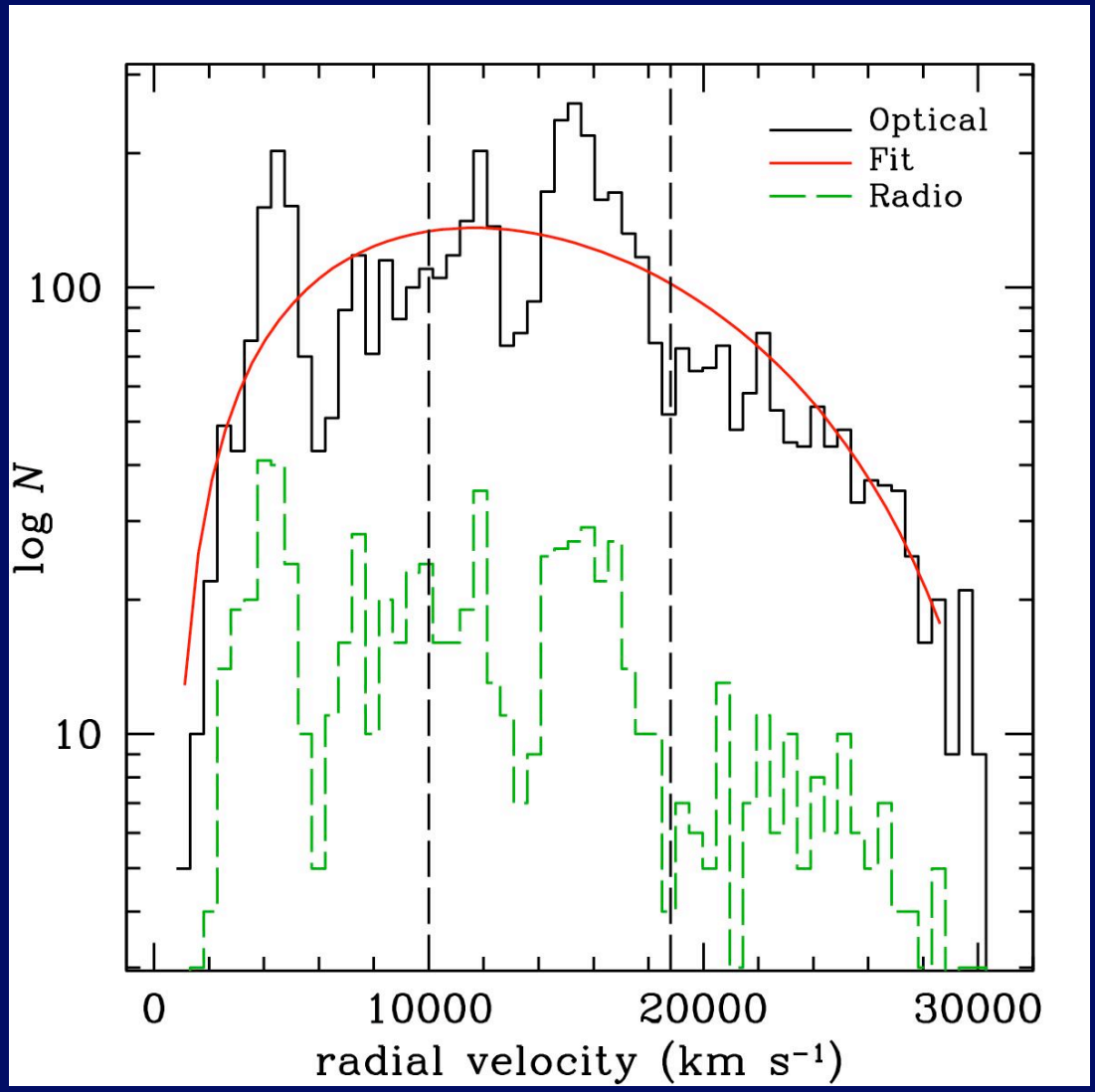
2MASS





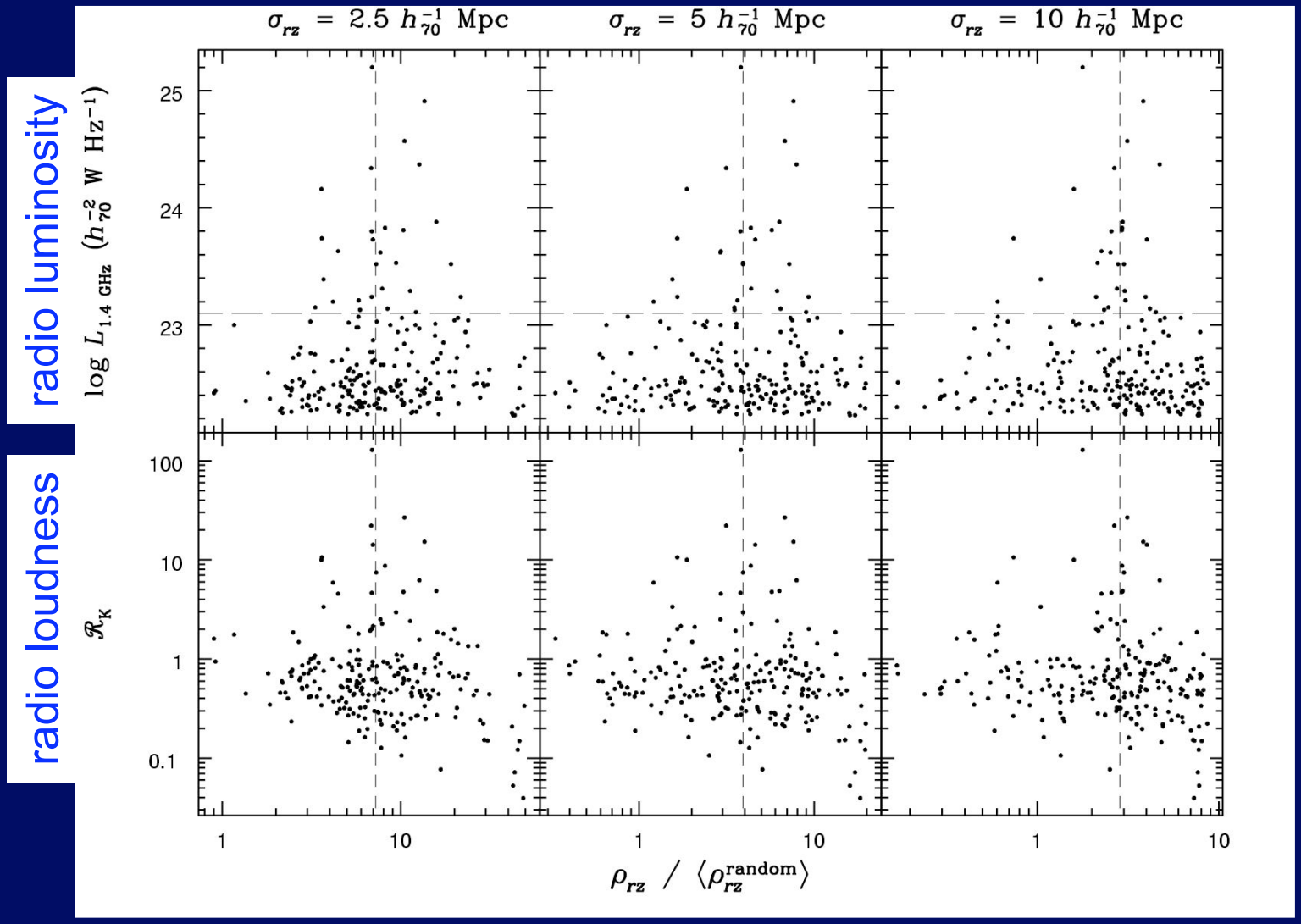
no AGN in A3558 Venturi et al 00

Radial velocity distribution

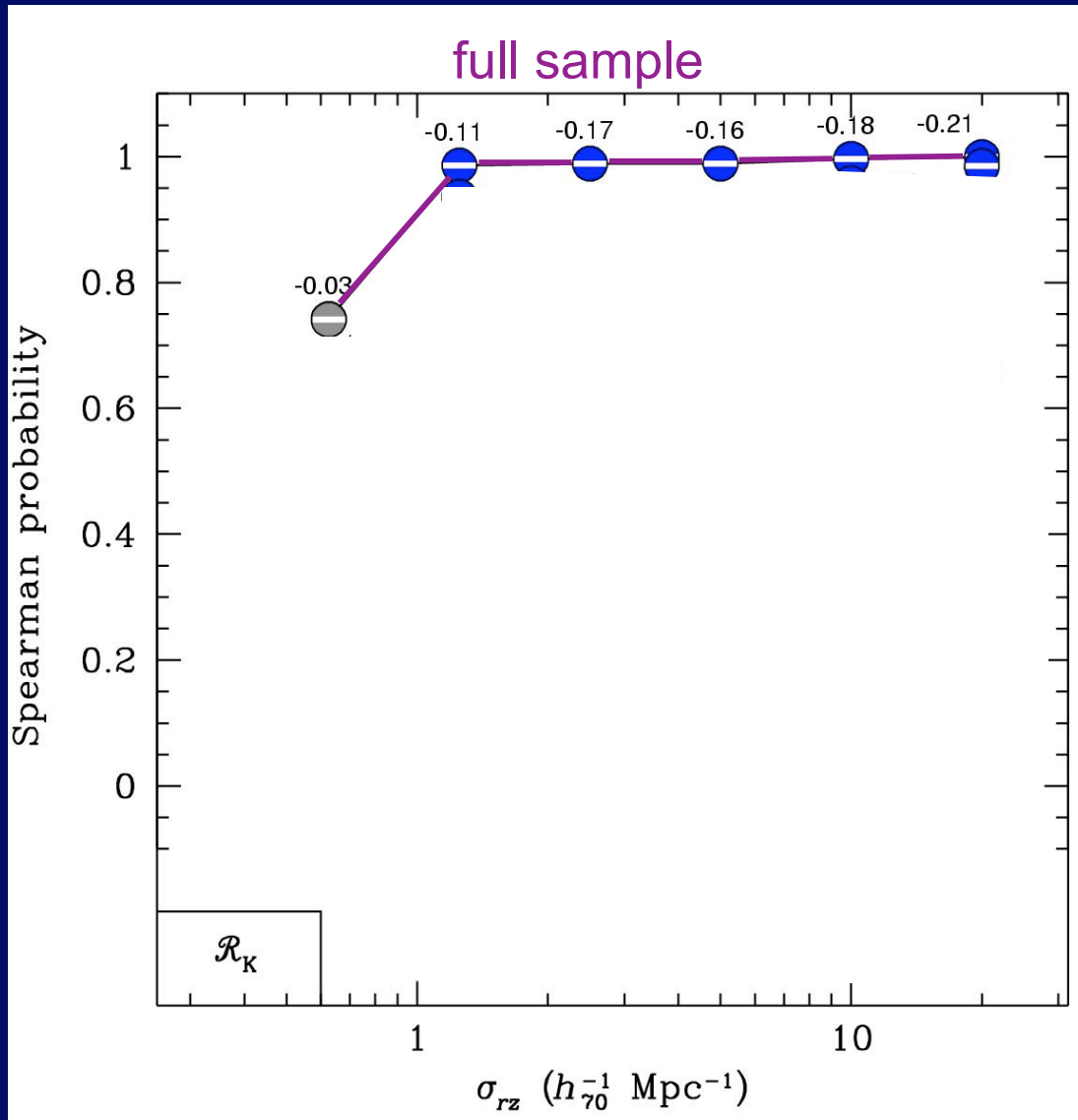


➡ radio sample not shallower than optical sample

Correlations with density of the environment



Statistics



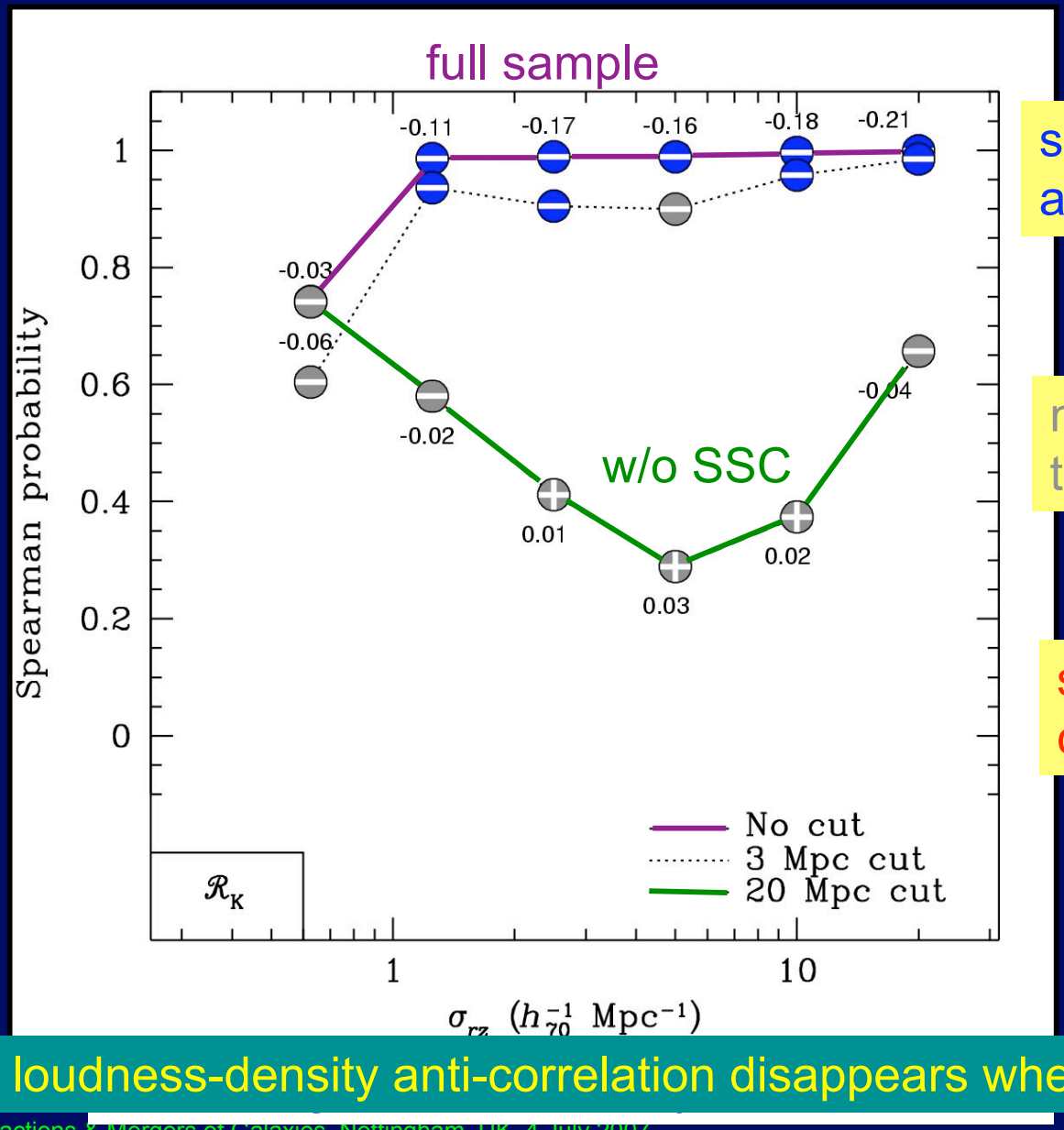
significant anti-correlation

non-significant trend

significant correlation

smoothing scale for density of environment

Statistics



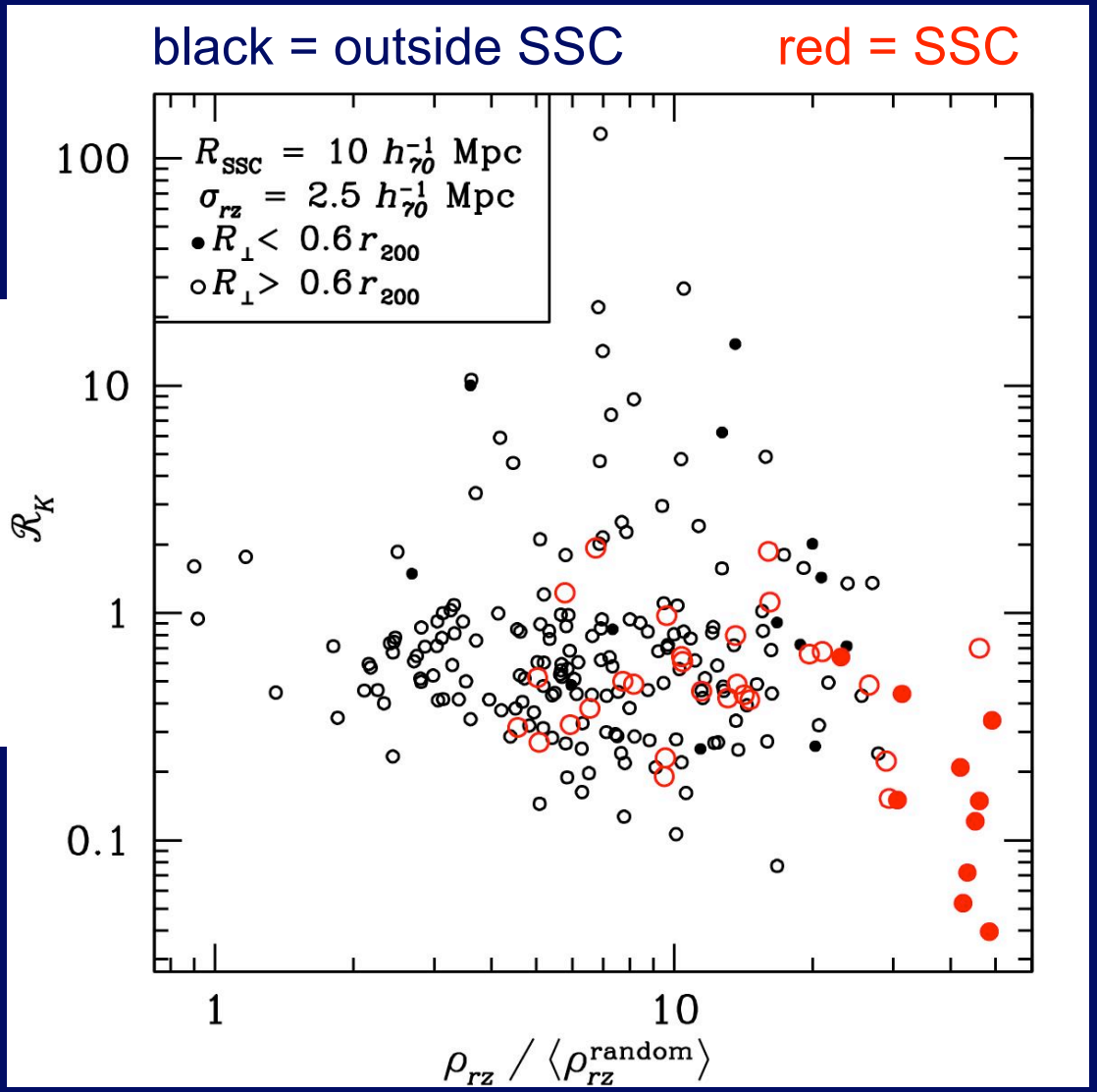
significant anti-correlation

non-significant trend

significant correlation

significant loudness-density anti-correlation disappears when SSC removed

Modulation by cluster

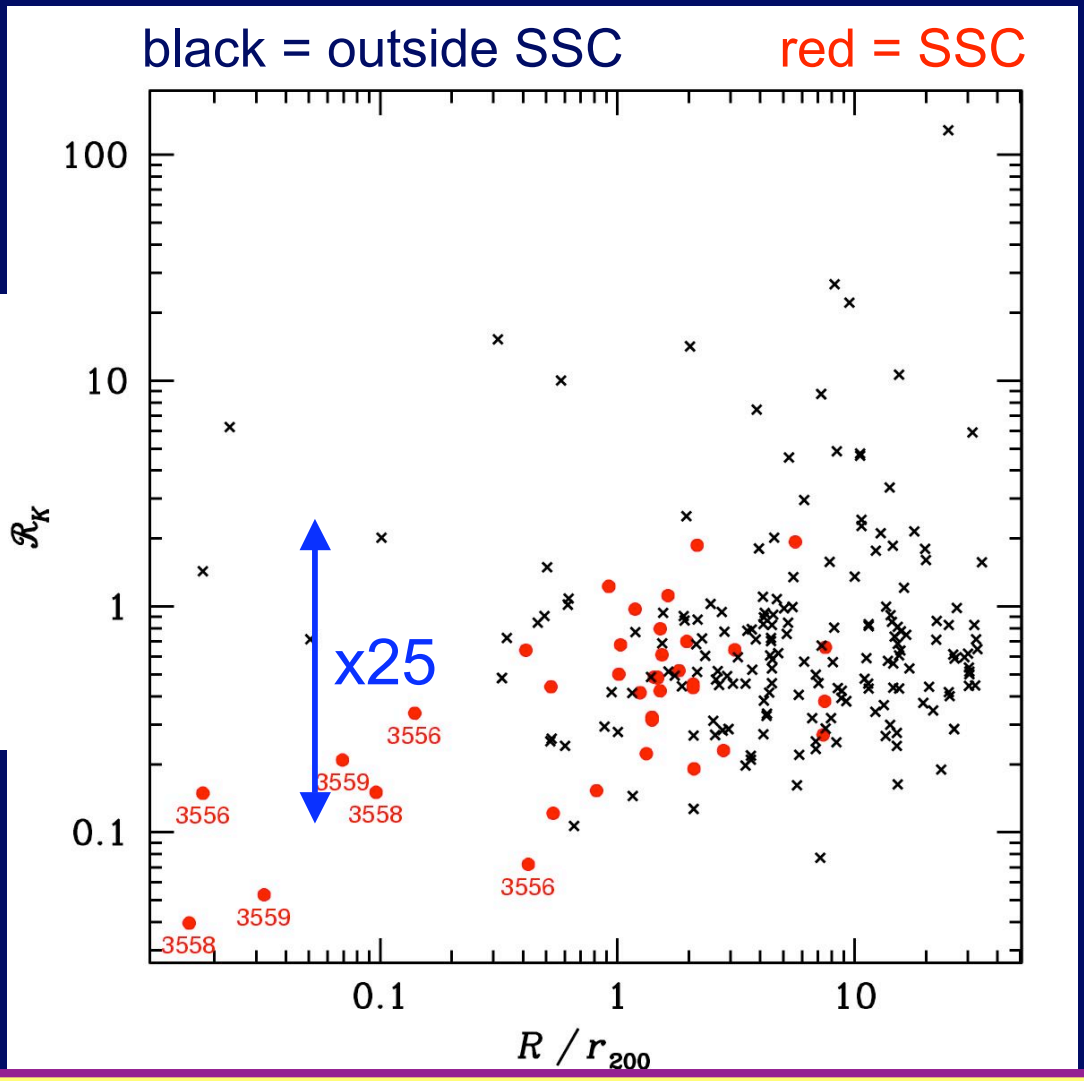


Significance of difference
of SSC clusters
vs non-SSC clusters

radio luminosity: 98%
radio loudness: 99.9%
K luminosity: 94%
B–*K*: 37%

➡ decreased radio-loudness of galaxies inside SSC clusters

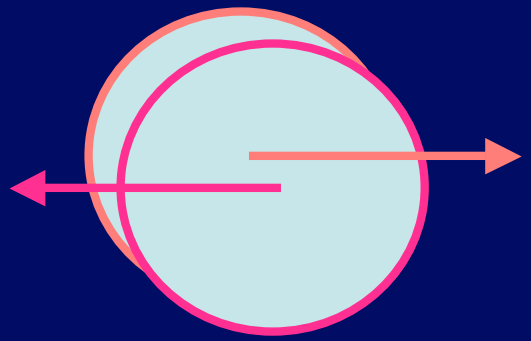
Radio loudness is decreased inside supercluster clusters



radio-loudness decreased within r_{200}, especially at small R

Why is loudness decreased in supercluster clusters?

Shapley supercluster = regions of colliding clusters



1st pericenter

Paths to lower radio loudness

AGN

Reduce Black Hole mass???
Reduce gas in galaxy ← ram pressure stripping
Prevent transport of gas near black hole
← fewer mergers & flybys
← strip gas at outer tip of bar

Starburst

Reduce gas in galaxy ← ram pressure stripping
Prevent stirring of gas ← fewer mergers & flybys

Radio loudness more reduced than radio or optical luminosity:
⇒ ram pressure stripping favored over tides

Decreased galaxy mergers or rapid flybys?

If so, would affect *fraction* of radio-loud galaxies,
not *values of radio-loudness*

Direct merger rates

$$\frac{d^2N}{dt\,dV} = n^2 k$$

$$k = \langle v S(v) \rangle$$

rate

$$S(v) = \pi\, p_{\rm crit}^2(v)$$

x-section

Rate of direct mergers in single cluster

$$\frac{dN}{dt} = n\,k = \int_0^\infty f(v)\, v\, S(v)\, {\rm d}v = {\rm cst}\, n\, \frac{r_{\rm gal}^2\, \sigma_{\rm gal}^4}{\sigma_{\rm cluster}^3}$$

Mamon 92, 00 (astro-ph/9911333)

Rate of direct mergers in overlapping clusters

$$\frac{dN}{dt} = n_1 k_1 + n_2 k_2$$

$$k_2 = \int_{-\infty}^{+\infty} {\rm d}v_{//} \int_0^\infty g(v_{//}, v_\perp) \sqrt{v_{//}^2 + v_\perp^2}\; S\left(\sqrt{v_{//}^2 + v_\perp^2}\right) {\rm d}v_\perp$$

Decreased galaxy mergers or rapid flybys?

If so, would affect *fraction* of radio-loud galaxies,
not *values of radio-loudness*

Galaxy merger and flyby rates in superposed clusters:
~ 4 x and 2 x merger and flyby rates in future relaxed cluster

Enhanced ram pressure stripping?

Galaxy feels *faster wind from 2nd cluster*

Ram pressure jump (≤ 4x) at shock front

Conclusions

Radio-loudness $L_{1.4GHz}/L_K$
decreased in Shapley supercluster clusters

Enhanced ram pressure stripping
caused by faster wind of 2nd cluster in merging clusters
and by ram pressure jump at shock front
quenches more efficiently star formation and the AGN