A homogeneous measurement of gas stripping and SF quenching in groups and clusters

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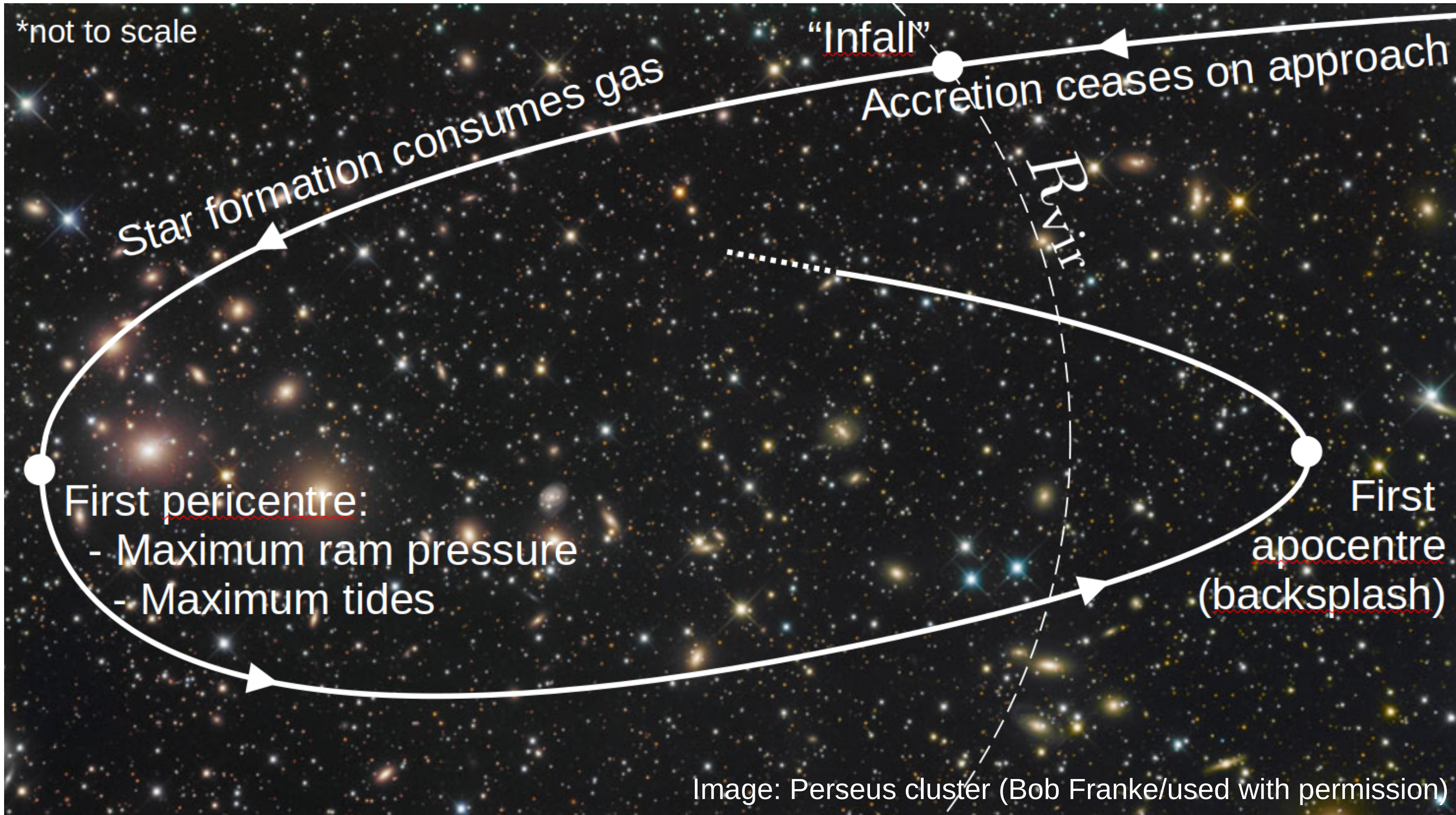
I. Context

Many physical processes are at play as satellites orbit their hosts. How can we *measure* which ones are key to regulating satellite evolution? This work links star formation histories and orbital histories to answer this question.

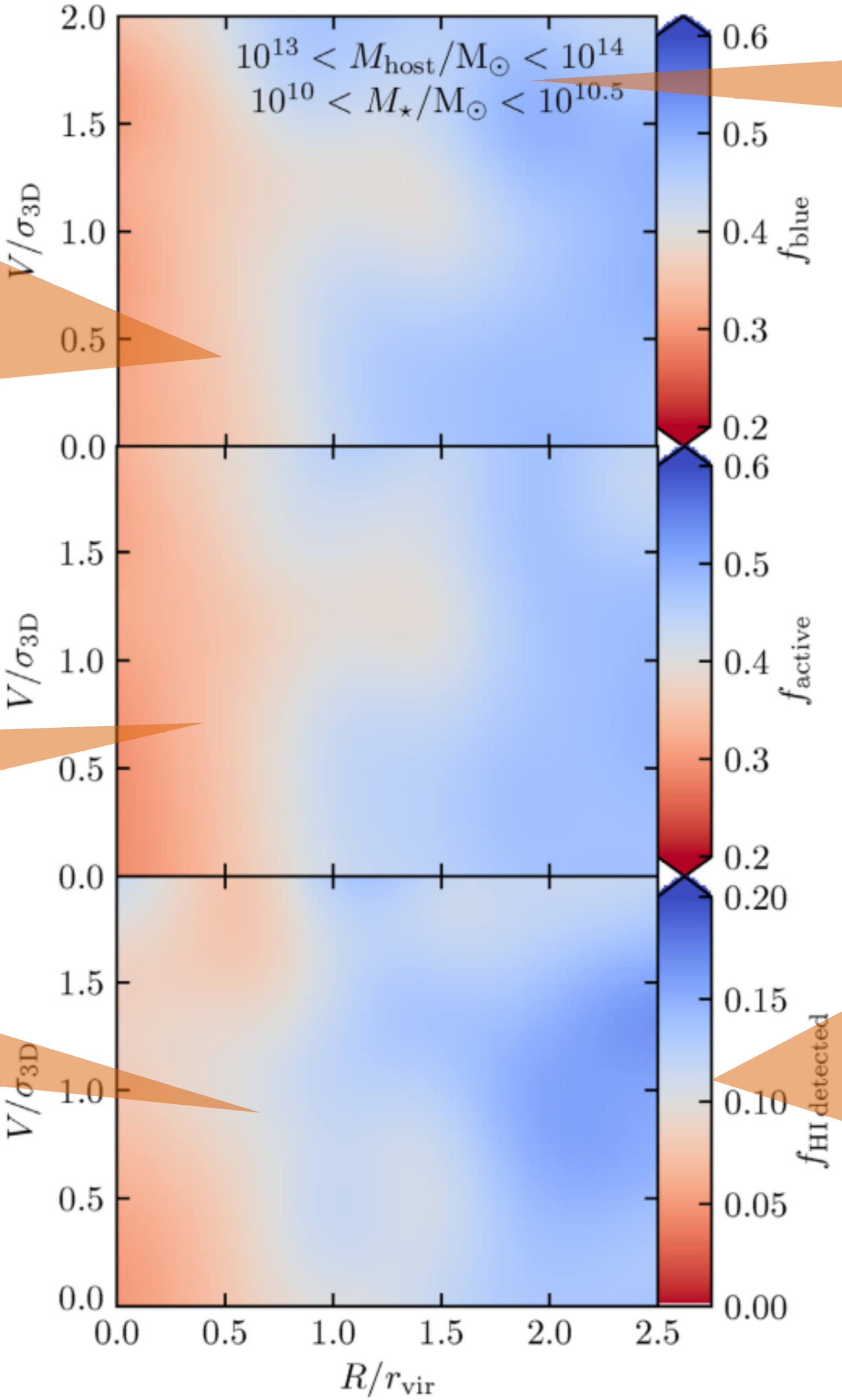


II. Method I

Projected phase-space (PPS) map of fraction of SDSS satellite candidates with blue (g – r) colour. Satellites with smaller projected offsets and/or velocity offsets from their host are more likely to be red…

…and more likely to be passive (sSFR < 10^{-11} yr^{-1})…

…and less likely to have neutral hydrogen detected in the ALFALFA survey.



Repeated for 6 x 3 bins in satellite stellar and host virial mass.

PPS coordinates encode information about satellite orbits. The probability distribution for the time since (or until) the first pericentric passage in the (current) host is estimated by referencing a library of orbits compiled from an N-body simulation.

Note smaller dynamic range. Most galaxies not detected in ALFALFA simply because they are too distant/faint, but can still use PPS map as a tracer of gas stripping!

III. Method II

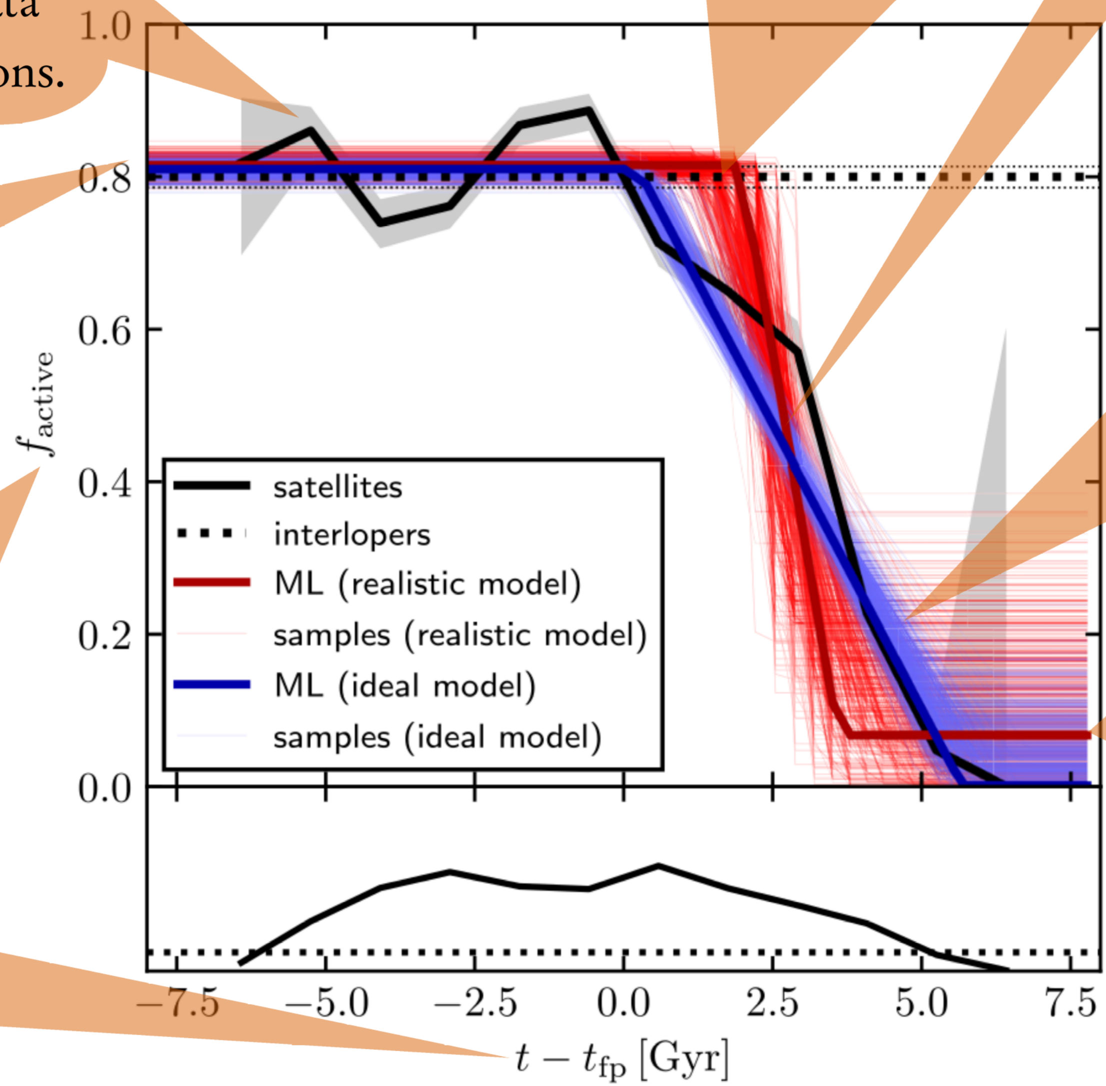
Trend to infer: the actively star-forming galaxy fraction as a function of time since first pericentre, here mock data from Hydrangea simulations.

Long before infall into host, $f_{active} < 1$: some quenched field galaxies.

Fraction of star-forming galaxies in satellite population as they progress on their orbits.

Reference time is time of first pericentre t_{fp}.
-ve: pre-first pericentre
+ve: post-first pericentre

When orbital information is inferred from PPS coordinates + reference library of orbits from an N-body simulation, model (red) accurately recovers *timing* of decline (but underestimates *timescale* of decline).



Key model parameter: time t_{mid} when half of galaxies which will be quenched (or stripped), by their host, have been quenched/stripped by their host.

If model (blue) is provided full orbital information (inaccessible in observations), true trend (black) is accurately captured.

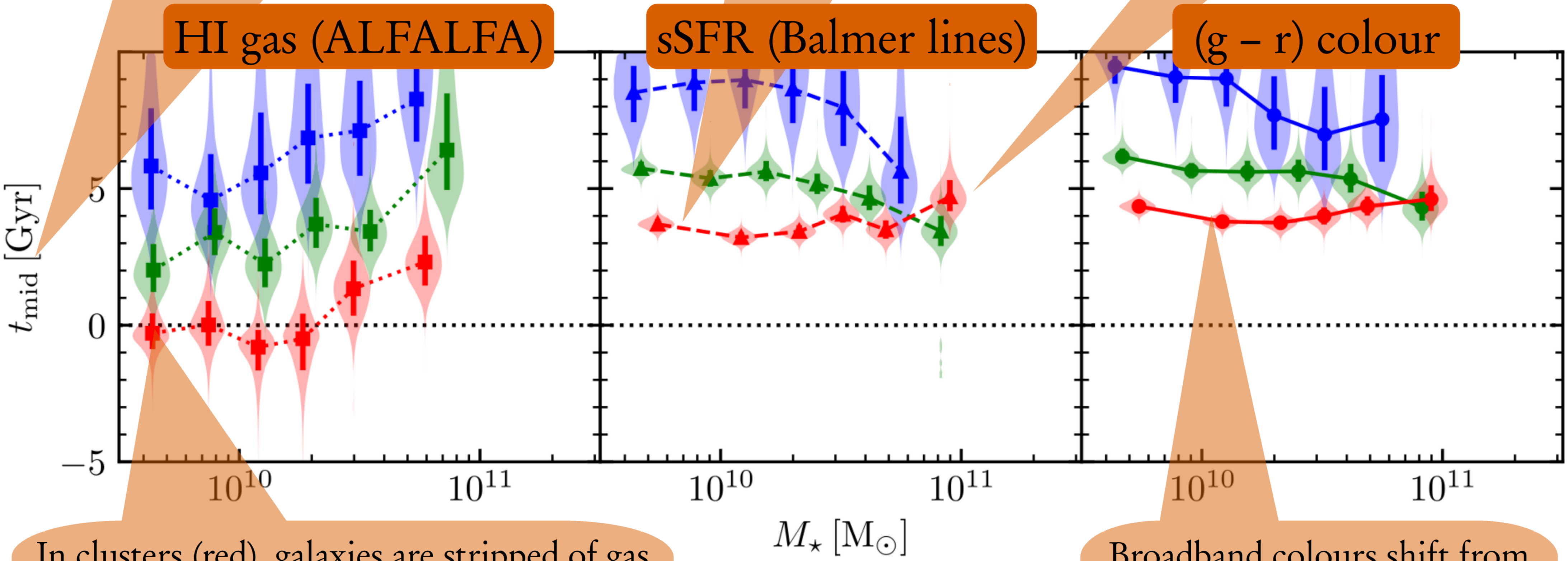
After “long enough”, essentially all satellites have been quenched by their host.

IV. Results

Main result: time since (or to) first pericentre when 50% of intially gas-rich (or active) satellite population has become gas-poor (or passive).

Quenching (based on sSFR from Balmer lines) occurs a few gigayears after satellites no longer detected in HI (ALFALFA). Some gas survives first pericentre to sustain star formation.

All trends (HI stripping, quenching traced by sSFR or broadband colour) fairly flat with stellar mass.



In clusters (red), galaxies are stripped of gas (no longer detected in ALFALFA) around first pericentre. In progressively lower-mass groups (green, blue) gas is retained longer.

See paper ↗ Sec. 6.3 for a detailed physical interpretation.

Broadband colours shift from blue to red a few hundred megayears after Balmer lines disappear.