Annoying neighbours

black hole feedback beyond the central host galaxy

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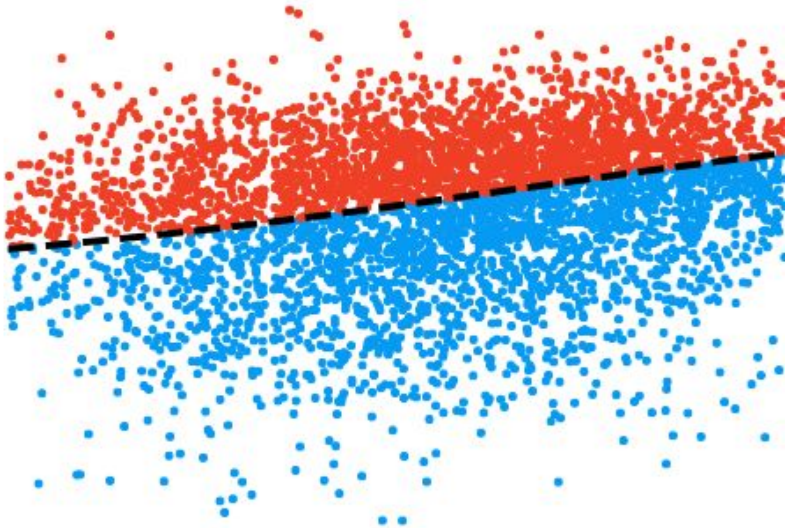
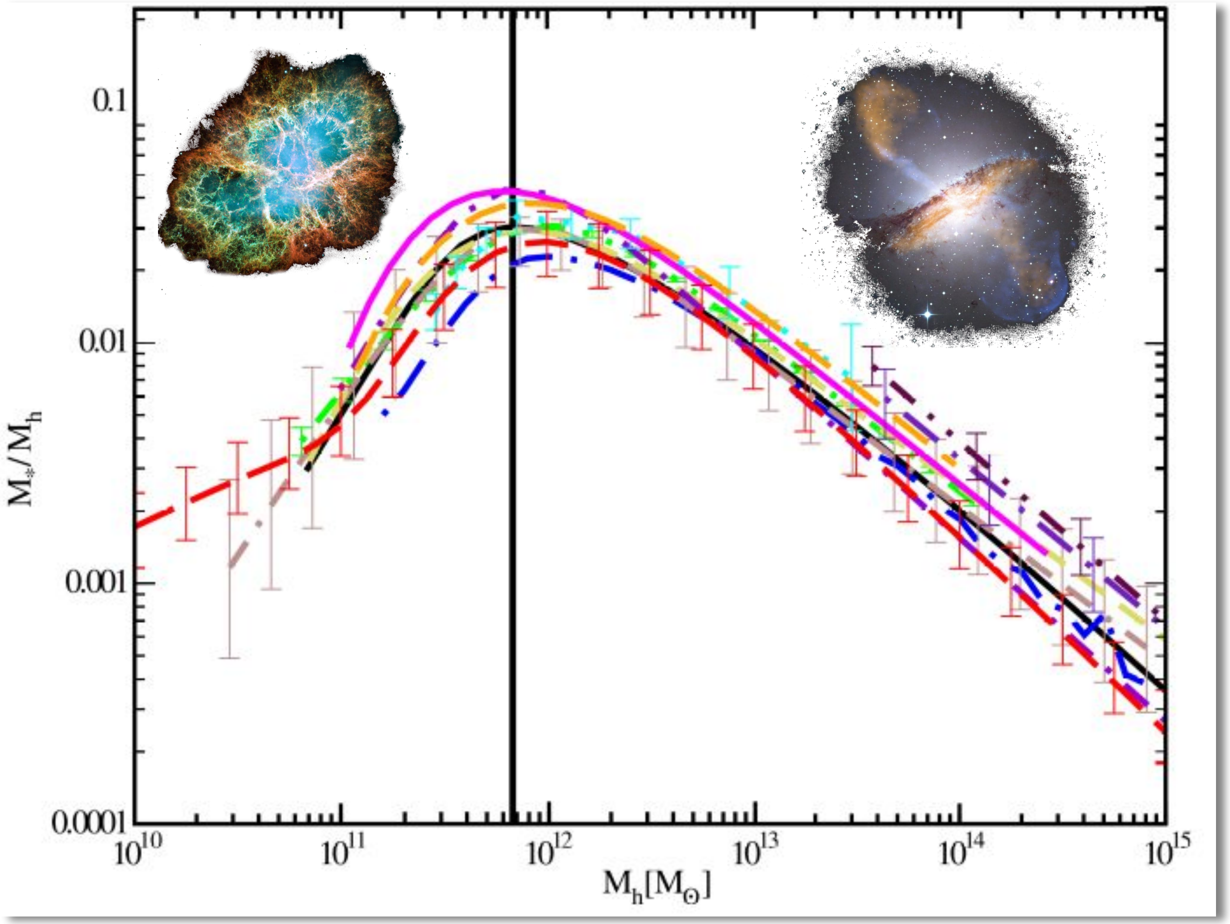
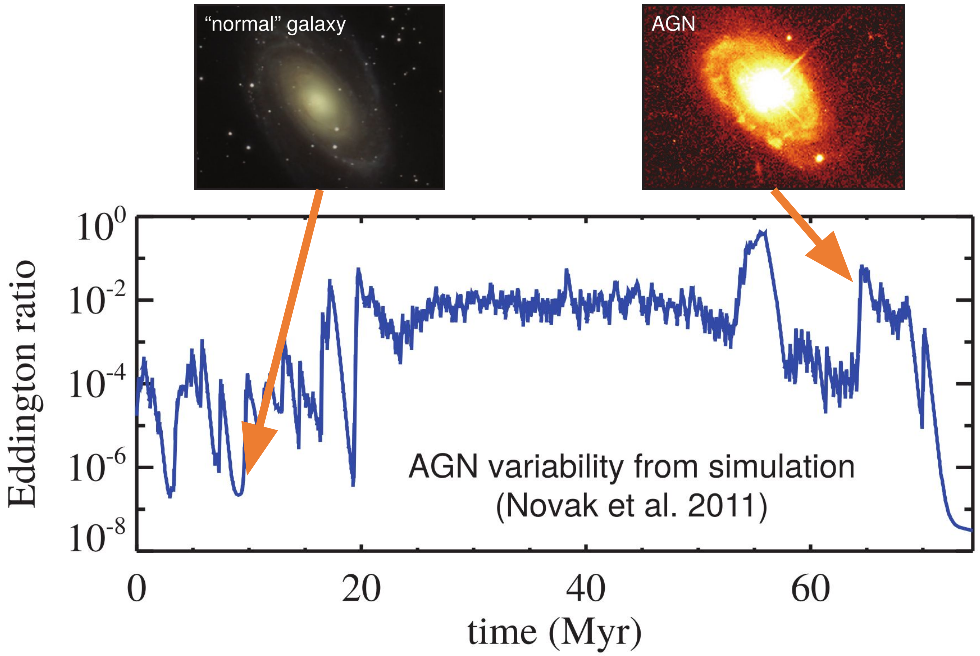
Black hole feedback results from the energy radiated at parsec scales from the centers of massive galaxies. Yet, this process is energetic enough to regulate the evolution of the host galaxy itself. ***We present here observational evidence suggesting that, in the most massive halos, black hole feedback from the central galaxy is able to drive the evolution of the satellite population***, megaparsecs away from the center of the halo. Moreover, this large-scale feedback leaves its energetic imprint on the thermodynamics of the intracluster medium, as halos hosting more massive black holes are heated more efficiently above the virial temperature.



Black hole feedback: an overview

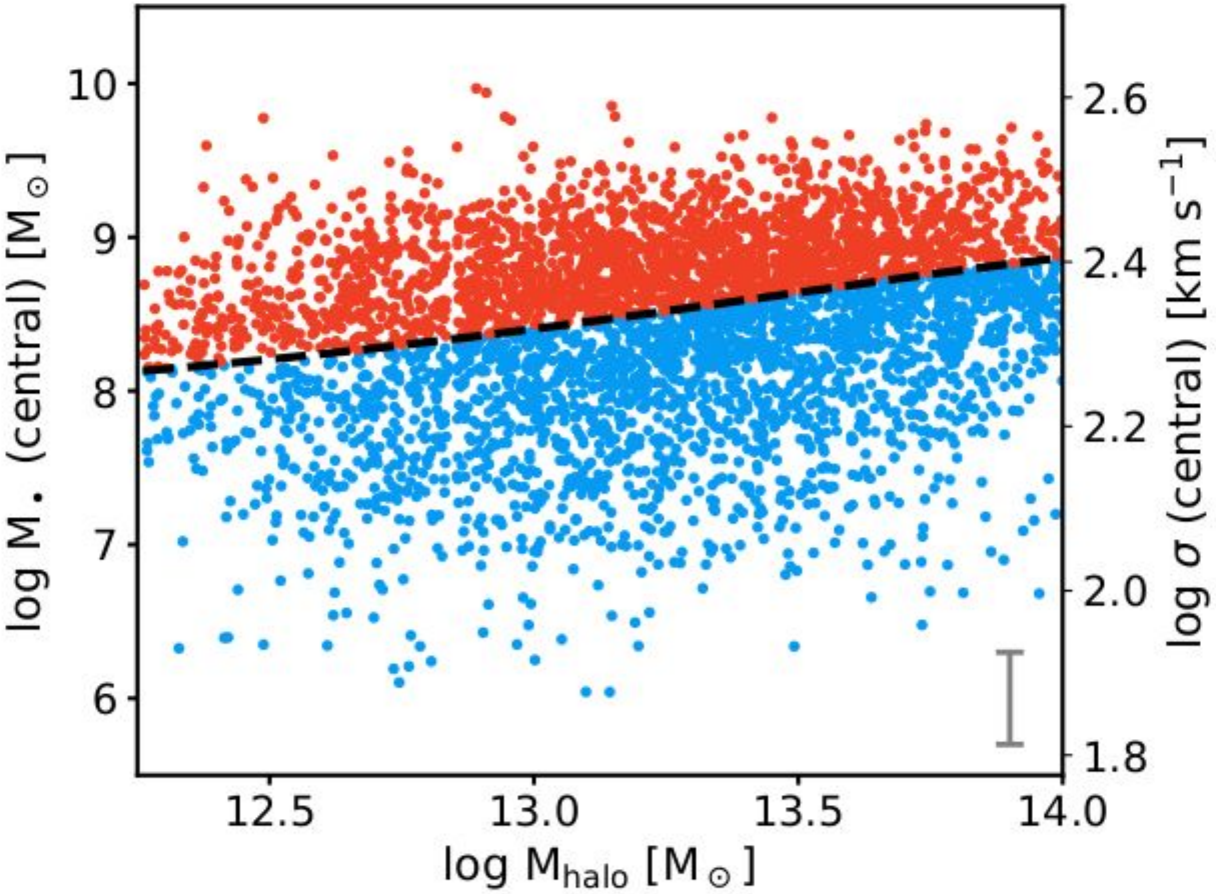
SN regulated **AGN regulated**





Within our understanding of galaxy evolution, black hole feedback is currently **the only feasible way to regulate the baryonic cycle in the most massive halos** ($M \gtrsim 10^{12}$ $M_\odot$). However, it varies in time-scales much shorter than gas cooling does, making the study of the star formation - AGN connection particularly challenging.

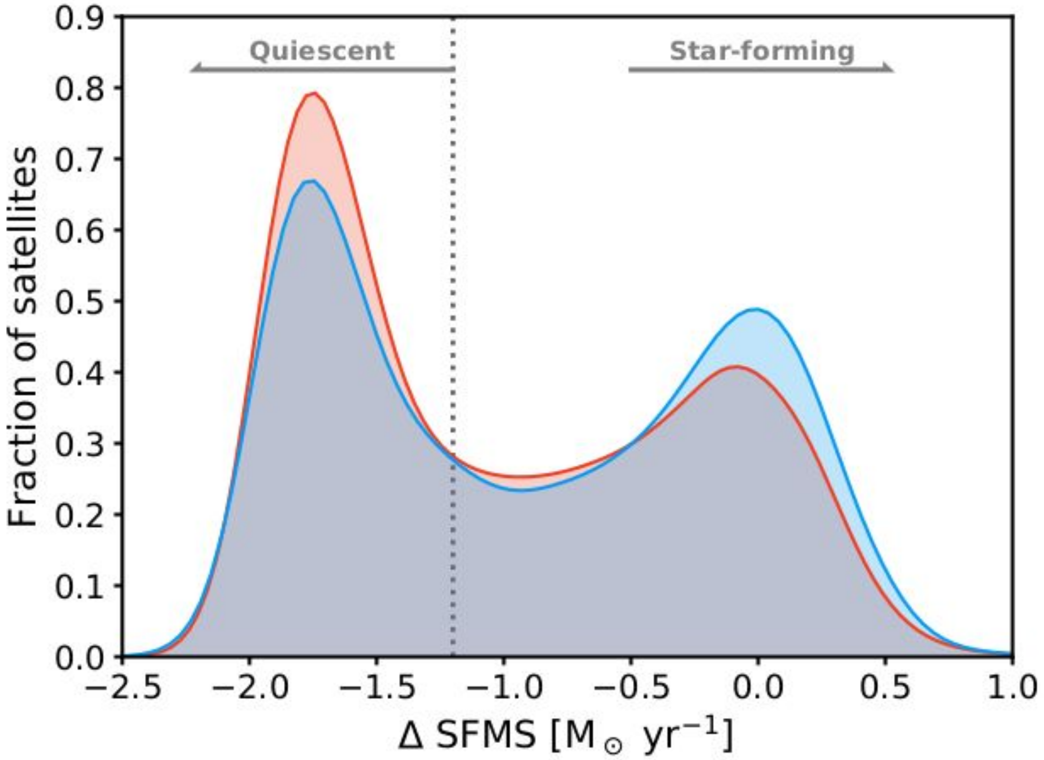
Similar halos, different black holes

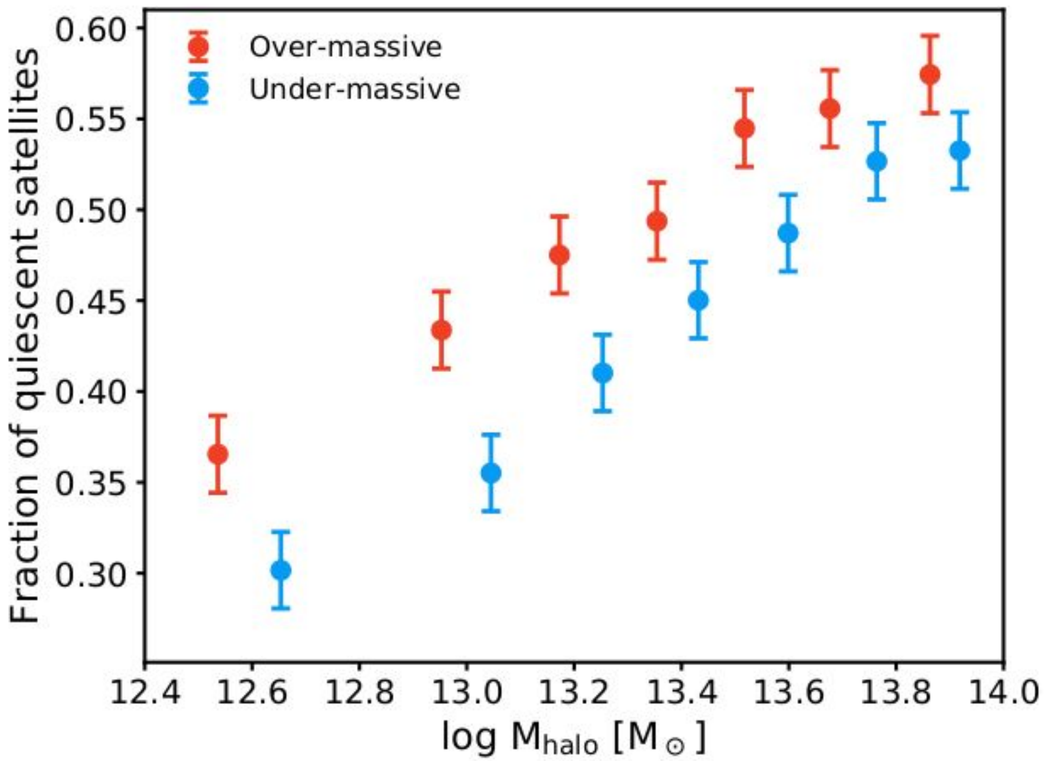


Based on our experience with individual galaxies ***(MN+16;18;20)***, we set out to do a rather simple experiment. We selected a sample of groups and clusters with similar characteristics (M_{halo}, size, richness, total stellar mass, density profile…) but different black holes in their centers, as measured from the velocity dispersion of the primary galaxy.

Since black a hole releases over its life an amount of energy that scales with its current mass ($\varepsilon \sim f\, M_{\bullet} c^2$), our working assumption is that **groups and clusters with more massive black holes in their centers should have experienced, cumulatively, more intense feedback**.

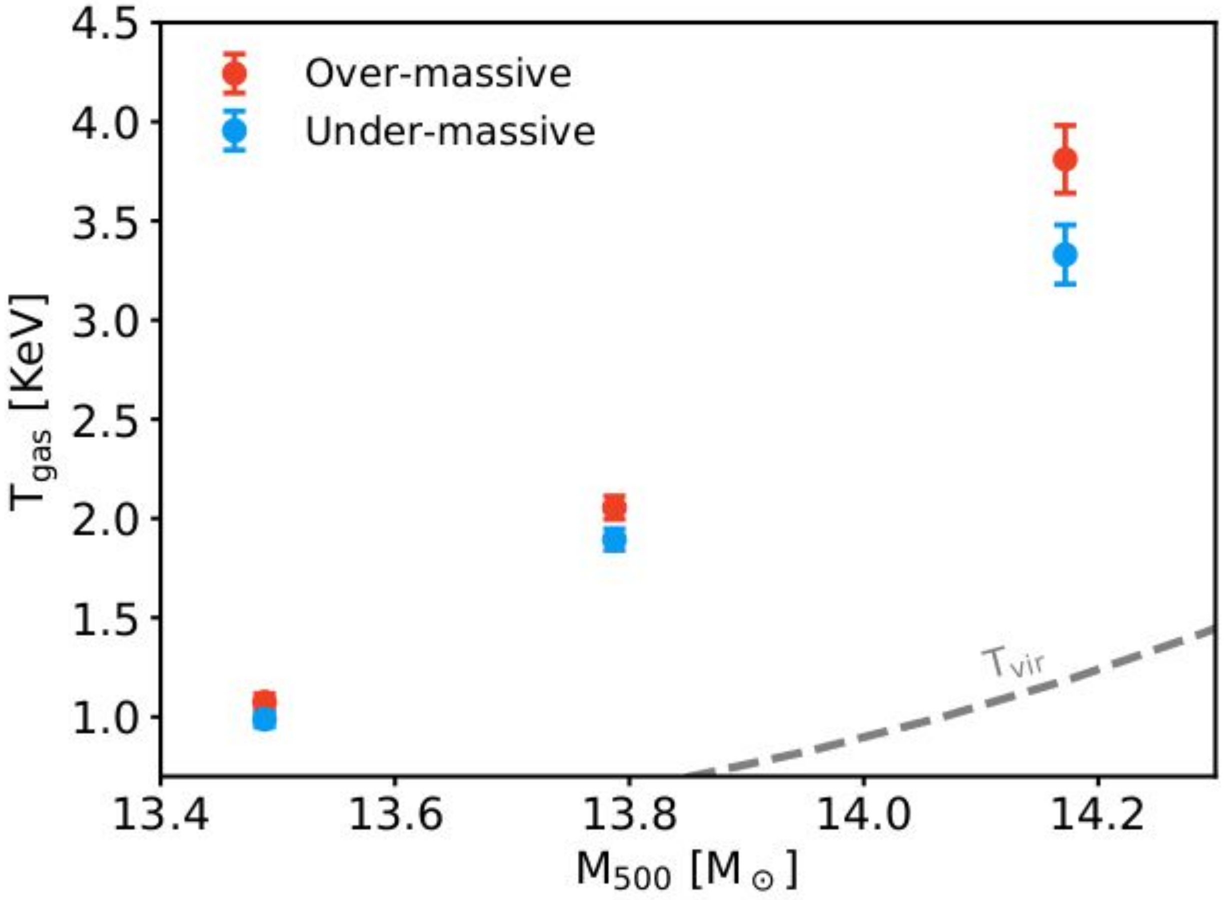
Results I: enhanced fraction of quiescent satellites





Although, by construction, the number and mass of satellites in over-massive black hole halos (in red) was the same as un under-massive black hole halos (in blue), we found that **the fraction of quiescent satellites was systematically higher in those halos harbouring massive black holes in their centers.**

Results II: hotter intracluster medium



When looking at the X-ray properties of our sample we found that both over-massive and under-massive black hole halos remain hotter than the expected virial temperature. **However, those halos with more massive black holes in the center exhibit systematically higher temperatures than those hosting lighter black holes.**

This is a striking result as the virial temperature of a halo is defined by its mass (and size), which are forced to be the same in our sample.

In summary

- Our definition of over-massive and under-massive black hole halos (groups and clusters) is an **empirical metric for the cumulative effect of black hole feedback** and thus, it can be used to study the role of black hole feedback in regulating the baryonic cycle within massive dark matter halos.

- We found that **halos hosting more massive black holes in their centers tend to have an enhanced population of quiescent satellite galaxies, as well as sustaining a hotter intracluster medium**, well above the expected virial temperature.

- Since our sample was selected to avoid any differences between over-massive and under-massive black hole halos, **we interpret our results as a consequence of the effect of black hole feedback** over megaparsec scales, heating up the intracluster medium and enhancing the effect of cluster-related quenching mechanisms such as ram pressure stripping and/or starvation.

- We are now carrying out a detailed **stellar population analysis** of our sample, which will provide the time-resolved picture of the effect of black hole feedback on the evolution of massive halos, constraining the way in which the central galaxy drives the evolution of the surrounding population of satellites.

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