

Black holes regulate cold gas accretion in massive galaxies

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Background

- SMBHs is believed to play a central role in regulating galaxy growth.
- It remains unclear whether and how BHs impact the ISM.
- The black hole mass (M_{BH}), rather than the instantaneous AGN power, should be the key parameter.
- Whether there is a direct link between M_{BH} and the cold gas (HI gas) content in galaxies?

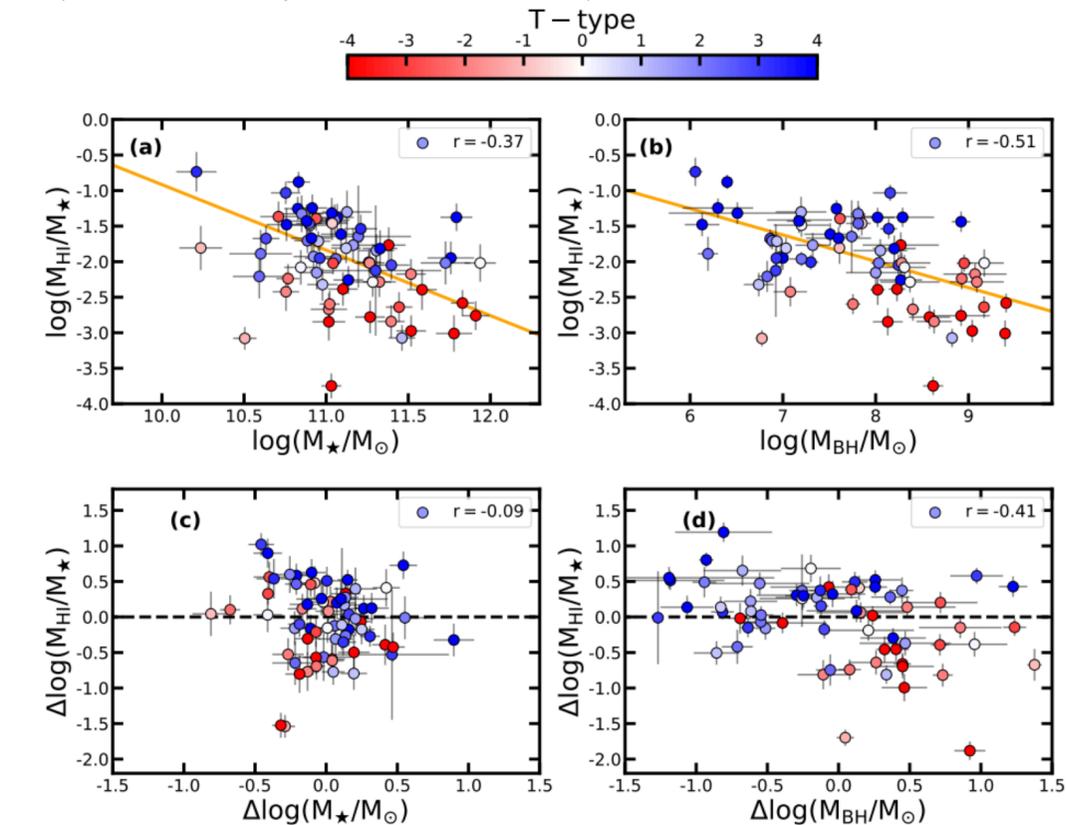
Sample

The BH sample (69 galaxies):

- galaxies with direct (dynamical) measured M_{BH} .
- HI mass (21 cm line) from HyperLeda database.

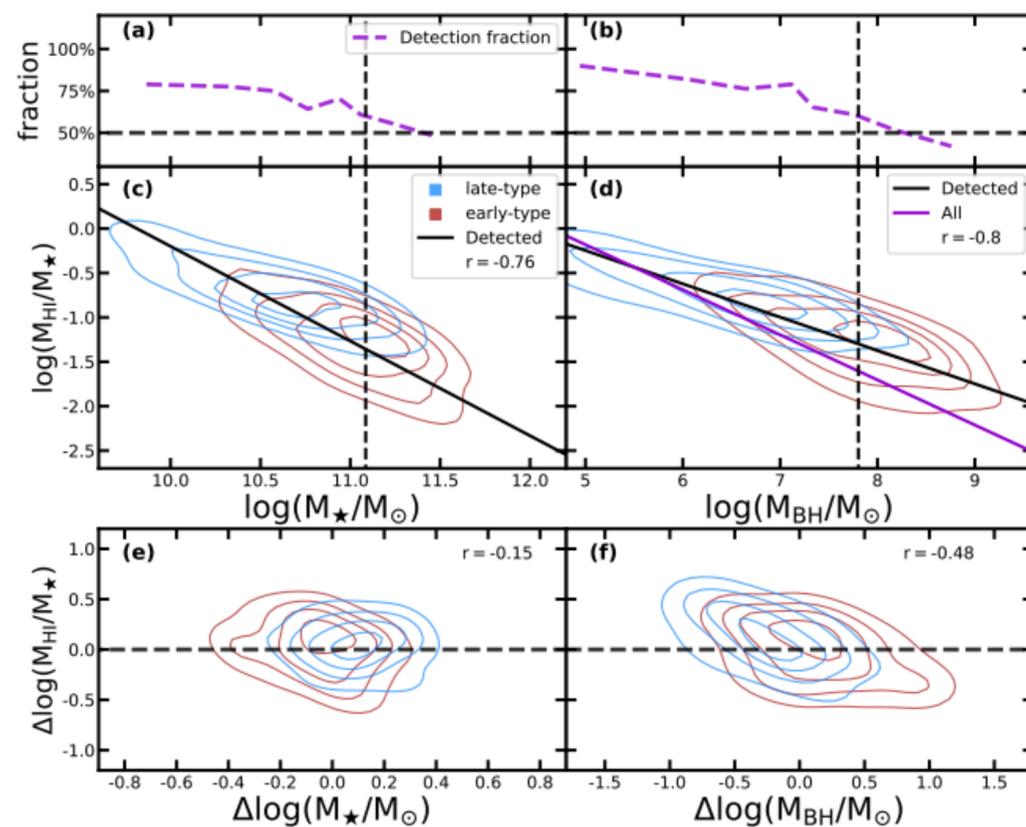
The galaxy sample (572 galaxies):

- Central galaxies with HI measurements and indirect (from L_K and Re_K) BH mass measurements.
- HI mass from xGASS or HI-MaNGA (365 detection/207 non-detection).



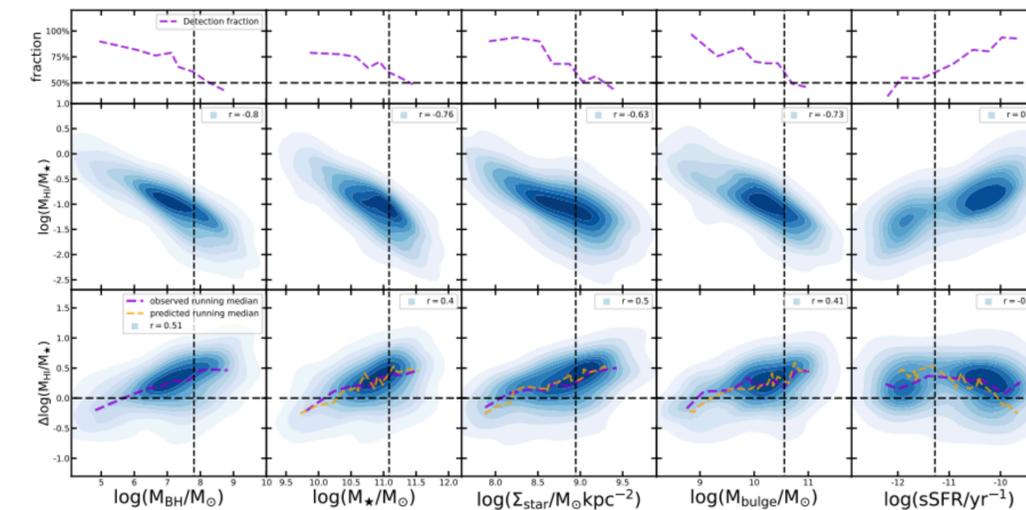
→ The impact of M_{BH} on the correlation between f_{HI} and other major galactic parameters

- Significant correlations exist between f_{HI} and all these parameters for the HI-detected galaxy sample.
- After removing the dependence on M_{BH} based on the $f_{\text{HI}} - M_{\text{BH}}$ relation (including non detection), the residual shows much weaker correlation with the other parameters.
- Residual correlations are due to the observational biases in the HI-detected galaxy sample.
- M_{BH} dominates the variance of f_{HI} . (the PLS analysis also suggests a similar conclusion.)



Comparison between the $f_{\text{HI}} - M^*$ and $f_{\text{HI}} - M_{\text{BH}}$ relation for the BH sample (←) and the galaxy sample (↑)

- A strong and inverse correlation was observed between the f_{HI} and M_{BH} .
- After removing the correlation of both f_{HI} and M^* with M_{BH} , f_{HI} shows no dependence on M^* .
- This suggests that the $f_{\text{HI}} - M^*$ correlation is primarily due to the correlation between M^* and M_{BH} .



Proposed scenario

The binding energy of the halo determines how much gas can be accreted onto the dark matter halo, while the energy from BHs heats up the gas, preventing it from further cooling and accretion.

1. f_{HI} is determined by inner halo binding energy and the energy released from BHs ($E_{\text{BH}} \propto M_{\text{BH}}$).
2. Enhanced gas accretion increases both f_{HI} and M_{BH} , triggering AGN heating.
3. The feedback prevents further gas cooling/accretion, leading to a new balance at higher M_{BH} .

