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Black holes regulate cold gas accretion in massive galaxies

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Nearly every massive galaxy contains a supermassive black hole (BH) in their centers. For decades, both theories and numerical simulations suggest a central role of BHs in regulating the growth of galaxies. In particular, BH feedback through heating or blowing up the interstellar medium (ISM) serves as the foundation for current models of massive galaxy formation. However, direct evidence for such an impact on the galaxy-wide ISM from BHs has only been found for some most extreme objects. For general galaxy populations, it remains unclear on how BHs affect the ISM. Here based on a large sample of nearby galaxies with measurements of both BH mass and atomic hydrogen, the major component of cold ISM, we reveal that the atomic hydrogen content ($f_{\rm HI} = M_{\rm HI}/M_\star$) is tightly and inversely correlated with BH masses with $f_{\rm HI} \propto M_{\rm BH}^{-\alpha}$ ($\alpha \sim 0.6$), which is valid across five orders of magnitude in BH masses. Once this correlation is accounted for, $f_{\rm HI}$ loses dependence on other galactic parameters, indicating that BHs masses serve as the primary driver of $f_{\rm HI}$. This result provides critical evidence on how the accumulated energy from BH accretion affects the surrounding ISM, which marks an important step forward in our understanding on the central role of BHs in regulating the growth and quenching of galaxies.

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