HOW MUCH ENERGY DO GROWING SUPERMASSIVE BLACK HOLES DUMP IN THEIR HOST GALAXIES AND HOW IS IT DEPOSITED?

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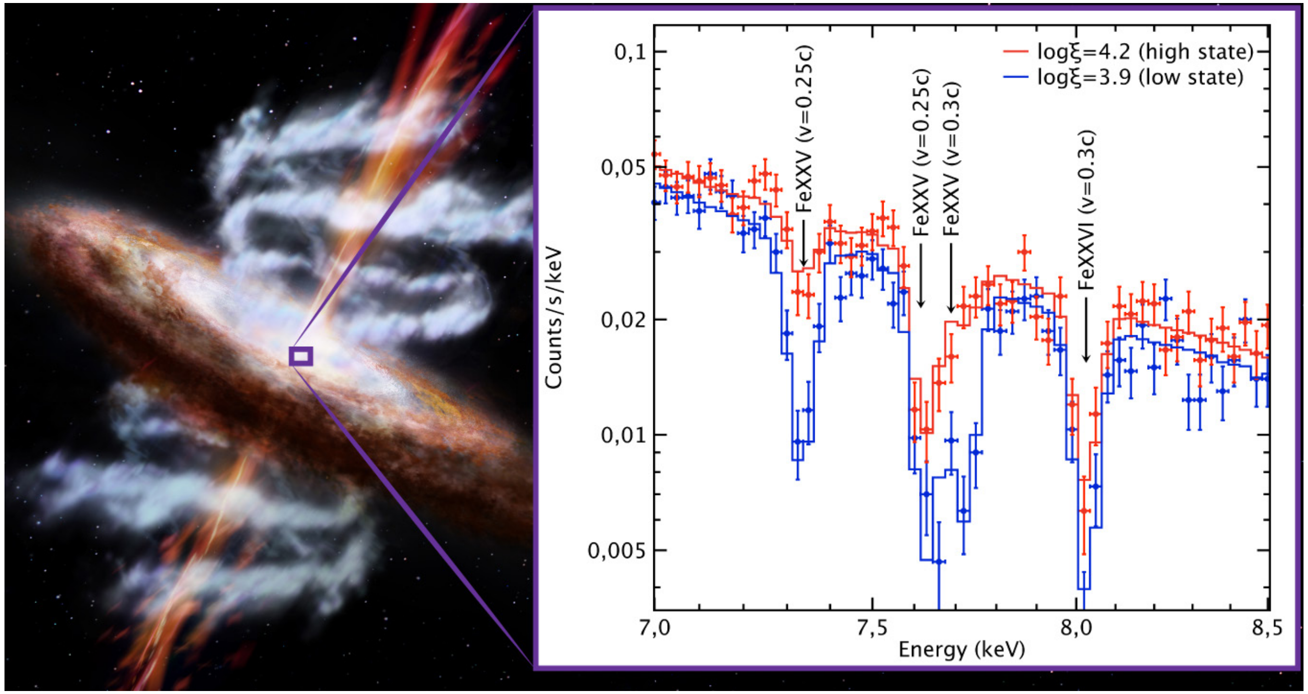
Massive galaxies host a supermassive black hole at their center with a mass tightly correlated with that of the host galaxy itself. The most likely reason for this remarkable observational fact is that a self-regulating mechanism connects the accretion-powered growth of the Super-Massive Black Hole (SMBH) to the star-formation-powered growth of the host galaxy. Winds and outflows expelled from the vicinity of SMBH are a possible such feedback mechanism impacting the entire host galaxy. The outstanding questions are then whether these winds and outflows have enough energy to do the job and how are they produced.

Winds and outflows produced by Active Galactic Nuclei (AGN) are commonly seen as blue-shifted and broadened absorption lines in their Ultraviolet and X-ray electromagnetic spectrum. These absorption systems trace ionized matter being expelled from the central engine. They span a wide range of velocities and physical conditions (distance, density, ionization), and each component carries energy and momentum away from the small-scale SMBH environment into its larger-scale (galaxy-wide) environment.



Simulation of the X-ray spectrum resulting from a system showing two types of X-ray winds. Left: Pictorial representation energy released by the SMBH at the center of the galaxy (surrounded by the accretion disc), via collimated (in orange-red) and uncollimated (white) winds. Right: a so-called "ultra fast outflow" with higher velocity, higher ionization seen only above 6 keV. The calorimeter on-board Astro-H would have probed simultaneously the many low and high-energy absorption features from these absorbers, thus yield a global characterization of AGN outflows/winds. Only the unprecedented sensitivity of the Athena/X- IFU will allow us to resolve temporal changes in the ultra-fast outflow wind structure for many bright AGN, and on short dynamical timescales (1000s seconds), revealing the wind acceleration process. Credit: ESA/AOES Medialab

The most powerful components of these outflows/winds are the fastest ones, observed to have a velocity up to a third the speed of light. These components are so highly ionised that they can be detected only at X-ray energies. The extremely large velocities point to an origin very close to the SMBH at the center of the AGN, but the launching and acceleration mechanisms remain unclear. Possibilities include radiation pressure and magnetic forces driving the outflowing wind. Yet, we would like to know not only how do AGN launch winds/outflows, but also how much energy is carried away, and how much of it is deposited in the interstellar medium.

The key to progress on these questions is a detailed characterization of the physical properties of these winds (column density, ionization state, outflow velocity, location, geometry, covering factor, luminosity, etc.), allowing researchers to seek correlations among these parameters that can be compared with those expected from theoretical acceleration models.

X-ray observations are required to determine the column density, the outflow velocity, the ionisation state and the geometry of each component, and hence the total kinetic energy in the wind. Athena's high spectroscopic throughput instrument X-IFU will allow for a giant leap of sensitivity to most ionization states of light elements, and to all ions of Fe, thereby providing a detailed characterization and understanding of the AGN outflows on their dynamical timescale.