Finding the infant massive black holes in the early universe

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A new computer model uses a novel X-ray feedback effect from a black hole as it soaks up matter from its neighborhood to better understand what a black hole does to its environment and the effect on its host galaxy's star formation.

"We'd like to see if we can distinguish, in the early universe, whether a young galaxy is hosting a massive black hole at its center or not, and how can we actually distinguish them," said Ayçin Aykutalp, a post-doctoral astrophysicist at Los Alamos National Laboratory. This work combines state-of-the art cosmological simulation with a radiative transfer post-processing analysis tool to derive observational signatures of these systems which has never been done before.

Aykutalp and collaborators Kirk Barrow, research fellow at Stanford Kavli Institute for Particle Astrophysics and Cosmology, and John H. Wise of Georgia Institute of Technology simulate the evolution of a halo that hosts a so called "direct collapse" black hole at its center using the cosmological radiation hydrodynamics code ENZO. In addition to the radiative-hydrodynamic simulation, the researchers stage a radiative transfer post-processing analysis using the CAIUS pipeline, an end-to-end radiative transfer model developed by Barrow, which allows the team to provide observational predictions of these systems to be seen through the forthcoming James Webb Space Telescope (JWST).

"When a black hole soaks up matter it irradiates X-ray photons that blows away the gas from the vicinity of the black hole that inhibits its further growth, but at the same time X-rays enhance star formation by increasing the electron fraction of the ambient gas," said Aykutalp. All this has distinct effects for the derived observables of these young systems.

"The work lays out a test bed for our theoretical models by providing, for the first time, observational diagnostics to distinguish and detect these galaxies in the early universe," said Aykutalp.

The JWST, set to launch in 2021, could one day use these observational diagnostics to detect the young galaxies hosting infant massive black holes.

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