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The Role of Supermassive Black Holes in Galaxy Evolution

Wednesday 24 September 2025 09:45 (45 minutes)

I will present an overview of the history of observing supermassive black holes (SMBHs) in contemporary astronomy, including discussing various methods to detect these objects, and constrain their masses and accretion rates. I will go on to review important evidence for SMBHs impacting their host galaxies via a mix of : (i) “quasar-mode”, ejective feedback; and via (ii) “radio-mode”, relativistic jet-triggered feedback. I will show how contemporary cosmological simulations require feedback from SMBHs to “quench” galaxies (i.e., causing them to stop forming stars). Indeed, without strong feedback from SMBHs, contemporary galaxy formation models fail to get even the most basic properties of the galaxy population correct - such as the multi-epoch stellar mass function, and the star formation rate density evolution with cosmic time. I will go on to present observational evidence for these processes operating in nature over 13 Gyr of cosmic history, much as predicted from these cosmological models. I will end this review talk by discussing the new evidence (largely from JWST) for over-massive SMBHs in the very early Universe, which may require either primordial black holes to form during the Big Bang, or else for direct collapse prior to galaxy formation. This turns the conventional narrative of galaxy formation on its head –instead of SMBHs forming as the end point of stellar evolution (via mergers of the remnants of the first populations of stars), they may well be the fundamental trigger for galaxy formation to initiate in the first place. I will conclude by remarking on the astonishing impact of SMBHs on scales of up to ten orders of magnitude greater than their gravitational sphere of influence.

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