Contribution ID: **47** Type: **Oral (onsite)**

The evolutionary trend of high-z SMBHs in co-evolution with host galaxies regulated by super-Eddington accretion and outflows

Thursday 21 November 2024 11:40 (20 minutes)

The unprecedented sensitivity of the JWST has led to the discovery of numerous supermassive black holes (SMBHs) with high black hole (BH)-to-galaxy mass ratios. This elevated mass ratio is thought to arise from the massive nature of seed BHs, which are believed to dominate the host galaxy's mass at the time of their formation. However, as seed BHs undergo different growth trajectories, the evolution of this mass ratio can diverge, making it challenging to maintain the initial ratios. In this talk, we apply a BH growth model to the merger history of dark matter halos to explore the emergence and evolution of high BH-to-galaxy mass ratios, taking into account galactic gas feeding and BH accretion feedback.

In our model, we attribute the specifics of feeding and feedback to the power-law index in the inflow rate profile M_inflow\propto r^p, which defines how gas is fed to the BH in the presence of powerful outflows. Our findings show that overmassive seed BHs tend to grow slowly (albeit at accelerated rates) toward the local relation, while undermassive seed BHs grow rapidly (yet at decelerating rates) to converge with the local relation.

Additionally, we introduce a stellar mass-dependent model for outflow strength that reflects realistic feedback mechanisms. In this framework, the early growth of seed BHs is initially suppressed but becomes more active once host galaxies reach sufficient mass to counteract the feedback. These rapidly growing BHs can naturally evolve into the observed SMBHs, maintaining a high BH-to-galaxy mass ratio of approximately 0.1.

Our model also provides an analytical derivation of the BH-to-galaxy mass ratio at epochs following their seeding, as a function of the feedback strength parameter, p. We demonstrate that the final mass ratio depends on the threshold between positive and negative second-order derivatives. The observed high mass ratio SMBHs at high redshift suggest that moderate (or even weak) feedback played a role in the early universe when seed BHs were growing rapidly.

Presenter: HU, Haojie (Center for Computational science, University of Tsukuba)